ROGER BEHRENS AND ALEXANDRA NEWLANDS

DISCUSSION PAPER

THE IMPACT OF THE COVID-19 PANDEMIC ON FUTURE URBAN TRANSPORT IN SUB-SAHARAN AFRICA

A VREF PROGRAMME

MOBILITY & ACCESS in African Cities

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ABSTRACT

After COVID-19 was declared a pandemic in March 2020, restrictions on movement began to be implemented across the world, including in Sub-Saharan Africa. There has been much speculation on what the long-term impacts of the pandemic on urban transport might be.

The aims of this paper is to: identify the impacts of the COVID-19 pandemic in Sub-Saharan African cities; consider the long-term disruptive impacts of the pandemic on mobility and access; and discuss the implications the pandemic has for urban transport policy and practice. To pursue these aims, evidence has been compiled from three sources: findings from a review of 55 published studies; secondary big data gathered by technology companies and research consortia; and a two-wave (n=15) panel survey of experts in Sub-Saharan Africa. 'Self-perception theory', 'land rent theory', a 'regulatory cycle', and 'time geography' were theoretical perspectives used to conceptualize possible future impacts, and to interpret findings.

Regarding impacts, it was found that the number of COVID-19 cases and deaths in Sub-Saharan Africa have been significantly fewer than in other global regions, but possibly not as low as the available data suggests. The available evidence indicates that in some Sub-Saharan African countries trip-making returned to base conditions sooner than in other parts of the world. It is predicted that longer term urban transport impacts will take the form of:

- reduced travel by, and accessibility for, vulnerable low-income households residing in peripheral locations, because of decreased economic welfare;
- reduced transport service availability because of operator attrition, particularly amongst unsubsidized formal operators;
- increased remote activity participation and fewer work and business trips for a minority of better resourced households with white-collar workers, determined largely by how extensively 'hybrid work' business practices become established, and;
- disrupted trip distributions as the mix of city center land-use changes in response to business attrition in economic recession rather than disrupted bid rents.

Regarding implications for urban transport policy and practice, it is argued that the disruptive impacts of the pandemic on trip substitution, which has been the focus of much policy debate elsewhere, will assume less importance in the Sub-Saharan African context. The major impact is likely to be on economic welfare rather than on disrupted business operating practices. There is a need, therefore, to focus policy attention in Sub-Saharan Africa on the mitigation of these impacts and, more particularly, on developing ways of measuring and monitoring changes in transport disadvantage and social exclusion, so that reliable data are available to inform mitigation strategies. The mitigation strategies considered should include investment in affordable 'digital connectivity' as a means of complementing accessibility from spatial proximity and physical mobility, and buttressing resilience. Further implications include the need to develop more robust transport planning practices to deal with uncertainty, and the use of available financial support to assist informal public transport operators as leverage for the introduction of reforms.

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INTRODUCTION

Background

As the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) began to spread outside the borders of China in January and February of 2020, and after the World Health Organisation declared the outbreak a pandemic on 11 March 2020, lockdown restrictions began to be implemented across the world as countries attempted to prepare for the anticipated onslaught on medical facilities, by curbing contagion and 'flattening the curve'. By the end of March 2020, most countries, including those in Sub-Saharan Africa, had implemented lockdown regulations in one form or another. These lockdowns required activities such as work, education, and exercise, among others, to be carried out remotely, and imposed restrictions on the use of public transport services.

Much has been written about the impacts of these lockdown regulations on urban transport systems. The pandemic has triggered an extraordinary output of academic publication. The (now discontinued) Elsevier Coronavirus Research Repository indicates that 252 421 coronavirus-related papers were published between January 2020 and August 2021, at the rate of a new paper every three minutes. A bibliometric analysis of this emergent body of literature by Benita (2021) found 6 969 papers (published between January and December 2020) focused on transport systems. It is unlikely a research topic in the field of transport that has captured more attention in such a short period of time.

There has been much speculation in this (and 'grey') literature on what the longer-term impacts of the virus (hereafter referred to as COVID-19) might be. With respect to urban transport, speculations include:

- an increase of work from home (or 'hybrid work'), and virtual business meetings and conferences (with associated impacts on trip generation/suppression, Vehicle Kilometers Traveled [VKT], and congestion profiles);
- an increase of online retail, and home-based online entertainment and dining (with associated impacts on trip suppression, and VKT);
- changes in land-use mix in business districts as the demand for office space declines (with associated impacts on trip distribution, and parking demand); and
    - regressed poverty alleviation (with associated impacts on trip generation, fare affordability, and mode use). (BMGF 2020; De Vos 2020; Marsden 2020; Matheson *et al.* 2021; Muller 2020)

Aim of the study

Given the surfeit of publications about COVID-19 impacts, why then is another thought piece warranted? Two reasons are offered.

