Transport Justice in Sub-Saharan Africa
Challenges, tools, perspectives

Alphonse Nkurunziza
Aivinhenyo Imuentinyan
Karel Martens
Bishop George Ucizi Mughogho
Obiora Nnene
Mark Zuidgeest

EP-2020-MAC-04

This research was generously supported by:

Project partners:

Preface

This report is the final result of a cooperation between researchers from Rwanda, Malawi, South-Africa and Israel, funded by the Volvo Research and Educational Foundations' Mobility and Access in African Cities (MAC) Program, under project number EP-2020-MAC-04. Funded under Theme 6: Analytical Tools, the research seeks to determine to what extent and how transportation planning based on the principles of justice and its underlying analytical method can be applied in Sub-Saharan Africa.

Table of Contents

1. Introduction

Prevailing methods of transport planning focus on the functioning of transport systems, rather than on the services people receive from those systems. In line with this perspective, and as epitomized by the four-step model, road congestion has been seen as the main transport problem, and investments to ease congestion are given priority. This approach, still very dominant in the Global North, has de facto caused the gradual emergence of transport-related social exclusion, as it has ignored the mobility and accessibility difficulties by people with limited or no access to private motorized transport.

The adoption of Western-style decision-making practices in countries in Sub-Saharan Africa may have similar impacts. Like in the Global North, a focus on solving congestion in African cities may exacerbate rather than reduce mobility difficulties of low-income population groups, while also failing to 'solve' congestion. The former risk is substantial, especially in light of the existing high levels of spatial and social inequality in cities across the African continent. While these inequalities strongly shape disparities in mobility and accessibility within a population, transport is rarely considered through a justice lens, even though "access" to safe, reliable, and affordable transportation is essential for every person. It links people to jobs, health care, education, family and friends, and recreational and other social opportunities crucial for livelihoods and wellbeing.

Transport justice, a term coined by Karel Martens (2017), proposes a new perspective for transport planning which is based on principles of justice. Rather than focusing on the functioning of the transport system itself, it calls on transport planners to analyze what differently positioned people receive from the transport system as dependent on the transport modes available to different people. Yet, this people-centered approach has been developed within a Global North context, where the majority of adults has access to high-quality car-based mobility and accessibility, while a smaller but substantial share of the population is less well served by the existing transport system, without any reference to distinctly different contexts.

Against this background, the purpose of this report is to explore if and how people-centered transport planning can be relevant for the context of Sub-Saharan Africa, where a vast majority of the population currently has no or limited access to (private) motorized transport modes. The report is based on field work, interviews with decision-makers and professionals, and workshops in two case study contexts: Rwanda with a special focus on the capital city of Kigali; and Malawi with a special focus on Blantyre, Malawi's main economic center.

The report is structured as follows. Following this introduction, the transport justice approach to transport planning is further elaborated in Section 2. In Section 3, we focus on the existing practices of transport decision-making in two selected case study contexts. In Section 4, we turn to the professional heart of a justice approach to transport planning: the analysis and modeling of accessibility and potential mobility as experienced by different population groups in the case study cities. Drawing on these experiences, we present an open-source transport justice tool that could assist transport planners in Sub-Saharan Africa in analyzing the transport challenges and problems in their urban regions (Section 5). We end the report with a brief discussion on how transport justice could be promoted in the context of Sub-Saharan Africa and with recommendations for further research.

2. Transport justice

The notion of transport justice takes its inspiration from other major domains of government intervention, such as health care, education and housing.[1] Broadly conceived, each of these domains is concerned with the delivery of a particular good to citizens, much like the domain of transport. Yet, in contrast to transport, each of these domains is firmly based on principles of justice.[2] For instance, in many countries health care systems are based on the notion of solidarity, meaning that people ought to have equal access to a reasonable minimum range and standard of health care services irrespective of their ability to pay for these services.[3] Likewise, over hundred countries have enshrined a right to housing in their constitution and many have set up extensive policy frameworks encompassing housing supply and demand measures with the purpose of providing adequate housing for all citizens.[4] While in none of these domains there is complete agreement about what fairness exactly requires from governments, there tends to be broad support for the core justice principles, among decision-makers, politicians and citizens, across a very large share of the political spectrum.

Transport justice takes the policy domains of health care, education and housing as its model. It calls for transport planning, policies and investments to be guided by firm principles of justice. This implies a deviation from traditional ways of conducting transport planning and policy in at least three respects.

First, it implies a move away from a focus on mobility, understood as the ease of movement, to a focus on accessibility, understood as the ease with which people can reach a broad range of activities dispersed over space. While the call to move from mobility to accessibility is at least three decades old, this shift is particularly essential from the perspective of transport justice.[5] From a justice perspective, accessibility does not merely represent the essential "service" people receive from the transport system, as argued by many accessibility proponents.[6] Rather, it captures the even more fundamental notions of choice and freedom. Accessibility, understood as the range of activities and destinations people can reach within a reasonable budget of time, costs and efforts, represents the choices available to persons. The higher a person's accessibility level, the more destinations are available, the larger her freedom to choose from multiple options, and hence the broader the possibilities for the person to execute her agency and give direction to her life. Accessibility can thus be seen as a, perhaps rather technical, measure of freedom, with freedom understood in a positive rather than a negative way, i.e. defined as "freedom to" rather than "freedom from".[7]

[1] An extensive account on transport justice and its implications for transport planning and policy can be found in: Martens, K. (2017) Transport justice: designing fair transportation systems. Routledge.
[2] Jeekel, H. and K. Martens (2017) Equity in transport: Learning from the policy domains of housing, health care and education. European Transport Research Review, 9(53).
[3] Jonker, J.-J. (ed.) (2012) Countries compared on public performance: A study of public sector performance in 28 countries. Sociaal en Cultureel Planbureau, Den Haag.
[4] Oren, M., R. Alterman, and Y. Zilbershatz (2014) Housing rights in constitutional legislation: a conceptual classification. In: P. Kenna (ed.) (2014) Contemporary Housing Issues in a Globalized World. Ashgate, Farnham/Burlington.
[5] See, for instance, Cervero, R. (1997) Paradigm shift: from automobility to accessibility planning. Urban Futures, 22, p. 9-20.
[6] See, for instance, Levine, J., J. Grengs, and L.A. Merlin (2019) From mobility to accessibility: transforming urban and transportation planning. Cornell University Press, Ithaca and London.
[7] Berlin, I. (1969, original 1958) Two Concepts of Liberty. In: I. Berlin (1968) Four Essays on Liberty, pages 118-172.

Second, it implies a move away from a focus on the functioning of transport systems, in favor of a perspective that gives people center stage. Currently, concerns over the functioning of the transport system prevail in policy debates, as evidenced by the common concern over road congestion. Rather than focusing such symptoms, transport justice calls on transport planners to focus on people and ask the essential question whether all people are served adequately by the transport system, across all transport modes.

Third, it requires a radical break from the utilitarian perspective, which can be summarized by Bentham's adage "the greatest good for the greatest number".[8] The utilitarian principle of justice, which underlies the commonly used tool of cost-benefit analysis, is concerned with the *aggregate* benefits of transport interventions. As a result, interventions that negatively affect already poorly served people can be justified, as long as the overall benefits for other groups are higher than these losses. In contrast, transport justice gives center stage to each and every person. It proposes to replace utilitarianism with 'sufficientarianism'. More precisely, transport justice proposes that each and every person is entitled to a sufficient level of accessibility. Hence, government's prime duty in the domain is to guarantee sufficient accessibility for all.

Taken together, these three shifts lead to a **new definition of transport policy and planning as the field of governance that seeks to guarantee sufficient accessibility for all through the regulation, operation, maintenance, and improvement of the transport system**.

This new definition implies profound changes to the practice of transport planning. It would not only require transport planners to analyze the functioning of the transport system in an entirely different way, but also adopt a very different problem definition. It would redirect the focus away from congestion on the network, towards population groups experiencing an unfair level of accessibility. Furthermore, it would demand the adoption of different analytical tools, indicators, and appraisal techniques, ultimately resulting in infrastructure investments, service provision and transport policies quite different from what is currently observed in much of the world.

[8] Bentham, J. (2000, original 1789) An Introduction to the Principles of Morals and Legislation. Kitchener, Batoche Books.

3. Practices of transport decision-making in two African cities

In this section, we provide a brief description of current practices of transport decision-making in the two selected case study contexts: Kigali, Rwanda and from Blantyre, Malawi. The section is based on an analysis of policy documents and especially on in-depth semi-structured interviews with 7 informants from Rwanda and 4 from Malawi. In both cases, informants were selected from different professional backgrounds (transport engineers, transport planners, urban planners, …) and from different levels of government (city, region, national government). The interviews were conducted in the period October 2021 – January 2022. Most interviews were conducted online, in part because of the Covid-19 pandemic. Except for one interview with a professional from Malawi, all interviews were recorded with permission of the informant and subsequently transcribed. Table 1 provides an overview of the interviewed informants. In what follows, we rely on quotes from these interviews. To protect anonymity of the informants, we only use abbreviations to refer to individual informants (e.g., K1 or B2, as listed in the table).

Table 1 Overview of interviewed informants.

Informant	Job description	Professional background
Kigali, Rwanda		
K1	Acting Director of Infrastructure, City of Kigali	Civil Engineering, Transport Planning
K2	E-mobility Specialist, City of Kigali	Civil Engineering, Transport Planning
K3	Senior Manager Transport Planning & Industrial Development, RURA	Civil Engineering, Transport Planning
K4	Director General, RMF	Civil Engineering, Transport Engineering and Economics
K5	Director General for Transport, Mininfra	Civil Engineering
K6	Transport services and road asset management Division Manager, RTDA	Civil Engineering
K7	Director of Engineering and Urban Planning Standards Unit, RSB	Electro Mechanical Engineering
Blantyre, Malawi		
B1	Director of Roads, Ministry of Transport and Public Works	Civil Engineering
B2	Technical Auditor, Roads Fund Administration (RFA)	Civil Engineering
B3	Deputy Director of Planning, Blantyre City Council (BCC)	Architecture
B4	Planning Officer, Blantyre City Council (BCC)	Urban planning

3.1 Brief background on transport in Rwanda and Kigali

Kigali, the capital and largest city of Rwanda has seen rapid population and spatial growth for the last two and half decades, with inhabitants of approximately 1.5 million and an urbanization annual growth rate of 4%[9]. With a modal share of majority of trips being on foot or bike (52%) or by public transport mainly bus services (16%), but also motorcycle taxis (12%), and low to moderate levels of motorization (approximately 15 automobiles per 1,000 inhabitants), Kigali has adopted important actions to address urban mobility in the last decade[10]. For instance, the city has seen remarkable incremental public transport reforms (i.e. transition from paratransit to formalized public transport) ; the introduction of public transport automatic fare collection system that today transacts ~160 000 daily passenger trips; the procurement and gradual introduction of Higher Occupancy Vehicles; prioritized investment in the improvement of bus terminals; road widening program with the intention of introducing dedicated bus lanes in the highly congested parts of the city's road network; the improvement of pedestrian safety based on the systematic implementation of sidewalks and the

[9] Ministry of Infrastructure (2015) National Urbanization Policy 2015.

[10] City of Kigali (2019) Feasibility study and Preliminary design for a Bus Rapid Transit (BRT) system for City of Kigali: final report.

introduction of safe pedestrian crossings, all reflecting very positive incremental steps to adapt the city to the evolving mobility needs.

While Kigali has implemented many measures to address urban mobility issues since the 2013 public transport reform, and accompanied by well-articulated sustainable mobility strategies in the 2013 City Masterplan and in the recently updated 2019 City Master Plan[11], the steps required to ensure that future mobility challenges are met are still much bolder. The visible latent demand in the form of large numbers of pedestrians, motorcycle taxis and private car users, indicates that the current public transport system is far from optimal. Last mile connectivity options as part of an integrated public transport system is still lacking to address the mobility needs of the 45% of the population, mainly low-income earners disconnected from current bus network[12]. Moreover, current buses are run by private operators without government subsidy resulting to high fare for the low income from city periphery to afford, despite strong fare regulation mechanism in place, while other common forms of transport, both as last mile connectivity options, and supplement to bus networks such as motorcycle-taxis are even more expensive. These factors mean that the low-income resort to walking long distances to access urban basic services such as employment, education, health, shopping etc. This results to restricted potential opportunities that may be reached by the low income pedestrians and compromised purchasing power for the low income captive to public transport.

Furthermore, some of the future mobility challenges that are expected to accelerate include: increased average travel distances with urban expansion; increased car ownership and motorized trips; increased numbers of motorcycle-taxis. These factors mean that without drastic measures implemented now such as improved public transport services and the prioritization of non-motorized transport infrastructure, transport planning in Kigali may soon fall in the danger of focusing on the functioning of the transport network, with traffic congestion on the network typically seen as the most important transport problem to be solved. The network focus will lead to the loss of attention to the users of the transport network and instead escalate the existing transport-related social exclusion. Kigali needs to urgently plan and implement urban mobility measures, while ensuring universal access to affordable and adequate transport infrastructure and services, that could range from bus fare subsidies, new bus routes, bicycle lanes, pedestrian walkways and crossings, to land use developments in order to provide an inclusive and integrated transport system.

The City of Kigali department of infrastructure is mandated to plan, develop and manage transport infrastructure under the oversight of the Ministry of infrastructure. Road expansion based on anticipated motor vehicle increase has not been a common practice in transport planning in Kigali, until of recent when car congestion levels have started to intensify. Thus, investment decisions skewed towards private motor vehicle growth will further threaten the levels of accessibility to urban basic services for the urban poor.