First, most of the literature and speculation has focused on cities and countries in the Global North. Some of the speculated impacts in the international literature have not been examined in a Sub-Saharan African context and, as will be discussed later, some outcomes that have emerged in Sub-Saharan Africa that are unique. Two bibliometric studies provide insight into the geographical focus of transport-related COVID-19 literature. Of the 6 969 general transport COVID-19 papers found by Benita (2021) mentioned earlier, 194 focused on passenger travel behaviour. Of these, 30% were international comparisons, 48% focused on countries in the Global North, and 22% in the Global South. Only three papers (2%) focused on Sub-Saharan African countries. Kutela *et al.* (2021) found a similar pattern. Of the 488 transport COVID-19 papers they identified, 21% were focused on countries in the Global South and only eight (2%) were on Sub-Saharan African countries.

Second, a literature search for academic papers on the impacts of COVID-19 on urban passenger transport systems in Sub-Saharan Africa undertaken for the purposes of this study revealed that almost all publications focus on impacts in the present or near-term. Relatively little attention has been given to future, long-term impacts. So, there are gaps in the literature with respect to both the geographical context and the time dimension of impacts.

The aims of this paper are therefore:

- to identify, and compare with global trends, the revealed impacts of the COVID-19 pandemic on urban transport in Sub-Saharan African cities;
- to consider the future, longer-term disruptive impacts of the COVID-19 pandemic in Sub-Saharan Africa; and to identify implications for required policy action.

The scope of the thought piece is limited to 'urban transport', and 'mobility and access'. Thus, the focus is on intra-city movement and travel modes, and the movement of people.

Structure

The report is divided into **eight sections**. The theoretical perspectives used in, and the data assembled for, the study are described in section 2. As a backdrop for subsequent discussion, a summary of the chronology of the spread of the pandemic, and regulatory responses to it, is provided in section 3. Insights into the impacts of the pandemic to date, drawn from primary and secondary data sources, are given in section 4. The heterogeneity of experiences is illustrated through four case studies in section 5. Propositions on likely future impacts common across Sub-Saharan African contexts are presented in section 6, drawn from primary data sources. Policy implications are discussed in section 7 and final conclusions are drawn in section 8.

ANALYTICAL FRAMEWORK

This section starts by describing the data assembled for the study. The evidence of impacts was compiled from three data sources: a review of the findings of published studies (sub-section 2.1); a fusion of available secondary data (sub-section 2.2); and a two-wave panel survey of local experts (sub-section 2.3). Finally, a set of theoretical perspectives is discussed, for the purpose of conceptualising possible future impacts and interpreting the available data (sub-section 2.4).

Review of past studies

The first source of data took the form of empirical observations of the impacts of COVID-19 on urban passenger transport systems in Sub-Saharan Africa reported in published academic papers. The search parameters for identifying publications included: inclusion of a Sub-Saharan African empirical context; consideration of the mobility and access (or lack thereof) of people in urban areas; and attention to revealed or anticipated impacts of the COVID-19 pandemic. The literature search yielded 21 published peer-reviewed studies.

Most of these studies focused on the geographical contexts of South Africa (60%) and Nigeria (17%), with the remainder dealing with Sub-Saharan Africa conditions more generally. The research methods applied, ranged from Analysing secondary big data on mobility and lockdown restrictions (e.g., Asweto *et al.* 2020; Lawal and Nwegbu 2020), to primary data collection in the form of quantitative surveys (e.g., Adeke *et al.* 2021; Balbontin *et al.* 2021) or qualitative interviews (e.g., Jennings and Arogundade 2021; Porter *et al.* 2021). Some papers focused on policy implications (e.g., Jobanputra and Jennings 2021; Odendaal 2021) rather than the measurement of impacts.

The major substantive themes covered in this body of literature included:

- travel behaviour, in the form of trip substitution because of working from home (e.g., Balbontin *et al.* 2021) and mode use switching due to movement restrictions and changes in service supply (e.g., Barbieri *et al.* 2020, 2021);
- disproportionality in reduced mobility and intensified economic hardship across socio-economic groups and genders as a result of the pandemic (e.g., Carlitz and Makhura 2021; Porter *et al.* 2021);
- public transport service availability and utilization, and consequences for operator viability and fares (e.g., Elbany and Elhenawy 2021; Mogaji 2020);
- local air pollution impacts because of changed travel behaviour patterns (e.g., Lou *et al.* 2021); and
* agent-based model simulation of the impacts of movement lockdown scenarios on viral transmission (e.g., Bossert *et al.* 2020; Schröder *et al.* 2021).

The search also yielded numerous grey literature publications (34), which were included in the review. While the academic literature focused on documenting and measuring the impacts of the pandemic, the grey literature explored the long-term disruptions and their required policy responses. The grey literature also provided a wider geographical focus. While South Africa and Nigeria still dominated attention, other countries were considered as well (including Cameroon, Ethiopia, Ghana, Kenya, Mozambique, Rwanda, Senegal, Tanzania, and Uganda).

The major substantive themes covered in the grey literature included:

- disruptions to travel behaviour from remote working (e.g., Venter *et al.* 2021);
- differential recovery across travel modes (e.g., McLachlan 2020b; Venter *et al.* 2020);
- the opportunity transport recovery strategies offer in recognising and improving informal public transport services (e.g., Bird *et al.* 2020; Calnek-Sugin and Heeckt 2020); and
- the prioritisation of sustainable modes of travel and vulnerable groups in recovery strategies (e.g., Brondum *et al.* 2021; Diouf *et al.* 2020; Jennings 2020).

Secondary data fusion

The second source of data took the form of secondary datasets relevant to analysing how the pandemic has impacted Sub-Saharan Africa countries, how governments have responded, and how urban transport systems have been impacted. Calendar-date data records were used to fuse these datasets, or least facilitate temporal adjacency. Secondary health data on COVID-19 infections, fatalities, vaccinations, and excess deaths were sourced from: the University of Oxford-affiliated *Our World in Data*; the Johns Hopkins University-affiliated *Centre for Systems Science and Engineering*; and *Worldometer*. Secondary data on the severity of lockdown restrictions were sourced from the University of Oxford-affiliated *Our World in Data*. Secondary travel and traffic data on changing activity participation and travel patterns, and congestion were sourced from: *Google COVID-19 Community Mobility Reports*; *Apple Mobility Trends Reports* (South Africa only); *TomTom Traffic Index* (South Africa only); and *Facebook Data for Good*. A comparison of the Facebook 'people localized to home' and 'people moving around' metrics with the Google 'residential duration' and various trip-purpose metrics indicated that the inclusion of both datasets in the analysis would be duplicative, as they reveal very similar patterns. The Google data were included in the analysis because they are more disaggregated with respect to trip purposes and cover a wider array of country contexts than the Facebook data.

Delphi panel survey

The third source of data took the form of an online survey of Sub-Saharan African urban transport planning practitioners and academics. The survey sought both retrospective and prospective perspectives on the impacts of COVID-19. A Delphi panel survey was identified as a suitable method for this objective. The Delphi technique was originally developed in the 1950s by the Rand Corporation in the United States for technology forecasting (Dalkey 1969). The method involves a sequence of two or more surveys used to gather the informed opinions of a panel of experts to gain insight into a complex problem. The method is especially useful in forecasting exercises in which expert opinions are the only available source of information. Expert panel interaction is structured around rounds of survey and feedback, providing opportunities for individuals to modify their earlier views and for groups to shift towards a considered consensus. In the later round(s), panelists are provided with the results of the earlier round so that they can either revise their original opinion (if they are influenced by the opinions of others) or maintain their original position.

For the Delphi method to be effective, the anonymity of panelists is essential. Advocates of the method hold that direct confrontation can either lead to the irrational defense of a position once it is taken (to avoid losing face), or to a predisposition to be swayed by persuasively-stated opinions of others without sufficient independent thought (Linstone and Turoff 2002). Anonymity is argued to promote independent and unbiased thought, and to avoid 'bandwagon' and 'halo' effects. In this study, therefore, panelists did not correspond with each other and responded independently to questions and propositions.