3.2 Practices of transport decision-making in Rwanda and Kigali

3.2.1 Introduction

Both the national government of Rwanda and the City of Kigali have produced an impressive set of transport policy documents over the past ten years. This includes documents such as the updated Kigali Transport Master Plan 2050 and the Transport Sector Strategic Plan for the National Strategy

[11] Surbana Jurong Consultants Pte Ltd (2019) Kigali City Masterplan 2050: Masterplan update final report.
[12] Transitec (2019) Business Model for Public Transport Services in the City of Kigali.

for Transformation, published in 2018.[13] Both these plans dedicate substantial more attention to both sustainability and inclusion than their predecessors. For instance, one of the main goals of Kigali's Master Plan is "to become a public transport-orientated city", with public transport and non-motorized transport jointly accounting for 70% modal share and private vehicles for 30%.[14]

The interviewees all agree about the quality and direction of the policy documents. These plans, and the underlying change in perspective, have also delivered results, as suggested by a range of informants:

- "In the past, there has been (…) a decision to ban cyclists in the city. That came following another move that came in 2008 or 2009 to ban also motorcycles on urban roads. But because of this transport justice, those decisions were reversed but (…) roads were not designed to accommodate non-motorized modes of transport." (K7)
- "Today we [are promoting the] upcoming bike-sharing system which is going to start very soon. Of course, it is piloting and it will be running for around 5 kilometers of the road network and we have a lane on both sides of the road which will allow them to run for 10 kilometers and the city is trying to work a lot to try to provide the cycling lane." (K1)
- "For each and every street we are providing walkways and a bit raised walkways so that people walking on the street are a bit safe. They have a raised curb with a very smart walkway and at some stages, there are some greens between walkways and carriageway and that is currently happening and we keep working on it to have it and to have the people who are walking and cycling in order to have them as the majority." (K1)
- "We ensure that the transport service is accessible by many people and we do this by extending the routes. Because when we give licenses, we also decide which route each transporter will deliver the service from. Whenever there is a new settlement of people, we make sure that a new route in the new area is provided and that needs to be covered and needs access to public transport service (…). So, we make sure that we extend our routes or service networks to the new upcoming settlements or even those that are not served, we make sure that they are served." (K3)
- "We think in this case as RURA that transport justice is a kind of equal accessibility or equal right to the transport service. And that is what we do when we are extending the service to other areas including the rural areas. It is not only for people in cities or inner city who deserve transport but also people in the city periphery or villages or far away from city centers. That is why every year we have a target that new routes will be achieved to have that justice, that equality or equal rights to the service." (K3)
- "We are now encouraging the investors to make sure they buy buses that are accessible by all kinds of people including the disabled. Sometimes, there is infrastructure and facilities but in conditions that are not accessible by all. So we make sure that the buses that are going to be bought are also accessible by people with disabilities." (K3)

3.2.2 Barriers for moving to transport justice

At the same time, some of the informants argue that plans are not enough to move towards a fair and inclusive transport system: "When you go in the planning document, you will find an amazing work, but when it comes to implementation, transport justice is just a minor thing" (K2). Another informant confirms this: "having it [a shift from cars to sustainable transport] in the policy is easy, but implementation like putting in place infrastructure for pedestrians and cycling [and] the shift from

[13] Surbana Jurong Consultants Pte Ltd (2019) Kigali City Masterplan 2050: Masterplan update final report; Ministry of Infrastructure (2018) Draft Final Transport Sector Strategic Plan for the National Strategy for Transformation (NST1).

[14] Surbana Jurong Consultants Pte Ltd (2019) Kigali City Masterplan 2050: Masterplan update final report, page 3 and page 86 respectively.

private transport to mass transport (…) is challenging" (K5). The informants underscore two/three main barriers that hinder the promotion of transport justice in practice: mindset and related lack of knowledge, funding and resources, as well as institutional capacity, challenges that may explain the slow implementation progress.

Mindset and lack of knowledge – Probably the most important barrier to promoting transport justice in Kigali and Rwandan cities in general is the mindset among professionals, decision-makers and the general public. As summarized by the informant from RURA, among some part of the public, including senior decision-makers, there is the mindset that "if you have an expensive car, you should be given priority instead of giving it to public transport. So, it is an issue of mindset. You who is covered in your private car with no sunshine, no rain, you think you should be given priority more than the person standing on the road who has no other option of being transported" (K3). The informant continues paraphrasing this mindset of some part of the car-owning public as follows: "I actually pay a lot and even when I was buying this car, I paid a lot of taxes which was used to build this road. So how come you are considering this simple guys more than me?" (K3). Some share of the public may thus see giving priority to public transport as an injustice and so "you get this resistance [from] what I can call strong people, major tax-payers, [who] may find it difficult as you are hindering them, get them stuck in congestion while others are moving" (K3). Another informant points at the perceived connection between car use and economic development, summarizing the mindset among some as follows: "People would say that if I am running faster from one place to another with my car, they think they are boosting the economy" to which the informant adds "that is wrong" (K2). The informant from the Ministry of Infrastructure underscores "the challenge to change of mindset" as a prerequisite for changes on the ground: "the challenge [is] to show people different ways of doing things like shifting from private cars to mass transport. That is why I am saying having it in the policy is easy but implementation, like putting in place infrastructure for pedestrians and cycling, [requires addressing the] mindset of people, to get educated, so that they can shift from private transport to mass transport. This is where it is challenging" (K5).
Other informants also underscore that the current mindset is related to a lack of knowledge among professionals, decision-makers and the general public. The informants argue that each of these stakeholders can only promote transport justice if they understand the issue: "Because these are new things, people need to know this kind of evolution in transport" (K3). Another informant points at the unique governance structure in Rwanda, where "the citizens are the ones who choose what kind of activities to be done" (K1). The informant speaks positively about this practice. He also underscores that this means "that (…) training is needed for both citizens and leaders. Some people who are influencers (who are middle-income, and want to advocate for their needs such as their personal cars) should be trained as well" (K1). These informants thus suggest that a lack of understanding of what transport justice implies, shapes their perspective of the transport challenges in Rwanda and Kigali, and restricts the support for measures that promote transport justice.

Funding – Most of the informants agree that budgetary restrictions and priorities are a major barrier to promoting transport justice in Kigali. As one informant put it: "when you're trying to prioritize [a budget], transport justice will definitely not take the first place" (K6). Another informant points out that international funding institutions "are the very first to say you have to remove cycling tracks to optimize the limited budget" (K1) , so that more kilometers of road can be build. The consequence is that new infrastructure primarily accommodates people who have access to private vehicles, while providing little or no improvements for people who rely on walking or cycling. It also does little to improve public transport.

Funding priorities may also be shaped by new requirements, such as the requirement to conduct a traffic impact assessment, which is in line with procedures in most developed countries. Going this route, however, may prove to be unfavorable to those without access to cars, as traffic impact assessments typically direct the attention to cars and car users to the detriment of other modes and travelers. Some informants point out that budget priorities are closely related to mindset and lack of knowledge: dedicating funds and resources towards investments that enhance transport justice requires politicians and policy makers to understand the entire scope of the problem.

Lack of space versus priorities – A third barrier is mentioned by only one informant: lack of space. This informant points out that "due to the nature of the city, there are informal settlements and activities along the street that are not well organized. That means if streets are being upgraded, expropriation remains a challenge and with this, carriage way space for private motor vehicles is prioritized and then minimize walkways and cycle ways" (K1). The problem highlighted by this informant is directly related to the prevailing mindset, as it suggests a preference for additional space for motorized traffic rather than for non-motorized modes. Rather than framing it as a lack of space, the issue could also be framed as an issue of priorities. Rather than following the priorities set in the national and city plans, which propose to strengthen the share of sustainable transport modes, when forced to make a choice in actual road projects, preference tends to be given to motorized transport over facilities for walking and cycling.

Institutional structure – Interestingly enough, informants do not perceive the institutional structure as a barrier to enhance transport justice. Currently, there are six main organizations that are responsible for transport in Kigali.[15] The Kigali plan suggests that this may cause fragmentation of policy and responsibility, lengthy approval and processing periods, as well as bureaucratic red-tape. The plan thus suggests that "the strengthening of policies to institutional capacity" to "ensure effective transport policy implementation" is essential.[16] For this reason, the Kigali Plan proposes a realignment of the "institutional arrangement".[17] Yet, informants do not raise this as an issue in the interviews. Quite the contrary seems to be the case. In response to a question whether the institutional structure maybe a barrier to promote transport justice, one informant is very explicit: "No! As I said, the ministry has worked on the new national transport policy and it has catered for all elements to promote transport justice. The ministry is also leading the development of the Urban Street Design Manual. I can say that the ministry is doing a good job and the city does the planning and implementation. So, I can say the stakeholders can't be the barrier to these kind of things." (K1).

3.2.3 Overcoming barriers to transport justice

The informants point at various ways for overcoming the barriers mentioned above, so that transport investments and policies will be more effective in delivering transport justice in Rwanda and Kigali. The insights of the informants can be organized around three themes: good strategic plans, education and awareness, and international donors and funders.

Strategic plans – Even though some informants stated explicitly that it is easy to promote transport justice 'on paper' and much more difficult to get it done in practice, some of them still point at the importance of having plans that explicitly enshrine transport justice as a core element of transport

[15] See Surbana Jurong Consultants Pte Ltd (2019) Kigali City Masterplan 2050: Masterplan update final report, Table 5.5 on pages 27-28.
[16] See Surbana Jurong Consultants Pte Ltd (2019) Kigali City Masterplan 2050: Masterplan update final report, page 83.
[17] As previous footnote.

policy: “I can say transport justice understanding is not shared by everyone based on what is happening. But the good thing, it is embedded in the masterplan as the leading bible and if we push it, it will help to cater for that.” (K2). The informant continues explaining how the ideas in the plan may shape guidelines, which will then shape the transport infrastructure: “The ministry is working on Urban Street Design Manual and many stakeholders are coming in and bringing in more strength. The most important tool is the master plan as well.” (K2).

Education and awareness – The obvious response to a lack of knowledge about transport justice is education and awareness raising. Various informants point at the importance of doing so and the role thought leaders can play in bringing about change: “Because these are some of the new things, people need to know this kind of evolution in transport” (K3). Another informant adds: “I think the more you tell people, do awareness and people read it, slowly slowly things can change” (K2). The informant continues by reflecting on the activities of the interviewer, Alphonse Nkurunziza, during his time as the city engineer of Kigali. He sees this as an example of how change can come about: “For instance, when you [= Alphonse Nkurunziza] were here in the City of Kigali, you understand non-motorized transport. The little non-motorized transport [facilities] we have, we got it from you when you were the city engineer, which means if we have another decision maker who understands well social transport justice, things can change. That is really important. It can play a very significant role in transport justice understanding.” (K2)
Another informant points at the importance of universities and knowledge institutes in “advising [government] institutions” and their contribution to “the sensitization effort” which will assist in making sure that “people will have the same understanding slowly slowly” (K2). According to another informant, this should also include explaining people about the economic benefits of non-motorized transport: “By expanding the road, we are just promoting motorized vehicles and it won’t last. By catering for those other people who can’t drive this will promote the economy because as you improve their mobility you also contribute to economic development” (K5).

Role of international donors, funders and organizations – While some informants were critical about the role of international donors and funders, they also underscore the positive role these organizations can play. One informant is very explicit: “When [development partners] give the money, they put some conditions and you have seen that developing countries’ governments fear development partners. If they can say, we give you all these billions for road but 5% goes for NMT, that can also play a big role to wake up those decision makers in governments.” (K2). This claim seems at odds with the current role played by (some) international donors and funders, suggesting that also among them, there is a need for education and awareness raising.
Another informant points at the role that international (non-profit) organizations can play in shaping awareness: “For instance, ITDP and the Ministry of Infrastructure are developing the Rwanda Urban Street Design Manual more specifically focusing on the City of Kigali. If we are going to design a street, we will be referring to that manual and a designed street will be having all the requirements [for public transport and non-motorized transport]” (K1). While such guidelines may not lead to earmarked budgets for non-motorized transport, it may change the face of Kigali: “I can’t say there is a separate budget for non-motorized transport facilities but with that manual we will be having the complete street design. Streets to be built will have both combined elements such as the carriageway for the motor vehicles as well as non-motorized transport facilities within the overall budget” (K1).

3.2.4 Conclusion

Transport planning in Rwanda and Kigali is impressive, even by international standards. The country and city boast state-of-the-art plans with ambitious goals to enhance sustainable transport. This

includes a clear commitment to an inclusive transport system. informants underscore the importance of these plans for changing the discourse, but also point at the barriers to actually implement solutions that enhance transport justice. Several informants underscore that the key challenge is to change people's mindsets – whether they are decision-makers, professionals or the wider public. Currently, the discourse still seems to center on congestion reduction and improved economic benefits, rather than on delivering a transport system that serves all. At the same time, important steps have already been taken and seeds of change have been firmly planted. This suggests that Rwanda and Kigali might become the leaders in Sub-Saharan Africa, and even beyond, in developing an inclusive transport system. In order to succeed, "transport justice has to be on top", as one informant formulated it (K2).

3.3 Brief background on transport in Malawi and Blantyre

Road transport plays a major role in the provision of accessibility to opportunities in Malawi. Roads and streets cater for 99% of travel by people in Malawi[18]. Other categories of transport include civil aviation, marine, and rail, but currently these forms of transport do not provide accessibility to opportunities for most people in urban areas of Malawi including the city of Blantyre. Therefore, in the city of Blantyre, like other cities in Malawi, walking, (informal) public transport, private cars, and cycling are transport modes used. Public transport comprises of low volume capacity minibuses, and small engine five-seater vehicles. Bicycles and recently motorcycles taxis have started penetrating the market. There are several factors that compromise accessibility to opportunities in the city of Blantyre. The main factor being that most low-income residential areas of Blantyre that accommodate about 75% of the urban population, lack a street network because of the unplanned nature of the neighbourhoods. Where a street network is available, most of the network consists of unpaved public streets that are in deplorable condition. Over the years, the condition of paved road and street networks, even in planned areas, has substantially deteriorated but not to as bad a situation as is in low-income residential areas. Consequently, travel times to opportunities for low-income areas have increased not because of congestion but because of low speeds on the bad roads. Consequently, transport costs have increased to compensate for the inconvenience of travel and risk of operating on the compromised road network for the service providers.