The panel of experts was selected from the participants of earlier MAC conferences and projects, supplemented by the authors' own research networks. Of the 37 experts invited to participate in the study (14 women and 23 men from 16 countries), 15 (from 10 countries, see Figure 1) agreed to participate. The panel was compromised of university researchers (10), non-governmental organization practitioners (2), private consultants (2), and a government official (1). Fifteen experts completed the first wave (circulated on 29 July 2021) and 14 (93%) completed the second wave (circulated on 31 August 2021).

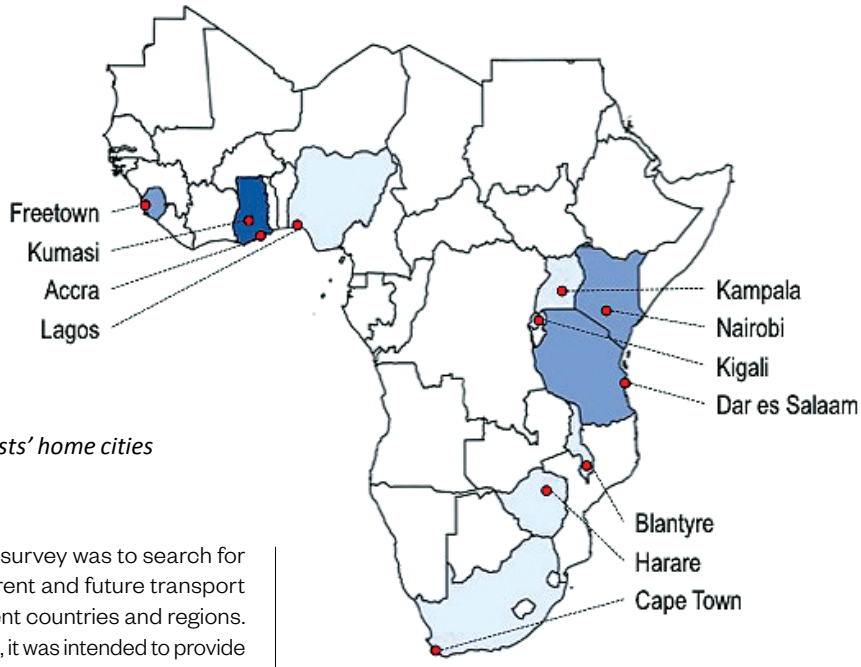


Figure 1: Delphi survey panelists' home cities

The purpose of the first-wave survey was to search for common positions on the current and future transport impacts of COVID-19 in different countries and regions. Through an online questionnaire, it was intended to provide insights into: the revealed impacts of COVID-19 on travel behaviour and trip substitution, operations, and livelihoods and poverty; as well as the possible long-term disruptive effects of COVID-19 on future public transport service supply, travel behaviour, and how impacts might vary across socio-economic and demographic groups. The second-wave survey was comprised of summary feedback on first wave responses and an accompanying further online questionnaire. The purpose of the second-wave survey was: to seek consensus on propositions regarding the future impact of COVID-19 on urban transport; and to explore policy implications for aiding public transport recovery and mitigating social exclusion.

Theoretical perspectives

Four theoretical perspectives were drawn upon to help conceptualise the possible future disruptive impacts of the pandemic, and to interpret available data.

The first is Daryl Bem's 'self-perception theory', which explains the impacts of temporarily-imposed travel restrictions or incentives on longer-term travel behaviour. In contrast to most other behavioural theories, which argue that attitude informs intention and subsequently behaviour (e.g., the 'theory of planned behaviour', Ajzen 1991), in 'self-perception theory' it is posited that in instances of imposed travel restrictions or incentives (e.g., car-use bans during mega-events or public transport fare reductions) behaviour can inform attitude (Bem 1972). If the experience of the new behaviour is positive, it is posited that attitude may become more favourable, and as a result the changed behaviur may endure after the period of imposed change has lapsed. So, might COVID-19 lockdown regulations that imposed an increase in online activity participation change attitudes towards remote working, schooling, and shopping, and thereby lead to enduring trip substitution after movement restrictions are removed?

The second is William Alonso's 'land rent theory', which explains the spatial distribution of different uses of land. In this theory it is posited that land-use distributions are determined by the ability of different economic functions (e.g., retailing, manufacturing, and housing) to compete for location (Alonso 1964). Each land-use activity can offer a 'bid rent' for land parcels, and the activity that offers the highest bid locates there. The 'bid rent' is determined by the 'rent' derived from putting the land to productive use, and is heavily influenced by the cost of physical access. In simplified isotropic, monocentric cities, the theory produces a concentric land-use pattern comprised of retailing in the center, followed by manufacturing and multi-unit housing. So, might shifts towards greater remote activity participation resulting from COVID-19 lockdowns, and associated decreased sensitivities to the cost of physical access, disrupt the 'bid rents' of competing land-use activities in city centers and lead to new land uses emerging in place of retail, office and parking space?