Initiatives to improve accessibility to opportunities for low-income neighbourhoods in the city generally include the construction of new streets and the upgrading of the unpaved roads and streets. For transport networks servicing business districts and centres, expansion of road networks and construction of bypass networks remain popular solutions in dealing with congestion, and thus time delays, in the two major cities of Blantyre and Lilongwe. Thus planning, construction and maintenance of road networks is a common transport planning strategy for improving the accessibility to opportunities for motorised transport in Malawi.

High travel costs, long travel distances and temporality of public transport are three main issues exacerbating social and economic exclusion particularly for low-income earners in Blantyre. The situation for low income worsened following the enactment of the National Transport Policy (NTP) in 2004 that fully deregulated the market by among other things removing restrictions on entry to passenger transport sector and liberalising tariff setting. Public transport in Blantyre and all cities in Malawi consequently evolved from a government provided and price regulated service to a fully-fledged privately managed and operated industry. The market is flooded with low volume capacity minibuses, small engine five-seater vehicles and (motor)bicycles taxis, all charging exorbitantly for services provided. Service runs mostly throughout the day, up to at latest, late evenings. The National

[18] Cross-Border Road Traffic Agency (C-BRTA) (2018) Malawi Handbook.

Transport Master Plan estimates that 66% urban low-income earners resort to walking to reach opportunities including employment, shopping, family and friends, recreation, health, and education. In fact, the streets of Blantyre are characterised by mammoth movements of pedestrians in the morning and evenings. The aforementioned limits access to potential opportunities, especially for low earners who primarily rely on walking due to significantly compromised purchasing power to access public transport. Revitalisation of government provided high occupancy buses and provision of social infrastructure close to people are among the solutions to make public transport services affordable and improve accessibility in Blantyre.

The Ministry of Transport and Public Works through the Roads Authority Planning and Design Department is mandated to plan and manage transport infrastructure. Transport project investments are informed by the modelling outputs of the Highway Development and Management (HMD-4) software while the return on investment remains the principal investment criteria. Nevertheless, there is significant political influence in the final transport investment decisions. Road expansion based on anticipated increase in private car trips are a common element in transport planning in Malawi, thus threatening further the potential accessibility to opportunities for low earners and the carless through skewed investment decisions favouring automobile and incentivisation of private car growth. The Blantyre City Council is a highway authority that manages road infrastructure at local level with funding from central government and local traffic user fees. Other stakeholders involved in transport planning include the Ministry of Local Government, the Ministry of Lands and Urban Development, the Ministry of Finance, Economic Planning and Development, the Roads Fund Administration (RFA), and International Funding Organisations are main stakeholders.

The Malawi National Transport Master Plan, published in 2017, seeks to push the transport agenda forward.[19] The plan covers all transport sectors, including road, rail, and waterways. It addresses a range of challenges and opportunities, as well as a range of cross-cutting issues that need to be taken into account in transport policy and transport investments. This includes climate change, but also social inclusion. Regarding the latter, the Master Plan underscores "the need for enhanced social inclusion, including explicit consideration of its gender dimension, current limitations which are hindering access to basic services such as healthcare and education and in particular for vulnerable sectors of the population. It is essential that collective and targeted measures are adopted to meet the needs of diverse social groups."[20] A substantial share of the Master Plan discusses ambitions and strategies to reduce the transport costs for passenger transport, while another part focuses on strategies for improving accessibility and mobility. The latter build on the former. Strategies include "foster[ing] public transport modes" and "improvement and promotion of more environmentally sustainable modes of transport, including mass transit". The actions proposed in the Master Plan "have been considered in the context of impacts on social dimensions including gender, income, mobility and age. They collectively meet the needs of diverse social groups, and infrastructural."[21] One of the "enabling actions" proposed in the Master Plan is to "establish baseline data and monitoring system for social inclusion".[22] The plan also proposes a new structure for the Ministry of Transport and Public Works, with a proposal to establish a division responsible for "safety, security and social inclusion". Among other tasks, this new division would be responsible for "gender issues and rural

[19] Ministry of Transport and Public Works (2017) Malawi National Transport Master Plan. Final Report. Atkins/World Bank Group/Ernst&Young
[20] Ministry of Transport and Public Works (2017) Malawi National Transport Master Plan, p. XV.
[21] Ministry of Transport and Public Works (2017) Malawi National Transport Master Plan, p. 71-72.
[22] Ministry of Transport and Public Works (2017) Malawi National Transport Master Plan, p. 274.

accessibility".[23] Moreover, "institutional and regulatory measures are proposed to design these considerations into the transport sector planning and operation in the long-term."[24] The Master Plan thus pushes transport policy towards a more people-centered approach, even though it also contains more conventional perspectives, components and proposed interventions.

3.4 Practices of transport decision-making in Malawi and Blantyre

The advanced language of the Malawi National Transport Master Plan hardly seems to resonate in the interviews with the Malawian informants. Indeed, the interviews have resulted in one key finding: in Malawi and Blantyre, the transport discourse is more firmly rooted in the traditional perspective on transport planning than in Rwanda and Kigali. Most informants underscore that congestion in the central business district of Blantyre and neighboring city Limbe is currently the main issue to be addressed. A Planning Officer of the Blantyre City Council states explicitly that the "main principal consideration for this year has been decongestion" (B4). This focus on congestion both comes from within the city and from the central government. For instance, the idea from central government was to build a ring road to ease congestion in Blantyre (B4). Also the Deputy Director of Planning of Blantyre City Council (BCC) underscores the role of the ministry in shaping the city's transport agenda: "Whilst we were getting funding from the ministry, the previous government could say yes, you have got funding from road fund administration yes, but maybe you could find a certain resource envelop, that could be specially for by-passes". In response, the city adopted this idea. Yet, the city decided to focus on "minor by-passes" as these were deemed effectively to "ease transport movement especially in the central business areas". Hence, the city "came up with what we call the small by-passes project within our city centres" (B3). Beyond small by-passes, the central government also concluded that it would not be possible to build paved roads throughout all cities in the country. Instead, the government decided to "improve our cities" by upgrading "existing roads that are single lane and (…) to dualize them", including the improvement of junctions (B3). The Director of Roads at the Ministry of Transport and Public Works confirms the focus on congestion at the national level: "Even in urban areas what matters most are traffic counts and connectivity. The focus is mainly on decongesting our roads" (B1). The Deputy Director of Planning, Blantyre City Council (BCC) expresses concerns about this approach: "[W]hen considering and designing roads there is limited attention for the variety of users that may use the road. While professionals and decision-makers in Malawi are discussing whether it is possible to move "out of single lane to double lane", they tend to so without understanding that if that has to work, we need to accommodate more road users equally" (B3).

The development of ring roads is certainly not seen as a panacea by all. First, not everyone is convinced that ring roads will solve congestion. In reflecting on the Mpemba-Chigumula ring road, one interviewee states that "it was an idea from central government with an idea to ease congestion" while "some of us did not see the justification and we were very opposed to the idea that you can reduce traffic in Blantyre CBD by the creating of a ring road" (B4). Second, roads do not necessarily serve all: "pedestrians and cyclists for example are forced to use road shoulders. Unfortunately, all road users compete for the main carriage way when road shoulders are eroded hence putting non-motorized transport users at risk" (B1).

At the same time, road projects may also have side benefits. The Director of Roads at the Ministry of Transport and Public Works reflects that "[t]here have been instances where residential locations have benefited, regarding accessibility, through a road project whose main objective was not necessarily to

[23] Ministry of Transport and Public Works (2017) Malawi National Transport Master Plan, p. 205.
[24] Ministry of Transport and Public Works (2017) Malawi National Transport Master Plan, p. 72.

improve the accessibility of residents but to provide alternative routes for traffic in times of congestion. (B1). He gives as an example the Area 36-Mwenikondo-Falls Road in Lilongwe.

The decision-making process on transport projects is shaped by both the national and the local level. While the local level has a substantial say, "the central government comes to Blantyre city council with the rules saying, we are giving you this money, and we want this money to be used in this way" (B3). The national government provides the budgets and thus sets the ceiling, yet "at council level (…) local councillors have to agree on their own which roads have to fund (…) for them to decide what roads to do it is entirely the council's business" (B2). At the same time, the Roads Fund Administration does check whether funds are spread within cities, to avoid that improvements only flow to one or a few wards within the city.

Given limited budgets, originally Blantyre City Council was mostly focused on doing as many kilometers as possible, as captured by the thinking: "instead of just doing 5 kilometers [of proper roads with all required furniture and provisions], let's do the carriage way, forget about these others [e.g., provision for pedestrians]" (B3). Moreover, at the local level there was a need to balance the wishes of the 23 political wards within Blantyre. This approach generated problems, with some projects even turning out to be a "disaster today because of the approach that was taken" (B3). More recently, the city council has taken a more systematic approach to prioritize road improvements. In prioritizing roads, "the demographics matter, (…) the size of an area, the density of an area, and the number of people that stay in an area" (B3). Yet, according to this informant, "we still have not reached the point where all road users are considered favourably" (B3). The Director of Roads at the Ministry of Transport and Public Works sketches a different perspective on the information used in prioritizing roads investments: "So far what matters most in prioritisation of projects are traffic counts (the world bank has an accessibility index that the ministry also uses sometimes), economic analyses justifications and, for main roads it is mostly connectivity between or among trading centers. Rarely are other road users considered" (B1). The Planning Officer of Blantyre City Council points out that even if a feasibility study is done, it is done for particular projects. Once the project is already defined, the main purpose of the study is "to identify negative effects and how to minimise them" (B4). According to this informant, it would be better to conduct analyses for many roads and then set priorities based on a broad overview.

As the above suggests, transport justice is not firmly on the policy agenda in Malawi. For the Roads Authority, the challenge seems to lie primarily at the local level: "The distribution of road projects in cities is done at council level, involving all councilors. The Roads Authority and ministry adopt the priorities as agreed at council level. There is nothing that the ministry can do if transport justice is ignored at council level since the ministry has no mandate to question city council decisions unless those decisions do not speak to national policies and strategies" (B1). Yet, this informant does see a potential role for the national level: "The fact that inclusivity is becoming an element in national frameworks may facilitate the ministry's influence where inclusivity has been forsaken" (B1). From the local perspective, transport justice has been addressed to some extent in the previous funding cycle. During this period, "[a]ll the roads have been done mainly in unplanned areas" (B4). This has been in part in response to pressure from constituents, as the majority lives in these unplanned settlements. This strong emphasis on unplanned areas has come at the expense of roads in planned areas, according to some. So, in the current funding cycle, the main objective "is to decongest the highway" (B4). Reflecting on this, the Deputy Director of Planning of Blantyre City Council (BCC) states that "we still have a long way to go for it [i.e., transport justice] to be fully embraced" (B3), especially looking at all the dynamics coming into play.

What also emerges from the interviews, is that the term transport justice is interpreted in different ways by the interviewed informants. In some cases, it was understood primarily as a matter of distributing transport investments and projects over different cities, neighborhoods or constituents. Other informants, such as the interviewed planning officer from Blantyre City Council, expressed a perspective more in line with the core idea that the transport system should serve all well. Referring to the general notion of justice, he states that "we have used that concept [= justice] in other sectors but not [in] transport. For example, in education they have used something like that – the distance to the nearest school. And even in health they are using something of that sort – the distance to the nearest health facility but I can't remember the minimum and maximum. For schools there is a maximum distance allowable for a kid to walk to school. [It is] 2.5 km, I think. (…) For (…) other services its working, but I wouldn't know if it would work in transport planning" (B4).

3.5 Data, models and tools

The importance of adequate data, models and tools to support transport decision-making was raised by most informants in both Rwanda and Malawi and was also an important topic of discussion during the two transport justice workshops in Kigali and Blantyre. Moreover, there was broad agreement that new tools and models would be necessary to conduct analyses that support of a transport justice approach to transport planning. This especially emerged in the two workshops, while at the same time data availability was identified as a bottleneck for conducting the type of accessibility analyses that are at the heart of transport planning based on principles of justice. Hence, in the next chapter we will explore whether the data sets that are (publicly) available in the two case study settings allow an analysis of accessibility sufficiency as proposed by Martens (2017).

4. Modeling transport justice

4.1 Introduction

To assess the fairness of a transport-land use system Martens (2017)[25] proposes an analytical method to identify population groups that suffer most from the unfairness embedded in their systems and subsequently the identification of causes and solutions to address the accessibility problems. This analytical method is implemented in the open-source transport justice tool presented in the next chapter.

Three key components of the analytical method are: 1) accessibility (to opportunities), 2) potential mobility (of a population group), and 3) an indicator of the fairness of the transport-land use system. These components are discussed individually before presenting the functionality of the tool.

4.2 Analytical components of transport justice

First, accessibility relates to the potential of opportunities for interaction. This is a function of the spatial distribution of activities *X* across locations *j* in a region *r*, the generalized costs of travelling by *m* on the transport system between locations *i* and *j*, and by the person's ability to overcome the spatial separation between *i* and *j*.

We are assuming that the locations *i*, even though spatial in nature, represent locations where population groups live. As in demand modelling we are assuming homogeneity at the level of the locations *i*. These locations are typically, but not necessarily, traffic analysis zones (TAZ).

Several types of accessibility indicators have been described in literature. Three of them were selected for this tool as:

a) they account for the effect of both the transportation network and spatial distribution of opportunities.
b) they do not require the derivation of additional theoretical constructs like a utility function and therefore the operationalization tasks of the study are simplified.
c) they do not merely focus on accessibility to specific facilities such as hospitals or fire stations but are generally applicable.