The third is Ken Gwilliam's 'regulatory cycle', which explains changes in a city's public transport operators and service mix (Gwilliam 2008). In this theory it is posited that a 'regulatory cycle' can be observed in public transport service provision in the Global South, comprising four main phases: (1) political pressure to keep public transport fares uneconomically low, and a lack of competition, lead to inefficiencies and decline in monopolistic or oligarchical public transport undertakings; (2) multiple smaller self-regulated informal transport operators emerge to fill the service gaps that result from declining formal public transport services; (3) the weak regulatory regimes associated with informal transport, and aggressive 'in-the-market' competition, lead to poor quality of service; and (4) public authorities seek to reduce the number of operators and reintroduce large formal public transport businesses, in an attempt to improve service quality levels. The cycle is repeated once the efficiencies of larger formal public transport undertakings begin to decline due either to a lack of competition or a failure in regulatory enforcement. So, might reduced financial viability (unmatched by compensatory state subsidy) resulting from reduced ridership during the pandemic nudge a change in cycle phase and lead to a growth or decline in operators?

The fourth is Torsten Hägerstrand's 'time geography', which explains how personal accessibility is constrained in time and space. In this theory it is posited that time and space are resources, and individuals experience constraints on how they utilize these resources (Hägerstrand 1987). 'Capability constraints' refer to the physical and technological limitations of an individual. 'Coupling constraints' refer to the need for an individual to undertake certain activities at certain time-space locations, or 'stations', with other people. 'Authority constraints' refer to institutionally-imposed restrictions and regulations. Travel patterns in time and space, and the autonomy of discretionary movement, are then measured in 'time-space paths' and 'prisms', which define the 'domains' within which daily life occurs. So, might increased capability constraints amongst the most vulnerable and marginalised, due to reduced household incomes resulting from the pandemic's impact on the local economy, reduce 'domains' and increase social exclusion?

PANDEMIC CHRONOLOGY

Before exploring the impacts of COVID-19 on urban transport, it is necessary to first trace how the pandemic spread over the past 20 months, and how governments responded. Infection and mortality data (sub-section 3.1) and government responses (sub-section 3.2) are summarised in this section.

Infection and mortality

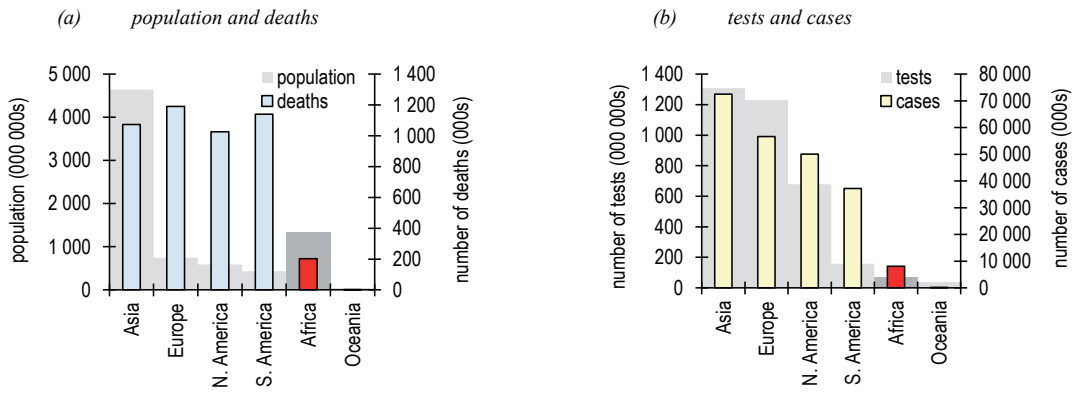
Despite being the second most populous continent, at the time of writing (apart from Oceania and excluding Antarctica) Africa had recorded the fewest COVID-19 cases and deaths (see Figure 2(a-b)).

Normalised daily recorded COVID-19 infections and fatalities across the six continents are compared in Figure 3(a-b). These data reveal that North America, Europe, and South America recorded significantly more infection cases and deaths per million people than Asia, Africa, and Oceania. At its peak in January 2021, North America recorded 19 times more cases per million per day than Africa (467 vs 24), while South America recorded 55 times more deaths per million per day at its peak in April 2021 than Africa (10.9 vs 0.2).