All three measures have the following general shape:

$$A_{i,m,p,r,s} = \sum_{j \in r}^{J} X_{j,p,s} \times f(t_{ij,m}) \quad \forall i \in r, m, p, s \qquad (1)$$

where:

- *i* is the origin location (out of *I* possible origin locations in region *r*).
- *m* is the mode of transport (walking, cycling, car, bus etc.).
- *p* is the activity type (working, school, leisure etc.).
- *s* is the socio-economic status of persons in *i*.
- *j* is the destination location (out of *J* possible destination locations in region *r*).
- $A_{i,m,p,r,s}$ is the zone *i* accessibility level for people of socio-economic status *s*, travelling by mode *m* for activities of type *p* [-].

[25] An extensive account on modelling transport justice can be found in Chapter 8 of: Martens, K. (2017) Transport justice: designing fair transportation systems. Routledge.

- $t_{ij,m}$ is the generalized cost of travel (travel time, travel cost etc.) in minutes between zone *i* and *j* on mode *m* [h].
- $X_{j,p,s}$ is the number of opportunities of type *p* in zone *j* for socio-economic status *s*.

The first variant is the inverse power gravity function:

$$A^1_{i,m,p,r,s} = \sum_{j \in r}^{J} X_{j,p,s} \times t_{ij,m}^{-\alpha_{m,p}} \quad \forall i \in r, m, p, s \qquad (2)$$

where:

- $\alpha_{m,p}$ is the travel impedance parameter, which is calibrated, and could be a function of mode *m* and activity type *p*

This means that if *α=1* the size of a possible interaction between locations *i* and *j* is inversely proportional to the travel time between them on mode *m*. I.e., if it takes longer to travel between *i* and *j* the potential for attending $X_{j,p}$ activities reduces.

The second variant to equation 1) is the exponential gravity accessibility measure:

$$A^2_{i,m,p,r,s} = \sum_{j \in r}^{J} X_{j,p,s} \times \exp(-\beta_{m,p} \times t_{ij,m}) \quad \forall i \in r, m, p, s \qquad (3)$$

where:

- $\beta_{m,p}$ is the travel impedance parameter, which is calibrated, and could be a function of mode *m* and activity type *p*.

This measure thus discounts travel impedance exponentially and is thus more sensitive to the level of $t_{ij,m}$ than in the inverse model.

Finally, a third variant is the cumulative accessibility measure, also known as the isochrone measure:

$$A^3_{i,m,p,r,s} = \sum_{j \in (r \cap t_{ij,m} \leq \gamma_p)}^{J} X_{j,p,s} \quad \forall i \in r, m, p, s \qquad (4)$$

where:

- γ_p is the generalized cost (travel time) threshold for activity type *p* in minutes.

Here, all activities of type *p* reachable under γ_p minutes will be counted (in full). Equation 4) can also be combined with one of the discount measures of equations 2) or 3).

The parameter estimates for $\alpha_{m,p}$, $\beta_{m,p}$ and γ_p can be calibrated as discussed in the next section.

4.3 **Impedance Function and Parameter Calibration**

A key component of gravity-type accessibility measure is the impedance function that describes the effect of spatial separation between origin and destination based on a defined travel cost attribute (distance, time or generalised cost). In essence, the impedance function weights the opportunities at destinations relative to the travel origin, based on the travel cost. It must be emphasized that perception and valuation of travel cost whether in terms of distance, time, or generalised cost, is very subjective and can vary from location to location, across activity types and across person groups. The impedance function is traditionally referred to as the distance-decay function based on the early models which considered spatial separation only in terms of distance. Recent studies have also defined

spatial separation in terms of travel time and generalised cost of travel[26]. Commonly utilised decay functions are the Exponential, Power, Tanner and Box-Cox functions, with parameters requiring calibration. The calibration is usually based on empirical data, say, trip length distributions for various travel modes and activity types in the location of interest. However, due to the rigors and challenges associated with detailed data collection and function calibration, it is common practice to assume a particular type of function and parameters from existing studies, ideally from locations or regions with similar characteristics to the location of interest.

The impedance function applied for the two case studies is the exponential function as described in the accessibility formulation (equation 3), with travel cost defined in terms of travel time. The parameter values for travel by car was based on judgement from similar investigation for Cape Town, South Africa. The value defined for car was further adjusted for NMT, to reflect a difference in travel time sensitivity for travel by car and NMT. The exponential-decay curves for the modes are presented below.

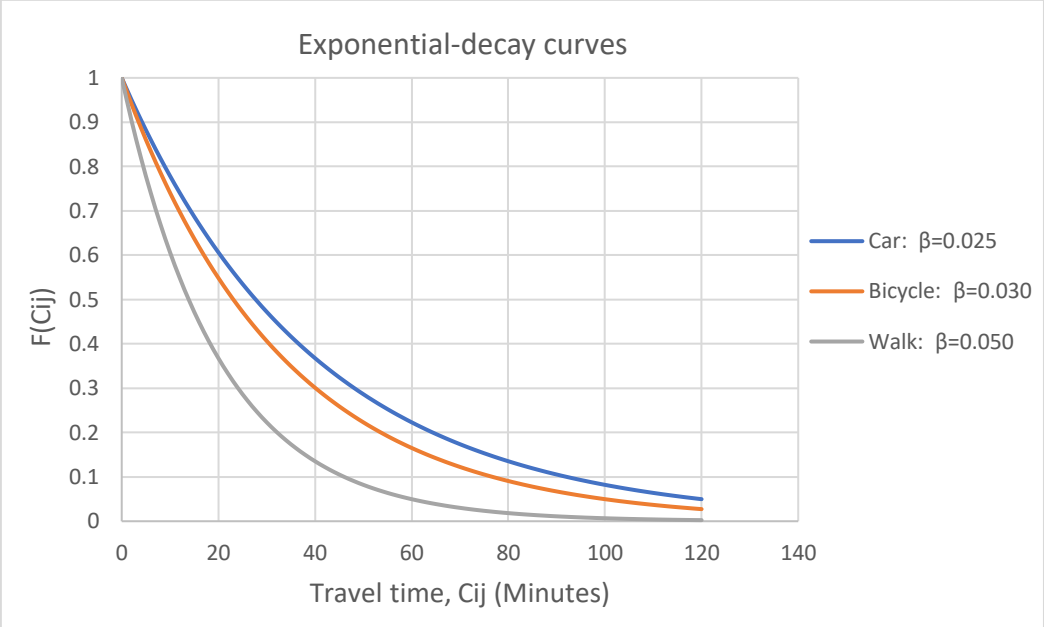


Figure 1: Exponential decay curves for accessibility computation

Next to the series of accessibility measures a potential mobility indicator ($M_{i,m,r,s}$) is used to quantify the contribution of the transport system to the potential mobility of a population group. This is a function of the both the speed of moving in mode *m* as well as the network structure for mode *m*. The potential mobility is defined in Martens (2017) as the quotient of the Euclidean distance and the travel time on the transport network between the origin and destination pair *ij*. The potential mobility indicator can be calculated for each origin *i* (and sub-group *s* and/or mode *m*) by taking the average of the $M_{i,m,r,s}$ values for all relevant destinations *j* on a network:

$$M_{i,m,r,s} = \frac{1}{J}\sum_{j \in r}^{J} \frac{d_{ij}}{t_{ij,m}} \quad \forall i \in r, m, s \tag{5}$$

[26] Typical example is the work of Martinez and Viegas (2013), a new approach to modelling distance-decay functions for accessibility assessment in transport studies.

where:

- $M_{i,m,r,s}$ is the average aerial speed [km/h] for people of socio-economic status *s* and mode *m* for zone *i* in region *r.*
- d_{ij} is aerial distance [km] between zone *i* and zone *j.*
- $t_{ij,m}$ is travel time [h] on the transport network between zone *i* and zone *j* by mode *m.*
- *J* is the number of zones in region *r*.

The main advantage of the potential mobility measure is that it captures the impact of both the structure of the transport network and the speed on the links in the network. Network inefficiencies are thus revealed by the measure. This makes it particularly suited to determining the contribution of the transportation system to accessibility. The measure is considered to be independent of the activity type *p*.

Finally, the level of sufficient accessibility is defined as the level of accessibility below which a person of population group cannot sufficiently engage in out of home activities (of type *p* in region *r*). Defining this level is an exercise itself. In Martens (2017) this level is defined as a function of the average car-based accessibility (in region *r*), or:

$$T^{M}_{\sigma,p,r,s} = \sigma \times \frac{1}{J} \sum_{j \in r}^{J} A_{j,M,p,r,s} \quad \forall p, \sigma, r, s \tag{6}$$

where:

- $T^{M}_{\sigma,p,r,s}$ is the accessibility sufficiency threshold at level σ [%] for people of soci-economic status *s*, activity type *p* in region *r* relative to reference mode *M* (typically the car).

The domain of insufficiency can now be identified as made up by those location, mode, activity type combinations *i,m,p,s* in region *r* for whom:

$$A^{\text{insufficient}}_{i*,m*,p*,r,s} \leq T^{M}_{\sigma,p,r,s} \quad \forall i, m, p, r, s \tag{7}$$

where:

- $A^{\text{insufficient}}_{i*,m*,p*,r}$ are the locations for which the modal accessibility is below $T^{M}_{\sigma,p,r,s}$ in region *r.*

The domain of sufficiency is then obviously the reverse of this.

4.4 The transport justice quadrant system

A key feature of the proposed analytical method is a quadrant system that summarizes population groups' current, modelled, levels of so-called potential mobility and potential accessibility juxtaposed on a set of axes, see *Figure 1*. Both axes represent a continuum from a low to high level and creates a coordinate system in which population groups can be positioned. The axes intersect in the middle, which is the intersection between mean potential mobility and mean accessibility. This simple coordinate system enables the placement of population groups (depicted as dots in the diagram) on both axes, based on the measurement of a group's potential mobility and accessibility. It also enables the introduction of a sufficiency threshold of accessibility (the dashed lines), which is positioned below the origin of the coordinate system for population groups that are in the lower half of the coordinate system. When a population's potential mobility and accessibility levels fall in quadrant one (bottom-left) the coordinate system, the group experiences insufficient accessibility and mobility. And it is thus a group that is entitled to accessibility improvements first because its accessibility shortfalls are caused by insufficient supply of transportation service and/or infrastructure. Groups that fall in the second quadrant experience insufficient mobility and sufficient accessibility, groups that fall in the third

quadrant experience sufficient mobility and accessibility, while the groups which fall in the fourth quadrant experience insufficient accessibility and sufficient mobility.

The notion of potential mobility is depicted on the horizontal axis (and could be normalized) and relates to how the transport system contributes to people's potential to move around. The vertical axis depicts the accessibility indicator that measures the opportunities a population group can reach within a reasonable time and budget, considering the spatial structure of the city, its transport network, the location of each population group and the mobility options at their disposal. Lastly the accessibility-sufficiency threshold is a minimum level of accessibility required, as represented for three levels by the dashed lines in *Figure 2*, which allows the identification of population groups that experience accessibility shortfalls and the level of severity thereof. In the 'domain of insufficiency', interventions are required that aim to uplift these population groups to above the sufficiency threshold. Such measures include higher fare subsidies, new public transport routes, bicycle lanes and land use developments.

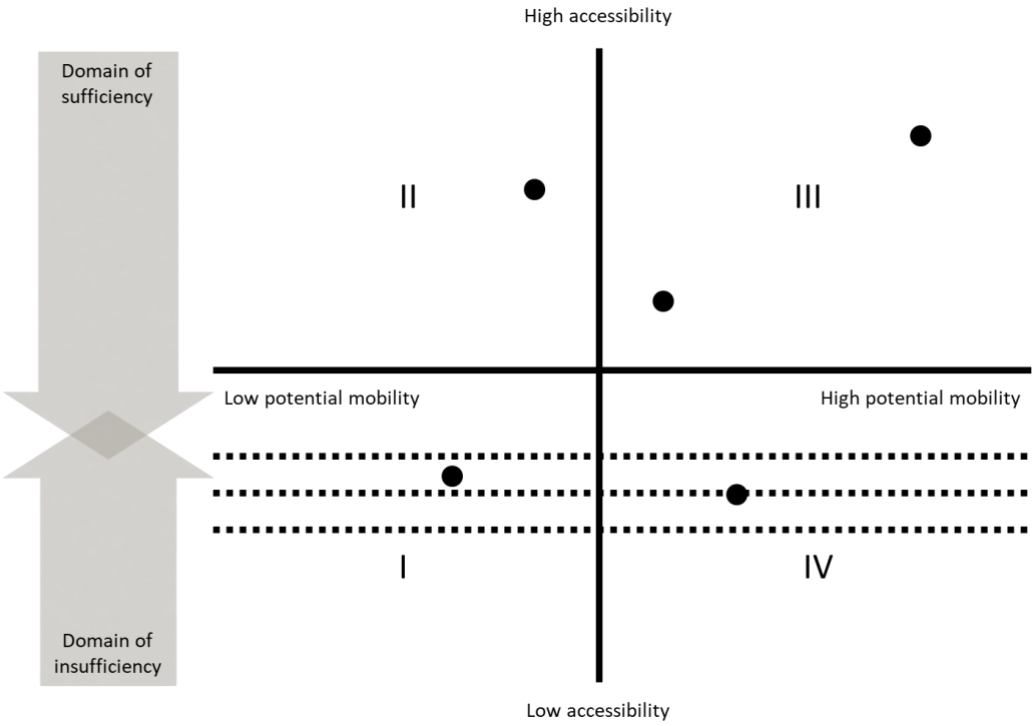


Figure 2: The transport justice quadrant (based on Martens, 2017)

4.5 Accessibility Sufficiency Index

It is not always possible to address accessibility shortfalls for all the population groups because of budget limitations. Hence it is necessary to identify which population groups experiencing shortfalls should be prioritized. To establish fairness, the accessibility sufficiency index (ASI) is used to determine the prevalence and intensity of accessibility shortfalls amongst population groups. The index is based on a poverty measure index developed by Foster, Greer, and Thorbecke (1984 as cited in Martens 2017, p 160).

The aim of this step is to calculate the Accessibility Sufficiency Index (ASI_r) of the region that represents the fairness of the city's transportation system using Equation 8). This step also allows planners to identify population groups that contribute the most to this index and consequently may be more deserving of improvements for accessibility. The index considers the size of the population groups,

the exact accessibility level experienced by the groups, and the share of groups experiencing accessibility shortfalls.

Sufficiency thresholds σ are defined as a percentage of the average accessibility level of the area/region/city. A range of sufficiency thresholds of 10%, 30%, and 50% of say the average car-based accessibility can be chosen/assumed for this study. However, the 30% and 50% sufficiency thresholds were used in this work.

$$ASI_{r,p,s} = \frac{1}{N}\sum_{i*}^{I*} n_i \left(\sum_{m}^{M} \left(\frac{T^{M}_{\sigma,p,r,s} - A^{\text{insufficient}}_{i*,m*,p*,r,s}}{T^{M}_{\sigma,p,r,s}} \right) \right)^2 \quad \forall r,p,s \qquad (8)$$

where:

- $ASI_{r,p,s}$ is the accessibility fairness index for region *r*, socio-economic group *s* and activity type *p.*
- *N* represents the total population in region *r*.
- *I** is the number of groups in region *r* experiencing accessibility levels below the sufficiency threshold $T^{M}_{\sigma,p}$.
- n_i the size of the *i*-th group in number of persons (or population of zone *i*, assuming homogeneity).
- $A^{\text{insufficient}}_{i*,m*,p*,r,s}$ is the accessibility level experienced by the *i**-th group below the sufficiency threshold $T^{M}_{\sigma,p,r,s}$.

The score on the ASI_r denotes the *severity of the accessibility deficiency* in a region *r*. The score of a region on the ASI_r measure is dependent on three components:

1. the position of the accessibility sufficiency threshold.
2. the share of the population that falls below the sufficiency threshold; and
3. the exact level of accessibility experienced by persons below the threshold.

The lower a group is below the accessibility threshold; the more accessibility shortfalls are experienced and the larger the weight it contributes to the overall measurement of accessibility. The index ranges between 0-1, the closer to one it is the more severe the population group is experiencing accessibility shortfalls. Although accessibility is multi-faceted, it does not mean ASI should not strongly aid decision-makers in the process of making a project priority list (Martens, 2017).

Singer et al. (2022) also introduced the indicator for the contribution to ASI (ASICON) for a population sub-group *i* (or location *i*) for activity type *p* in region *r*. This means that the contribution of a population subgroup to overall ASI_r in a region *r* can be expressed as a percentage ($ASICON_{i,r,p}$) as follows:

$$ASICON_{i,r,p,s} = \left(\frac{n_i}{N}\right) \times \left(\frac{\left(\left(T^{M}_{\sigma,p,r,s} - A^{\text{insufficient}}_{i*,m*,p*,r,s} \right) / T^{M}_{\sigma,p,r,s} \right)}{AFI_{r,p,s}} \right) \quad \forall r,i,p,s \qquad (9)$$

where:

- $ASICON_{i,r,p,s}$ is the contribution to $ASI_{r,p,s}$ for population sub-group *s* (and/or location *i*) for activity type *p* in region *r*.

4.6 Data

For the model, first a map for the region of interest *r* is required, with spatially disaggregated numbers of opportunities $X_{j \in r,p}$ of activity type *p* per spatial unit *j* (a raster cell, an enumeration area, a traffic analysis zone etc). These opportunities will then be represented in the zonal centroid, which will be attached to a multi-mode (*m*) street network model for the area *r*. The street network accommodates trips by model *m* for activity type *p* between the spatial units (from *i* to *j*). Public transport modes are modelled on routes, using shortest path travel times and/or costs to travel between *i* and *j*. Parameters for discounting opportunities over travel time can be calibrated from observations or taken from literature.

Further details on these data elements are presented here, while the sources and other contextual information and challenges about the data are discussed in the section on case studies.

4.6.1 Zonal data or zonal centroids

The study uses some level of disaggregated spatial data. Traffic analysis zones (TAZ) are the unit of geographically bounded regions for traffic analysis, including the generation or attraction of traffic. A TAZ may vary in size based on population size and socio-economic characteristics. We assume that these socio-economic conditions are at least homogenous within the zone. The spatial extent of zones also varies, ranging from very large areas lying outside a city's suburbs to as small as city blocks or buildings in central business districts. In this work, the centroid of the TAZs serve as the origins and destinations at a zonal level. The main features of the data are their unique name or identifier and their geographic coordinates. The data may be supplied by transport planning authorities.

4.6.2 Demographic and socioeconomic data

The population (n_i) and opportunity data (X_j) of an area by zones and socioeconomic are key data inputs in the work. The data specifies the levels and distribution of economic activities by zone, within a geographical area. Socioeconomic data are important factors in understanding the distribution of opportunities, hence the levels of accessibility in a study area. In this work population census and employment statistics are required at the zonal level. They will facilitate the measurement of transport justice indicators that are crucial to the work.

4.6.3 OpenStreetMap (OSM) street network

The street network normally consists of nodes and links. Nodes are ingress and egress points on the network while links are the infrastructure alignment that connect the nodes. Mobility and accessibility will not exist outside the context of transport networks as the latter facilitates our ability to get to identified activities and opportunities. The network data input used in this work are obtained from the OpenStreetMap (OSM) platform.[27] OpenStreetMap is an open-source mapping tool that is built by a community of mappers who contribute and maintain data about transport infrastructure and activity locations distributed around a geographical area. The data is easily accessible on the internet, with no proprietary requirement, which is advantageous with regards to the objective of this work. Where available the data includes specifications about the modes allowed to use the segments. The existing road alignments are extracted from *Openstreetmaps* in vector and digitized format, known as a Protocolbuffer Binary Format (*.pbf*) which is compact and not editable, thereby, retaining the integrity of the data.

[27] https://openstreetmap.org/

4.6.4 Transit schedule data

Transit network and operational schedule data are organised in a format known as General transit feed specification (*GTFS*).[28] This is a standard format that public transportation agencies around the world use to share information with the public regarding their services. The data format is a set of text files with comma-separated values that represent different fields including *agency*, *routes*, *stops*, *trips*, *stop times*, *calendar*, and *calendar dates*. The individual text files are then, compressed into a .zip file called a feed. To use the feed in this work, it is first parsed or analysed to reveal its components. The feed will then be used to calculate transport indicators such a as distance and travel time matrices for the various origin-destination (O-D) pairs operated by public transport services.

[28] Wong, J., 2013. Leveraging the general transit feed specification for efficient transit analysis. *Transportation research record*, 2338(1), pp.11-19.

5. An open-source transport justice approach for Africa

5.1 Introduction

This chapter summarizes the development of the transport justice approach based on the indicators previously described in Chapter 4. Two workflows are proposed based on the availability of data and the nature of analysis to be carried out. Both approaches comprise a two-step process involving the calculation of multimodal travel time and distance matrices in addition to estimating key indicator values for the study area. Initially, distance and travel time matrices are calculated for the different available travel modes in a study area. The matrices are then used to calculate indicators like the $M_{i,m,r,s}$ (equation 5) and $ASI_{r,p,s}$ (equation 8) among others that will measure the mobility and accessibility levels of local population groups in region *r* in the study area. However, there are differences in how both tools are implemented and operationalized. The details of both approaches are described as follows. See flow chart in the Figure 2.

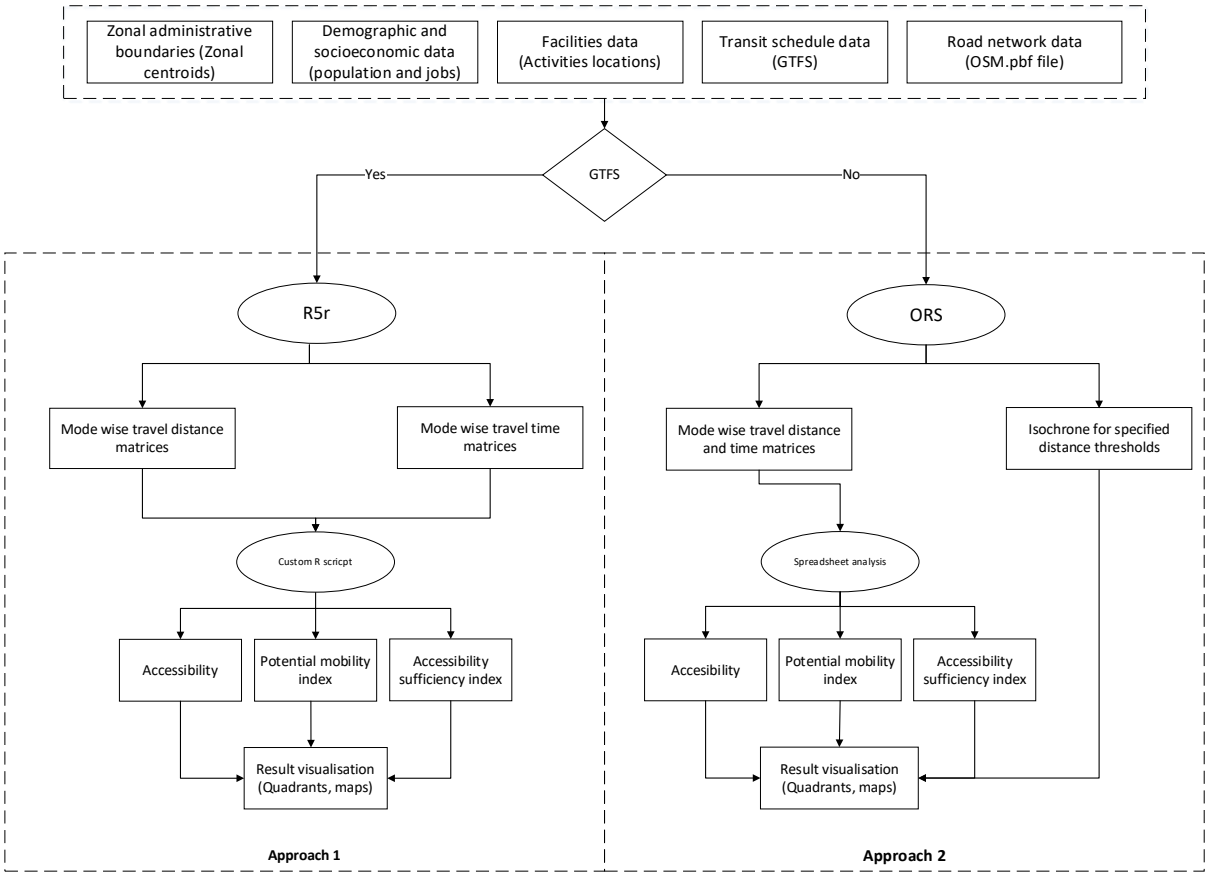


Fig 2: Flowchart for the transport justice tool

5.2 Approach 1

The tool used for the first approach is known as *r5r*.[29] This is a package in the R-statistical programming environment developed for the purpose of routing on multimodal transport networks that include modes like walk, bike, public transport, and private cars. The package allows for the generation of

[29] Pereira, R. H. M., Saraiva, M., Herszenhut, D., Braga, C. K. V., & Conway, M. W. (2021). r5r: Rapid Realistic Routing on Multimodal Transport Networks with R5 in R. Findings, 21262. https://doi.org/10.32866/001c.21262

detailed routing analysis or calculation of travel time matrices using seamless parallel computing techniques. *r5r* first builds the multimodal transport network used for routing. Travel times are then computed between O-D pairs on the network based on available *GTFS* data. The latter makes *r5r* more suited for cases where formal public transport schedule information is available. Other input variables in the *r5r* tool are the *maximum walking distance*, in meters, and the *maximum allowed trip duration* for each trip in minutes. The resulting distance and mode wise travel time matrices are then generated. In the second step of the model, custom scripts are written in *R* to compute the $M_{i,m,r,s}$, and $ASI_{r,p,s}$. The $ASICON_{i,r,p,s}$ (equation 9) is not estimated in this study because of lack of data. A flowchart for Approach 1 is presented in Figure 2.

The *r5r* package has three main functions, these are described as follows:

1. setup_r5(): This is used to initialize an instance of r5r. It also builds a routable transport network using the OpenStreetMap street network and public transport feeds in *GTFS* format as input.
2. travel_time_matrix(): This function is used for the fast computation of travel time estimates between O-D pairs on a network. It receives as input the integrated road network generated by the setup_r5() function and the zonal centroids data.
3. detailed_itineraries(): Lastly, this function is used to obtain detailed information on one or multiple alternative routes O-D pairs on a network.

The r5r package essentially requires only the following input datasets:

1. An Open Street Map network in .pbf format (mandatory).
2. A public transport *GTFS* feed in *.zip* format.
3. A points of interest file, in *.csv* format, containing the names and spatial coordinates of traffic analysis zone

5.3 Approach 2

In the second approach a tool known as OpenRouteService (*ORS*) tool.[30] It is an open-source tool developed at the Heildelberg Institute for Geoinformation Technology. The tool is built with a set of algorithms for multimodal routing analysis with capability to compute directions, isochrones and travel distance or time matrices within *QGIS*.[31] *ORS* utilises open-source network data from the OpenStreetMap platform in addition to user supplied data such as administrative boundaries and facilities location. The tool has similar capabilities to the *r5r*. They both provide multimodal routing analysis and compute travel time matrices for a set of input locations using network data from OpenStreetMap service. However, while the *r5r* relies on *GTFS* data as a required to compute network-based travel times, the *ORS* tool only utilises the open street map data for its routing analysis, making it more suitable for situations where formal public transport schedule information is unavailable. The overall workflow for the computation of potential accessibility and potential mobility using *ORS* is also show in the flowchart in Figure 2. The workflow described above is a two-step process where the *ORS* tool is employed in the first step for routing analysis and computation of travel distance and time

[30] https://openrouteservice.org/

[31] Hugentobler, M. (2008). Quantum GIS. In: Shekhar, S., Xiong, H. (eds) Encyclopedia of GIS. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-35973-1_1064

matrices for car, walking and cycling. The resultant travel matrix from step 1 is employed at the second step for calculation of potential accessibility and potential mobility using a spreadsheet tool like *Microsoft Excel*. The basic data required for analysis of potential accessibility and potential mobility include

1. Administrative boundaries (Traffic analysis zones) shapefiles.
2. Population and Employment distribution by zone.

The summary of the key steps implemented in the workflow described in *Figure 3* are below

1. Download and Install *QGIS* application and the OpenRouteService (*ORS*) Plugin.
2. Sign up on the Open route service website to request an *API* Key
3. Open *QGIS* and load the *ORS* tool with the *API* Key
4. Run the Matrix service within the *ORS* tool to compute travel distance and time matrices for the modes of interest. Origin and destination locations are loaded as point shapefiles representing centroids of the zones. The resultant many-to-many matrix is exported to spreadsheet.
5. Compute accessibility and potential mobility using the equations described in previous chapter.
6. Visualize results using quadrant plots (Figure 1) and GIS Maps.