There are no doubt multiple and complex reasons for the lower recorded COVID-19 infection and fatality rates in African countries. Adam *et al.* 2021 explore several hypotheses for why this might be the case, concluding that the demographic structure of populations is the leading factor. African countries have younger populations with fewer elderly persons with chronic comorbidities (Clark *et al.* 2020). Total country COVID-19-related deaths are plotted against life expectancy in Figure 4, illustrating a trendline fitting older mean populations to higher fatalities. Life expectancy – which is illustrated to be consistently lower in Sub-Saharan countries – is estimated to be (moderately) correlated to COVID-19 fatalities (p=0,4311) and infections (p=0,5786). Thus, Sub-Saharan African countries may have recorded fewer fatalities because their populations are younger and less vulnerable.

Another explanation – as illustrated in Figure 2(b) – is that there have been lower rates of testing and diagnosis on the continent (Hasell *et al.* 2020). Testing and infection-case reporting data are (strongly) correlated (p=0,9045). Insight into possible underreporting can be gained from 'excess death' data (i.e., the actual number of deaths, less the predicted number of deaths based on prior mortality patterns). South Africa is the only Sub-Saharan African country with readily-available data on excess deaths (see Figure 5). Observing that there are numerous excess deaths adjacent to COVID-19 waves, these data suggest that significantly more COVID-19-related deaths may have occurred than were reported. Other Sub-Saharan African countries may have followed a similar, perhaps even exaggerated, pattern. So, it is likely that COVID-19 infections and mortalities in Sub-Saharan Africa have been low relative to the rest of the world, but possibly not as low as available data suggests.

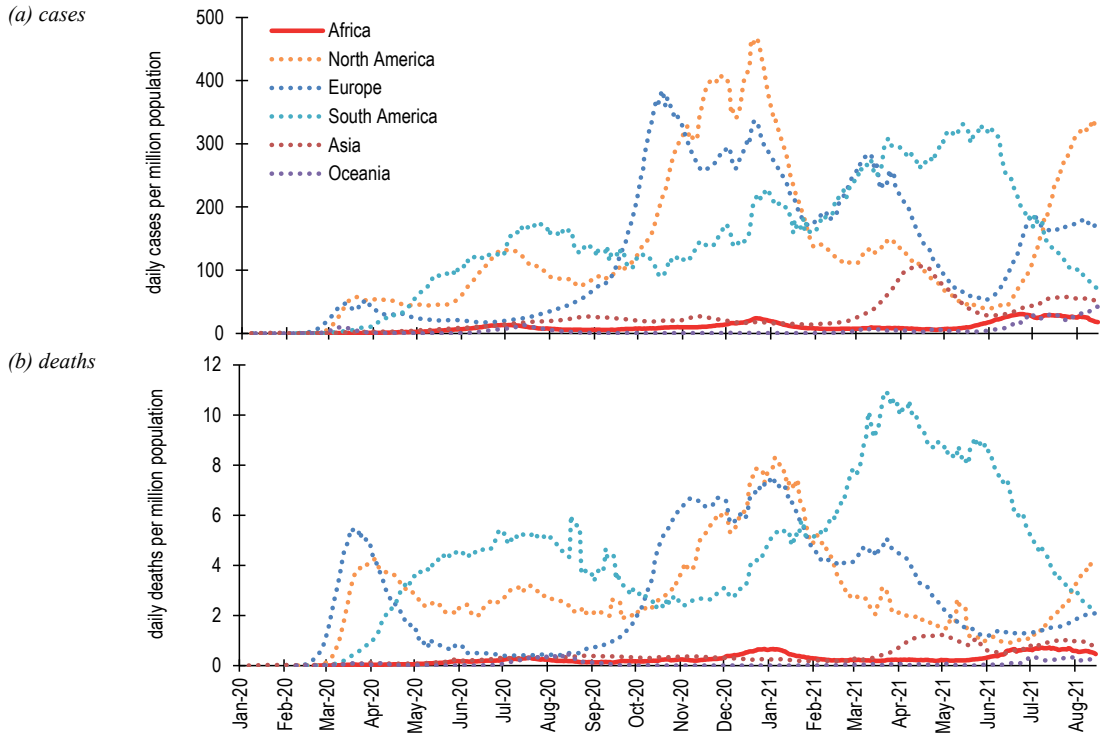
Figure 2: Absolute global COVID-19 deaths and cases, by continent