Due to insufficient public transport data, the second approach which utilises *ORS* is used in this work. Next, we discuss the application of the method to the cases of Kigali and Blantyre.

5.4 Case study 1 – Kigali, Rwanda

The results of the accessibility and potential mobility for Kigali is represented in *Figure 3* below.

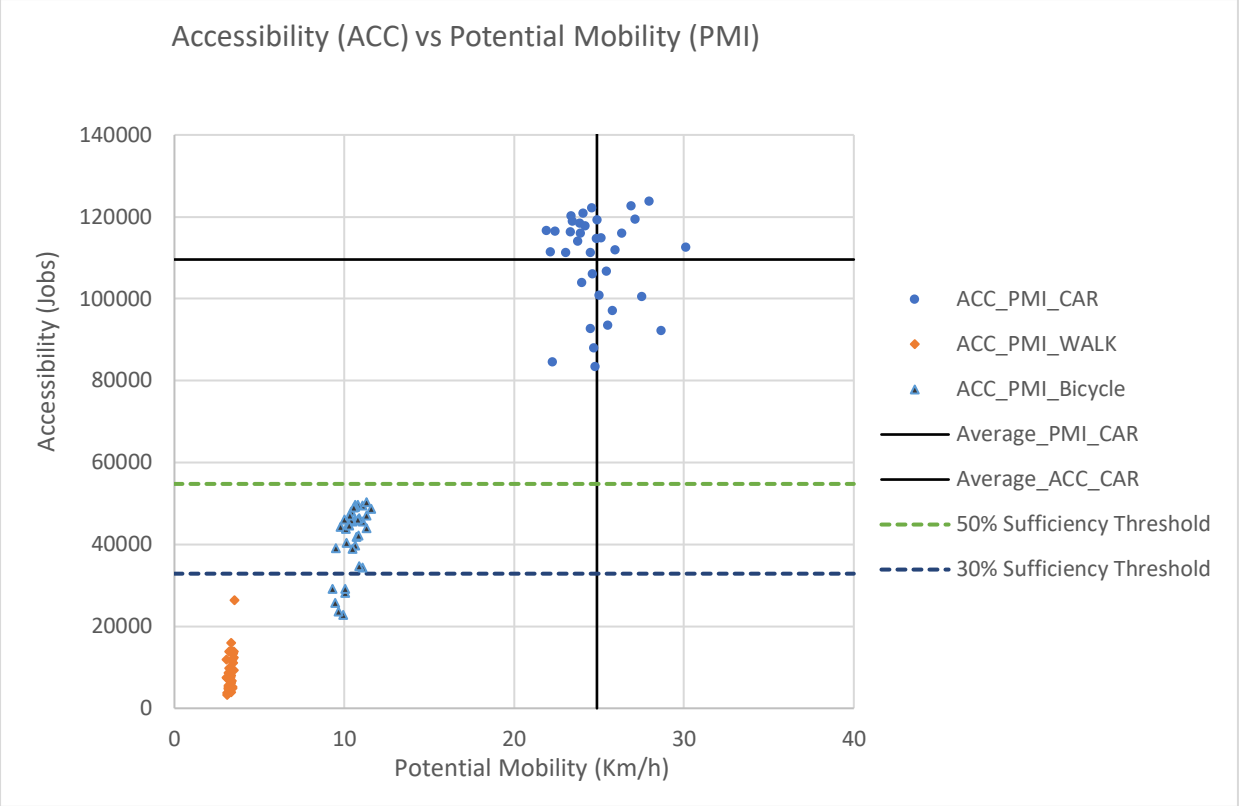


Figure 3: Accessibility and corresponding potential mobility for travel by car, walking and cycling in Kigali.

In the Figure, each scatter point represents the measured potential accessibility and potential mobility of a zone, for the three modes considered. The Figure also reveals the disparity that exists between the opportunities 'potentially' accessible by car and those accessible by Non-Motorized Transport (NMT). The average potential accessibility by car across the 35 Traffic Analysis Zones is about 110,000 jobs, representing about 50% of the total jobs (estimated as 212,000) in the study area. In comparison to NMT, the average number of jobs 'potentially' reachable by walking is only about 8,400 jobs, while for cycling, it is about 41,600 jobs. From a justice perspective, this implies that households with access to car are almost thirteen times better off than households with no car, in terms of potential opportunities within reach.

The sufficiency thresholds further reveal the level of disparity in accessibility level. Sufficiency thresholds are measured as a percentage of the average potential accessibility by car. In other words, the threshold of accessibility by car is used to benchmark NMT accessibility. The two thresholds implemented in the analysis are σ =50% and the σ=30% sufficiency thresholds. It can be seen from the plot that for all the zones, accessibility by walking is below the 50% and 30% sufficiency thresholds. For cycling, all zones are also below the 50% sufficiency threshold, while some zones are above the 30% threshold. Furthermore, relating the measured accessibility by NMT to the population in each zone, the proportion of the total population that have accessibility 'above' and 'below' the sufficiency thresholds can be established. This is achieved by identifying the respective zones that are below or above the thresholds and taking the total population of individuals in those zones into account, while adjusting for estimated levels of car ownership. The Accessibility Sufficiency Index (ASI), which is a measure of the overall fairness of the transport system, is also computed. The ASI is mode specific and also dependent on the set sufficiency threshold. Table 2 shows a summary of the percentage of the

population and their accessibility relative to the defined sufficiency level σ. Also presented is the ASI for walking and cycling for the respective sufficiency levels.

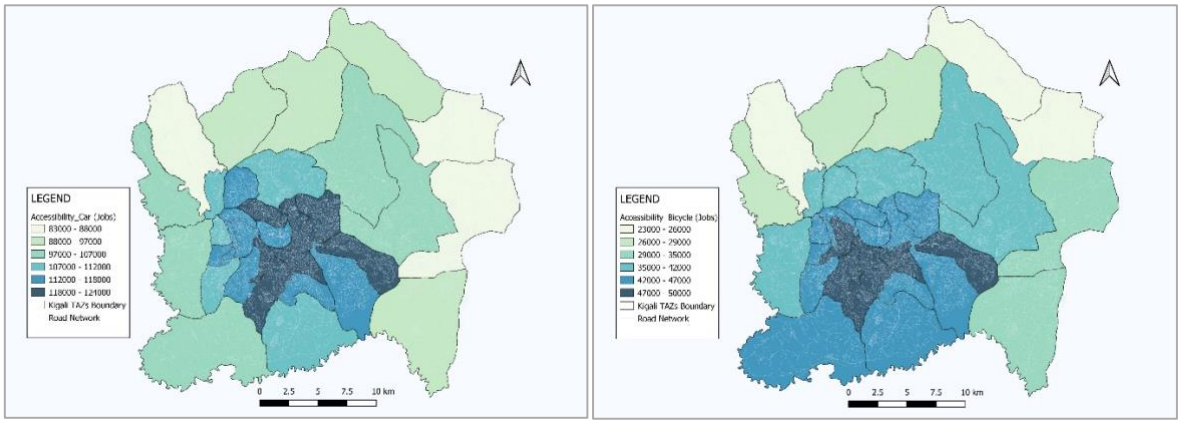
Table 2: Percentage of the population and their accessibility relative to sufficiency level, $T^{M}_{\sigma,p,\mathrm{r}}{}^{*}$

Total Population (Persons) = 1.1 Million	**Mode M**		
	Car	**Walk**	**Bicycle**
% of Total Population with Accessibility above σ=50%	100%	0%	0%
% of Total Population with Accessibility below σ=50%	0%	100%	100%
% of Total Population with Accessibility above σ=30%	100%	0%	74%
% of Total Population with Accessibility below σ=30%	0%	100%	26%
Accessibility Sufficiency Index (ASI) for σ=50%	-	0.61	0.115
Accessibility Sufficiency Index (ASI) for σ=30%	-	0.41	0.011

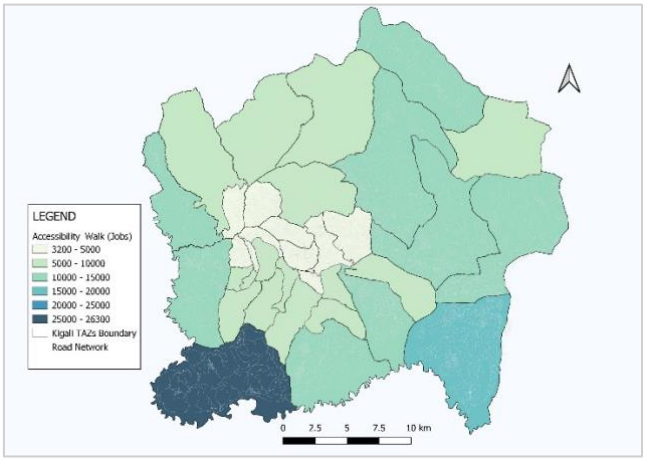
** all purposes, region Kigali city.*

5.4.1 Accessibility Maps

The maps of accessibility for the city of Kigali are presented for car, walk and bicycle as shown below in Figures 4a to 4c.



(a) Car (b) Bicycle



(c) Walk

Figure 4: Accessibility by (a) Car (b) Bicycle (c) Walking

5.4.2 Public Transport Service Area analysis for Kigali

Lacking adequate GTFS data covering all formal and informal public transport in Kigali, it is not possible to calculate accessibility by public transport. Hence, to gain some understanding of public transport-based accessibility, in this section an alternative approach is adopted. Rather than calculating accessibility, a service area indicator is performed for the public transit network in Kigali. The indicator can also be considered an indicator of transport justice, as it identifies the set of areas/locations that are served by the system and those that are not served. The public transport system of Kigali comprises the formal bus service and informal paratransit (minibus and motorcycle taxis). The analysis of bus coverage for Kigali is carried out by running the isochrones API service within the ORS tool to generate isochrones around the formal bus stops within assumed threshold walking distances of 400m and 800m. These thresholds fall within the typical range of walkability distances considered in the literature. The generated isochrones around each stop are further dissolved into a common area for each distance threshold level. Figure 5 shows the resulting service area map of the Kigali bus service.

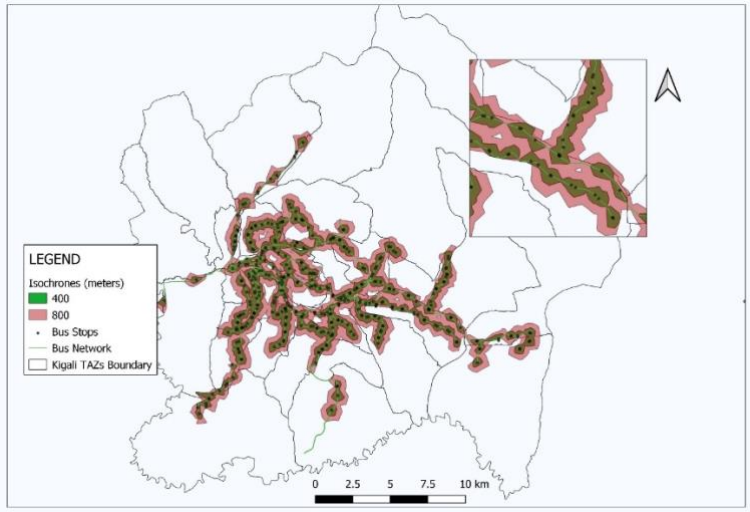


Figure 5: Bus Service Area in Kigali

Overlaying the resulting coverage area above with population density raster map of Kigali and carrying out a raster statistics computation, the total population within the service coverage is established as shown in Table 3.

Table 3: Population within coverage area of public transport

Walking distance threshold	Total population within coverage area	Proportion of the total population in the study area
400m	410000	34%
800m	792194	66%

Service coverage assessment of public transport, as shown for the Kigali Bus network, can provide vital information that could aid planning of network expansion or system upgrade. The coverage map can be applied for further analysis at population group level depending on data availability of the population profile say by income group or car ownership. It should be noted however that the service area analysis does not speak to the accessibility framework presented earlier since it only considers access to the public transport network, but not access to opportunities at destination.

5.5 Case study 2 - Blantyre

The scatter plot of accessibility and potential mobility computed at the zone level for Blantyre is presented in Figure 6.

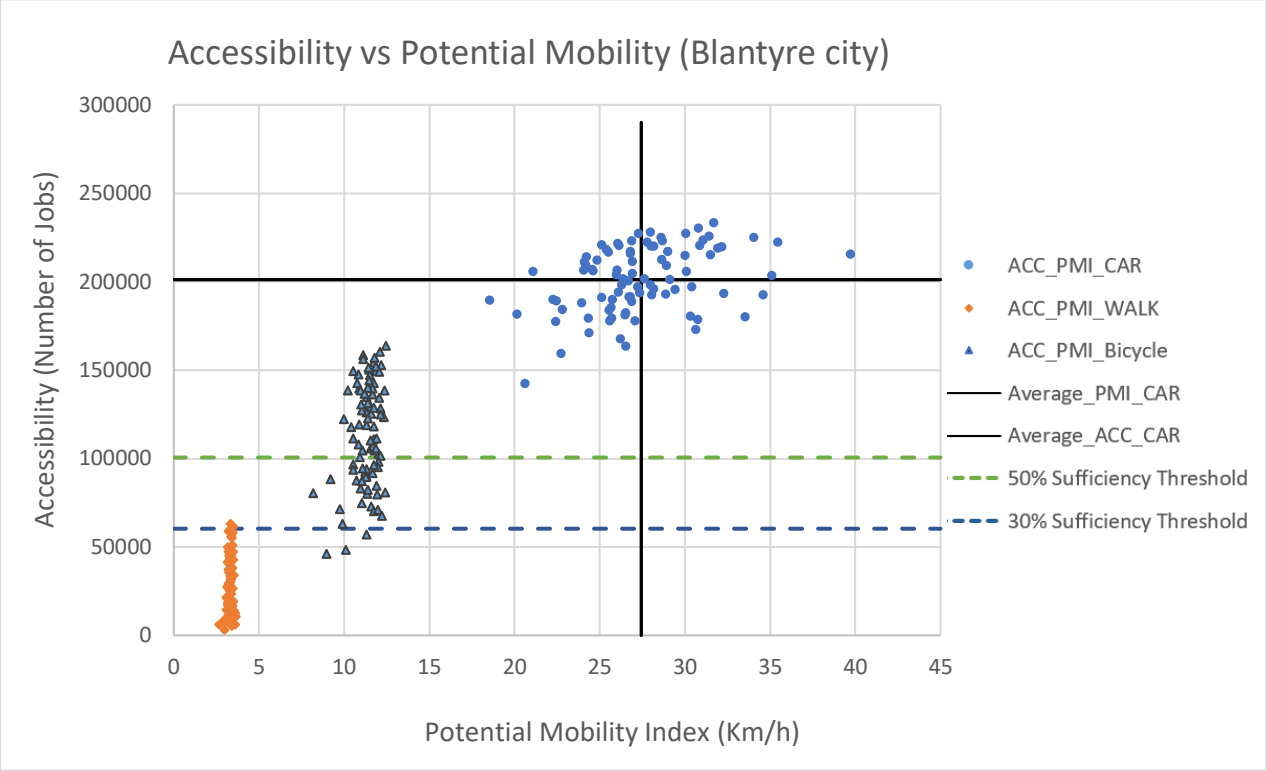


Figure 6: Accessibility and corresponding potential mobility for travel by car, walking and cycling in Blantyre city.

From the figure, the average number of jobs 'potentially' reachable by car from all the zones is about 200,000 jobs. This represents about 70% of the total jobs (280,000) in the study area. In comparison to NMT, the average number of jobs 'potentially' reachable by walking is only about 21,000 jobs, while for cycling, it is about 113,000 jobs. This implies that households with access to car are almost ten times better off than households with no car, in terms of potential opportunities within reach.

In terms of the sufficiency, it is seen that accessibility by walking for all zones is below the 50% and 30% sufficiency thresholds. The proportion of the total population experiencing accessibility level below or above the sufficiency thresholds are also established in Table 4, as in the case for Kigali.

Table 4: Percentage of the population and their accessibility relative to sufficiency level, $T^{M}_{\sigma,p,\mathrm{r}}{}^{*}$

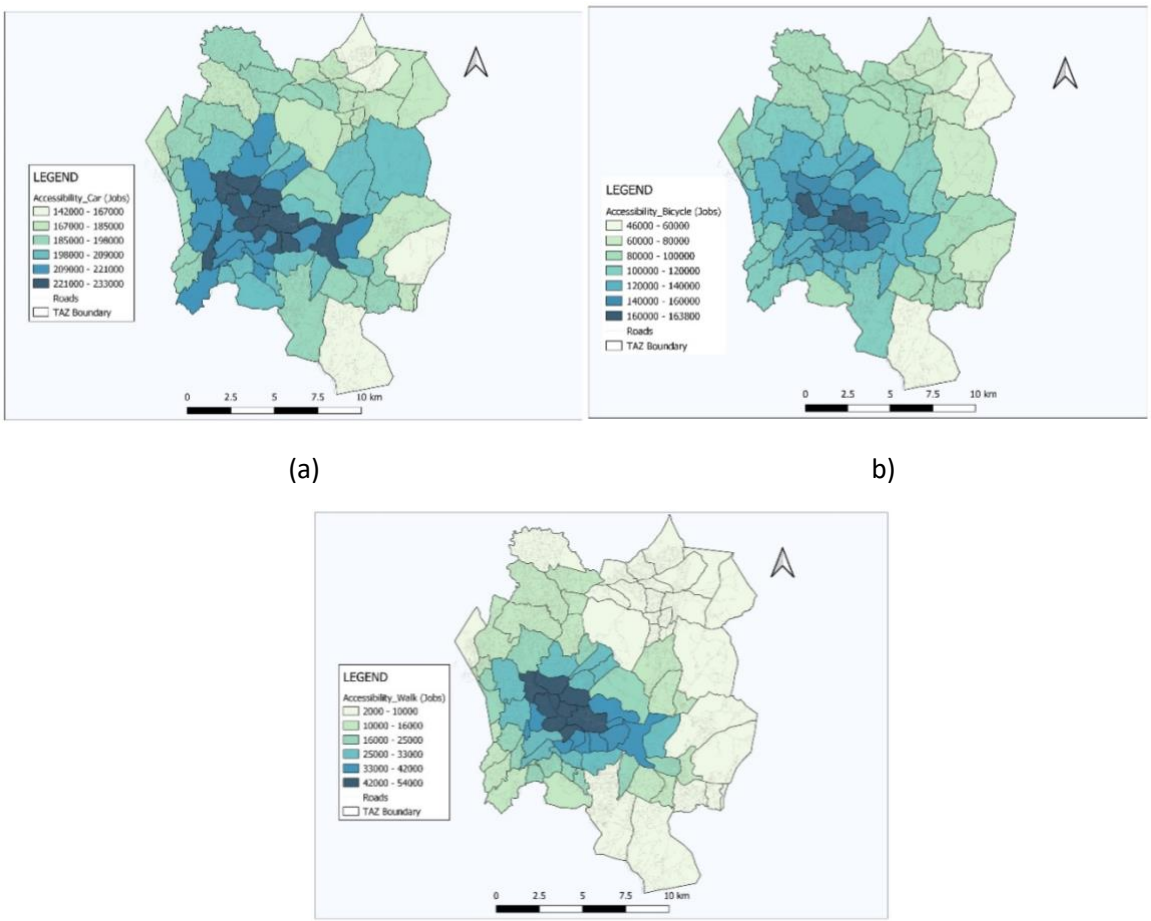
Total Population (Persons) = 0.8 Million	**Mode M**		
	Car	**Walk**	**Bicycle**
% of Total Population with above σ=50%	100%	0%	66%
% of Total Population with below σ=50%	0%	100%	34%
% of Total Population with above σ=30%	100%	0%	2%
% of Total Population with below σ=30%	0%	100%	98%
Accessibility Sufficiency Index (ASI) for σ=50%	-	0.69	0.017
Accessibility Sufficiency Index (ASI) for σ=30%	-	0.53	0.001

** all purposes, region Blantyre city.*

The justice assessment presented for this study is performed at the spatial aggregation level of zones. With the availability of more disaggregated data capturing more details about the population within each zone, say by household income level and car ownership, a more refined assessment of transport justice can be achieved at the household level. While the measure of opportunities considered in this case is jobs, other measures of opportunities such as education or health facilities distribution can equally be considered, given data availability. The type of opportunity considered would be dependent on, and reflective of the planning objective. and reflective of, the planning objective as well as the population group of concern (e.g., youth, working-age adults, or elderly).

5.5.1 Accessibility Maps

Accessibility maps for the modes considered are shown in Figure 7.



(a) b)

(c)

Figure 7: Accessibility by (a) Car (b) Bicycle (c) Walking

5.6 Reflection

Detailed data of a transport system and its operational schedule are required for transport planning based on the principle of transport justice. The key data challenges faced in this chapter revolve around the limited nature of public transport data and the lack of detailed socioeconomic and demographic data in both case studies cities. This confines the work to an aggregated analysis at the zonal level rather than a disaggregated household level analysis. Public transport operations in Kigali and Blantyre are largely informal with little or no available data about their schedules and operations

as such the inability to represent informal public transport which accounts for the larger share of the public transport sector within the transport justice analysis framework is considered a key limitation of the work. Furthermore, there is a lack of detailed socioeconomic data in both cities which limits the level of analysis that can be done. Lastly the aggregated opportunities data used in the analysis limits the assessment of transport justice to a zonal level. These issues affect the outcome of the transport justice transport planning approach in both cities and are similar to the challenges faced in the transport environment of many sub-Saharan African cities.

6. Promoting transport justice in Africa

The way in which transport problems are framed and understood strongly shapes transport policies and investments. Transport problems can only be addressed if they are explicitly acknowledged. Hence, an understanding of the dominant framings in the two selected countries and case study cities is key to understand how this may enable or hinder a transition towards a fairer transport system.

The results show that concerns for equity are on the policy agenda in Rwanda/Kigali, even if they disappear more towards the background in the actual implementation of policies. Barriers for transport justice include the mindset among professionals and decision-makers that implicitly prioritizes cars over other road users, budget limitations and lack of physical space leading to 'incomplete streets and roads' without public transport priority or pedestrian and cycling facilities, and a lack of knowledge about transport (in)justice among decision-makers and professionals.

In Malawi/Blantyre, in contrast, transport justice is hardly on the agenda. While concerns for fairness are implicitly reflected in a focus on road improvements in unplanned areas, the current discourse centers around congestion and road widening. Transport justice, understood as the government's duty to gradually deliver a transport system that serves all, is not part of the discourse. While it has a relatively prominent place in the most recent Malawi National Transport Master Plan, concerns for equity, justice or social inclusion hardly resonate in the everyday discussions about transport. Yet, in both contexts, as evidenced in the two workshops, the transport justice approach was generally considered very relevant and something they would like to look into.

What stands out in both countries/cities is the key importance of investments in paved roads. Where transport justice in a Global North context is probably first and foremost about a shift from cars and road building towards investments in public transport infrastructure and operations (complemented with walking and cycling investments), transport justice in Sub-Saharan Africa is essentially about rethinking the role of paved roads for an inclusive transport system. This will require a major shift in thinking about who and what roads are serving.

Given the lack of often basic infrastructure, paved roads are an essential means to enhance mobility and accessibility in SSA and thus to promote economic development. Yet, not all roads are created equal. The focus on road investment tends to be on providing paved roads, with little attention for how they **may serve** different users and how they **may act as a barrier** for other users. These are two distinct issues.

The question how roads may serve a broad range of users is one of road design. The move from single to dual lane roads in Malawi is a case in point. Simply widening roads without earmarking one of the lanes for particular users will ultimately primarily serve private motorized traffic and freight, as the roads will gradually become hostile environments for anyone else except those in a car or truck. With increasing car ownership, private cars will simply gradually fill up the widened road, recreating congestion currently seen on single lane roads. This well-known vicious cycle, which has occurred throughout the Global North, will thus repeat itself. If SSA is to create inclusive roads that serve all users, it will have to explore ways to dedicate space to (informal) public transport, cycling and walking **from the very start**. SSA can benefit from the extensive knowledge developed over the last two decades in inclusive street and road design, even if adaptations to the local circumstances will of

course be essential.[32] Choosing for length instead of quality is likely to exacerbate the problems and contribute less to economic development, than streets and roads that serve all users.

Outside urban areas, paving roads is essential for providing access to markets and other destinations. Here, roads may well be designed from the very start as spaces for all users, rather than as primarily roads for motorized vehicles that are hostile to pedestrians and cyclists by their very design. Principles of shared space or the Dutch concept of 'bicycle streets' (streets where bicycles where the entire right-of-way can be used by cyclists, while motorized traffic is merely a 'guest' in this space) may well be employed in rural areas, thereby giving pedestrians and cyclists the status of full road users, on equal footing or even above motorized transport. Inside urbanized areas, streets can be designed from the very start for relatively low speeds, so that different user groups can safely use the same infrastructure, while also reducing investment and maintenance costs. It will obviously not be easy to guarantee that inclusive street and road concepts, whether in urban or rural areas, will actually function as intended. Yet, giving up at the outset on roads designed for all implies purposely building a transport system that fails to serve all users.

The question of how roads may act as a **barrier** for different users is just as important. Wide roads with fast moving traffic are a major barrier in both rural and urban areas. This makes these roads extremely problematic in an environment where most of the population either relies on walking, cycling or informal transport as their main mode of transport. For people using these modes of transport, wide roads with fast traffic may force them to make detours to cross the road, thereby substantially increase the distances and thus travel times to destinations. Given such detours, people may prefer to cross busy with speeding traffic anyway, substantially increasing the risk of road injury and death. This may occur even if these wide roads feature parallel pavements for pedestrians and separate lanes for cyclists. This is because pedestrians, informal transport users and even cyclist do not necessarily move over long distances along the road. They tend to travel over shorter distances, so that a large part of their movements **crosses** major roads, rather than occurring along them. Hence, these groups are not adequately served by merely providing dedicated infrastructure along the road. It is just as important to carefully consider safe crossing options every 50 to 100 meters, which in turn requires relatively low speeds of motorized transport. This is particularly important within urbanized areas, but also warrants attention around (small) population clusters in rural areas. Making sure paved roads do not act as a barrier is thus also a matter of appropriate road design.