Data source: Worldometer (11-Sep-21)

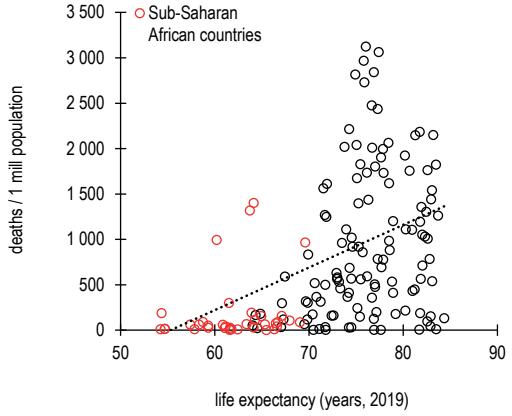
Data source: Worldometer (10 Sep 21)

Figure 3: Normalised global COVID-19 contagion and deaths, by continent



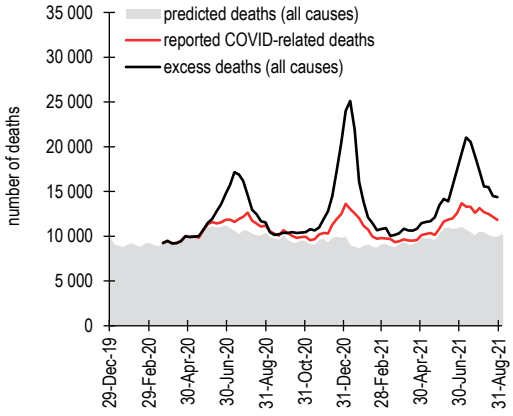
Data sources: Our World in Data; Centre for Systems Science and Engineering
Note: 'Africa' includes both North and Sub-Saharan Africa.

Figure 4: Country COVID-19 deaths versus life expectancy (n=159)



Data sources:
World Bank Open Data; Worldometer (10 Sep 2021)

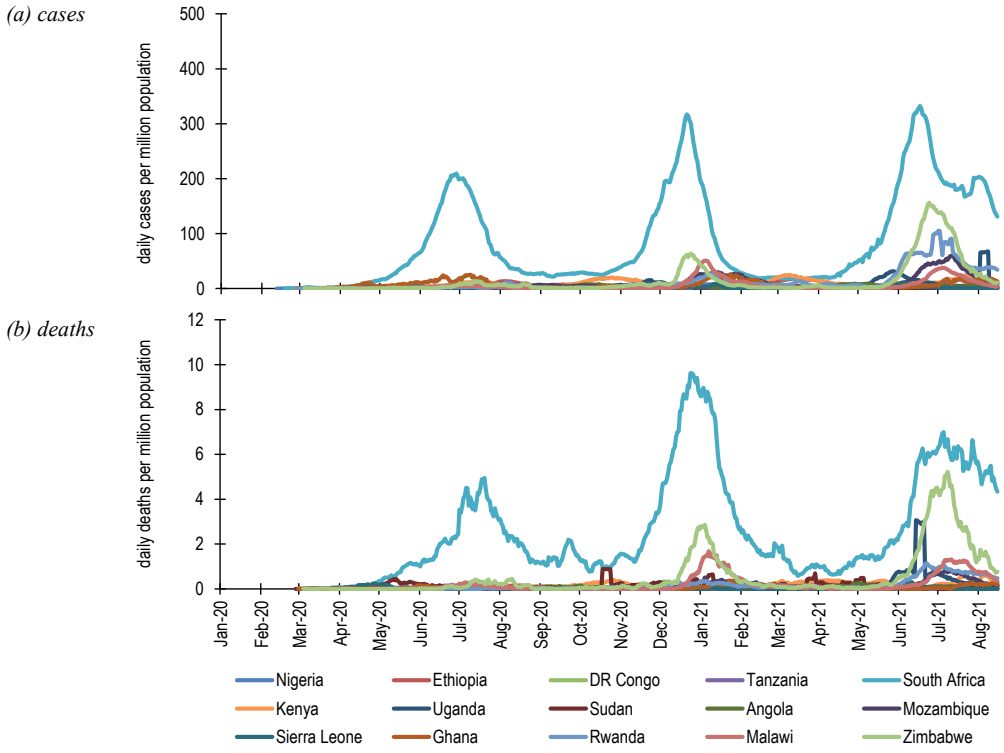
Figure 5: South African reported COVID-19-related excess and predicted deaths