Transport justice principles should also inform new planned urban developments. This includes both new residential areas for the rising middle-class and employment, office, and shopping centers. Given the aspiration for car-ownership among the middle-class, these new urban developments are often designed to serve people traveling by car, even though a substantial share of users (especially service workers) is unlikely to obtain access to private motorized transport in the near future. When planning new developments, it is key to avoid creating car-oriented environments. Instead, they should be designed so that they are walkable and bikeable, and can be served comfortably by (informal) public transport. Hence, even while often lacking formal public transport, cities in SSA could benefit substantially from the design principles underlying transit-oriented development. Key principles include: employment, leisure, and residential developments facing main streets rather than detached from (arterial) roads; buildings oriented towards main streets rather than to parking lots; high levels

[32] See, among others: ANWB (2016). Urban mobility: a new design approach for urban public space; National Association of City Transportation Officials (2013). Urban street design guidelines, Island Press; Roads Task Force (2013). London's street family: Theory and case studies.

of street connectivity, i.e. a high level of intersection density; mixed land uses; and placing (most) parking at a distance especially for office buildings to avoid priority for the private car over other transport modes from the start. By choosing for inclusive urban design from the start, cities in SSA can avoid the enormous efforts currently seen across much of Europe, the USA, and Australia, where car-oriented built environments are increasingly retrofitted against high cost to better serve transit users, cyclists and pedestrians.

Transport justice in Sub-Saharan Africa thus requires a distinct approach from the approach so far developed for a Global North context. The key starting point captured by the notion of transport justice remains the same: providing a transport system that serves all people adequately. The systematic mapping of the population groups that are not served well remains a key component of the approach, as it is essential to shift the discourse from a concern over congestion to the more important goal of delivering accessibility to all. Yet, the existing transport system and the available tools are substantially different in Sub-Saharan Africa from what is common in the Global North. Hence, it will be necessary to adapt and adjust the transport justice approach to this particular context.

The core lesson from the case studies in Rwanda/Kigali and Malawi/Blantyre, briefly presented in this report, is the challenge to avoid building transport systems and land use patterns that give preference to the private car over other modes of transport. The challenge is to make sure that every new investment enhances accessibility for all. If governments and cities in Sub-Saharan Africa manage to take up this challenge, they can become global leaders in envisaging a different, more inclusive, urban model from what can currently be seen in the Global North and beyond.

The core lesson from the analytical model development is that even though resolved here, the dependency on formal GTFS data and data structures posed a challenge in both cities, and by extension for many cities in Africa. The GTFS data is either non-existing or only available for the formal modes in the system. Methods and procedures for deriving GTFS data for paratransit have not received much attention in literature (except in Williams et al., 2015)[33] and is something that needs to be looked into.

The flowchart in Figure 8 below gives an idea of the steps, data and tool requirements for transport planning based on principles of justice in these contexts going forward.

[33] Williams, Sarah & White, Adam & Wagacha, Peter & Ochieng, Dan & Klopp, Jacqueline. (2015). The digital matatu project: Using cell phones to create an open source data for Nairobi's semi-formal bus system. Journal of Transport Geography. 49. 39-51. 10.1016/j.jtrangeo.2015.10.005.

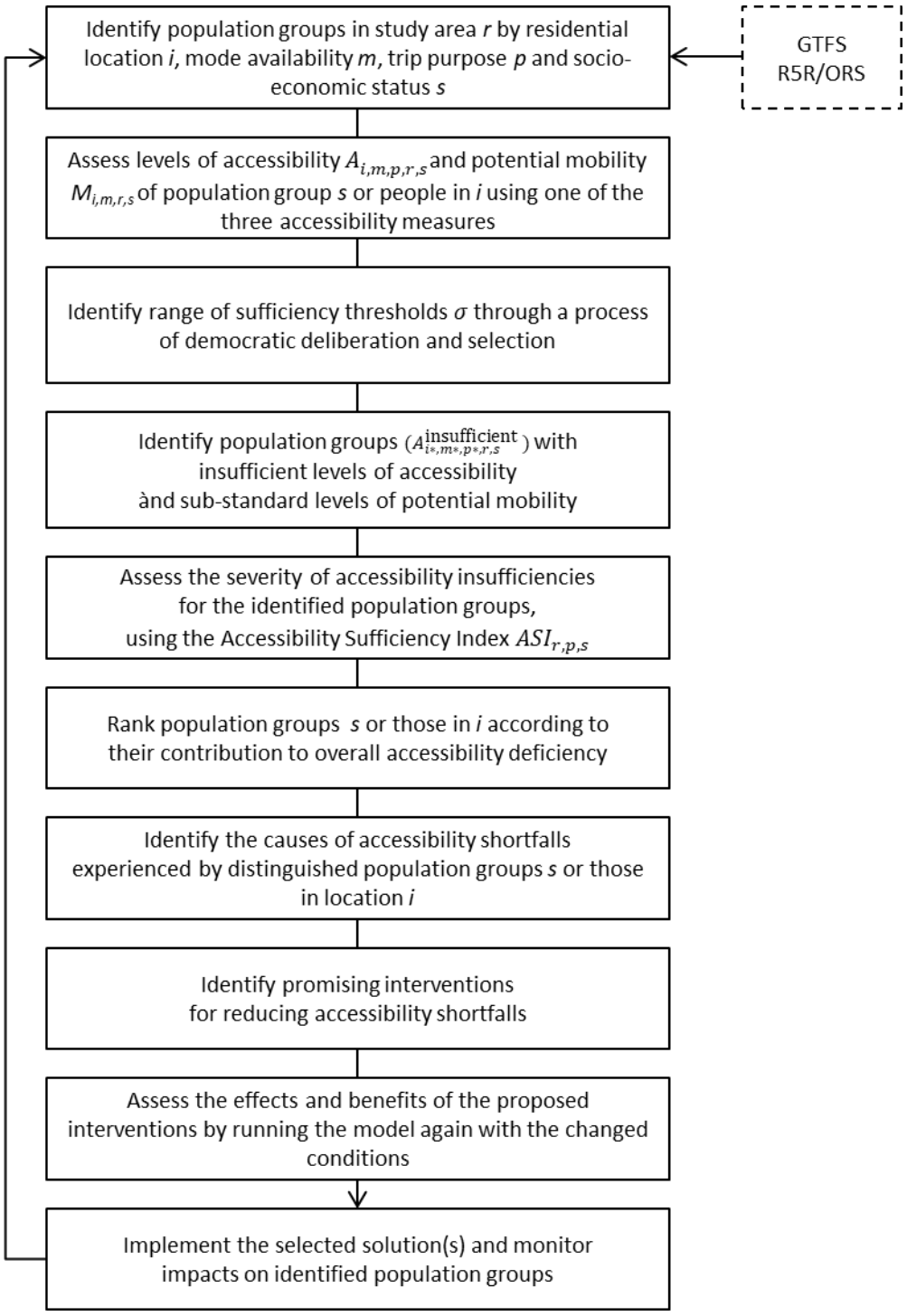


Figure 8: Proposed steps, data and analytical methods for transport planning based on principles of justice (after Martens (2017)).

Bibliography

ANWB (2016). Urban mobility: a new design approach for urban public space

Bentham, J. (2000, original 1789) An Introduction to the Principles of Morals and Legislation. Kitchener, Batoche Books.

Berlin, I. (1969, original 1958) Two Concepts of Liberty. In: I. Berlin (1968) Four Essays on Liberty, pages 118-172.

Cervero, R. (1997) Paradigm shift: from automobility to accessibility planning. Urban Futures, 22, p. 9-20.

City of Kigali (2019) Feasibility study and Preliminary design for a Bus Rapid Transit (BRT) system for City of Kigali: final report, Kigali, Rwanda

Cross-Border Road Traffic Agency (C-BRTA) (2018) Malawi Handbook.

Hugentobler, M. (2008). Quantum GIS. In: Shekhar, S., Xiong, H. (eds) Encyclopedia of GIS. Springer, Boston, MA. https://doi.org/10.1007/978-0-387-35973-1_1064

Jeekel, H. and K. Martens (2017) Equity in transport: Learning from the policy domains of housing, health care and education. European Transport Research Review, 9(53).

Jonker, J.-J. (ed.) (2012) Countries compared on public performance: A study of public sector performance in 28 countries. Sociaal en Cultureel Planbureau, Den Haag.

Levine, J., J. Grengs, and L.A. Merlin (2019) From mobility to accessibility: transforming urban and transportation planning. Cornell University Press, Ithaca and London.

Martens, K. (2017) Transport justice: designing fair transportation systems. Routledge.

Martínez, L. M., and Viegas, J. M. (2013). A new approach to modelling distance-decay functions for accessibility assessment in transport studies. Journal of Transport Geography, 26, 87-96.

Ministry of Infrastructure (2015) National Urbanization Policy 2015, Kigali, Rwanda

Ministry of Transport and Public Works (2017) Malawi National Transport Master Plan, Lilongwe, Malawi.

National Association of City Transportation Officials (2013),Urban street design guidelines, Island Press;

Oren, M., R. Alterman, and Y. Zilbershatz (2014) Housing rights in constitutional legislation: a conceptual classification. In: P. Kenna (ed.) (2014) Contemporary Housing Issues in a Globalized World. Ashgate, Farnham/Burlington.

Pereira, R. H. M., Saraiva, M., Herszenhut, D., Braga, C. K. V., & Conway, M. W. (2021). r5r: Rapid Realistic Routing on Multimodal Transport Networks with R5 in R. Findings, 1262. https://doi.org/10.32866/001c.21262

Roads Task Force (2013). London's street family: Theory and case studies.

Surbana Jurong Consultants Pte Ltd (2019) Kigali City Masterplan 2050: Masterplan update final report.

Surbana Jurong Consultants Pte Ltd (2019) Kigali City Masterplan 2050: Masterplan update final report; Ministry of Infrastructure (2018) Draft Final Transport Sector Strategic Plan for the National Strategy for Transformation (NST1).

Surbana Jurong Consultants Pte Ltd (2019) Kigali City Masterplan 2050: Masterplan update final report, page 3 and page 86 respectively.

Transitec (2019) Business Model for Public Transport Services in the City of Kigali.

Williams, Sarah & White, Adam & Wagacha, Peter & Ochieng, Dan & Klopp, Jacqueline. (2015). The digital matatu project: Using cell phones to create an open source data for Nairobi's semi-formal bus system. Journal of Transport Geography. 49. 39-51. 10.1016/j.jtrangeo.2015.10.005.

Wong, J. (2013). Leveraging the general transit feed specification for efficient transit analysis. *Transportation research record*, 2338(1), pp.11-19.

Appendix 1 – Kigali Masterclass

The Master Class on Transport Justice in Kigali was successfully organised and took place on the 21st of April 2022 in Park Inn Hotel by Radisson with facilitation of Prof. Karel Martens and Prof. Mark Zuidgeest for the lectures and workshop. The Master Class's main objective was to share the principles of transport justice, explore how transport justice is executed in transport practice in Kigali, as well as disseminate and validate the findings from interviews. The Master Class in Kigali was attended by 30 participants from the government, non-governmental organizations, development partners, and private sector institutions in the transport sector. The Masterclass opening and closing in Kigali was officiated by the Director-General Transport of the Rwanda Ministry of Infrastructure. The lecture content of the master class triggered rich discussions around justice in the transport planning practices in Kigali and was appreciated by participants. The content of the Kigali masterclass involved lectures and group discussions, including reflections on the biases and challenges related to the traditional approach to transport planning; the principles of the people-centered perspective on transport planning; and the tools for promoting transport justice.

One of the key findings from the workshop was that the people-centered approach to transport planning may provide a solid foundation for promoting the ambitions laid down in a range of plans and policy documents for Rwanda and Kigali. These documents, including the 2050 Kigali City Masterplan, have set goals that resonate closely with principle of transport justice, but implementation of the policies to achieve these goals is still a big challenge. Moreover, the issue of lack of data and tools for informed planning and decision-making was raised by the workshop participants, a point that validates the outputs of the interviews with informants from Rwanda and confirms the need for analytical tools to be developed.

Photos- Kigali Masterclass

Appendix 2 – Blantyre Workshop

The Workshop on Transport Justice for Malawi took place on 23rd August 2022 at the Amaryllis Hotel in Blantyre. The aim of the workshop was to complement the information collected through the interviews regarding transport decision-making in Malawi and Blantyre, to disseminate the people-centered approach to transport planning and its focus on fairness, and to discuss how this approach could be adapted in the Malawian context. The Blantyre workshop was attended by 26 participants from the government, development partners, academia, and the private sector, with different professional backgrounds including transport planners, civil engineers, urban planners, lawyers, environment scientists, politicians, and geographers.

The workshop was officially opened by the Deputy Vice Chancellor of the Malawi University of Business and Applied Sciences (MUBAS), Prof. Dr. Ishmael Kosamu. In his opening speech the DVC for MUBAS stressed the increasing importance of social inclusions, and the need for proper transport planning to achieve the aims and goals contained in transport planning and policy documents, such as the National Transport Policy of 2015 and the Malawi National Transport Master Plan of 2017.

The workshop generated rich discussions about the transport challenges in Malawi, with several topics emerging as key issues. First, it was acknowledged by participants that while the people-centered approach seemed promising, there is currently a lack of adequate data and tools to fully adopt or test the approach in Malawi. Second, the participants discussed the distinct ways in which priorities are set, with national level government relying, to a large extent, on the cost-benefit analysis to prioritize transport projects, while at the local level, prioritization of projects is usually politically negotiated in council meetings. Both approaches were considered unfair because of the approaches' tendency to worsen accessibility disparities. The participants also resolved to enforce integrated reasoning among relevant stakeholders during transport planning initiatives. Further, the custodianship of data and data sharing among transport planners was noted to be in need of improvement, to overcome the fact that data are scattered over multiple stakeholders and thus not easily accessible to those who need it for developing evidence-based policies. Lastly, it was agreed that while a shift towards a people-centered approach holds much promise, especially at the urban level, the development of major roads that are economic corridors for Malawi must not be ignored, even if these, too, could potentially serve a broader constituency.