Data sources:
South African Medical Research Council; The Economist; Our World in Data

Figure 6(a-b) unpacks contagion data for the African continent by plotting the Normalised daily recorded infection case and death trajectories of 15 selected Sub-Saharan countries. These countries include the 10 most populous nations in the region, as well as the home countries of the 15 Delphi survey panelists. While representing only 33% of Sub-Saharan countries, together they account for 72% of the regional population. The contagion data suggests that there has been considerable heterogeneity, with South Africa, and to a lesser extent Zimbabwe, recording significantly higher infection and mortality rates per million. In absolute terms, South Africa accounts for 64% of the infection cases and 73% of the deaths amongst this group of countries, while accounting for only 7% of the population. In contrast, Nigeria, accounting for 25% of the population, has recorded just 5% and 2% of infection cases and deaths. The trajectory of Normalised plots suggests that the countries recording the highest cases and deaths have experienced waves at similar times of the year. South Africa and Ghana experienced a first wave of cases in July 2020. South Africa, Zimbabwe and Malawi experienced a second wave in January 2021. And South Africa, Zimbabwe Rwanda, Mozambique, and Uganda experienced a third, less spiked, wave in July-August 2021.

Figure 6: Normalised Sub-Saharan African COVID-19 contagion, by country (n=15)



Data sources: Our World in Data; Centre for Systems Science and Engineering

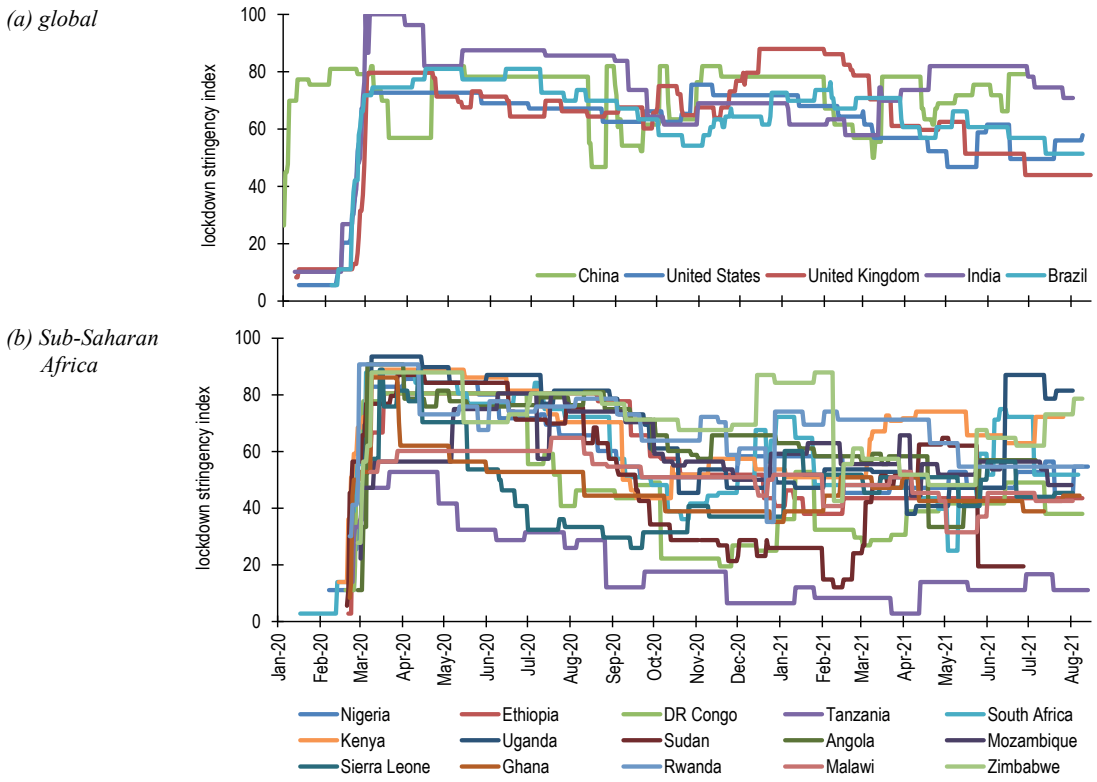
Note: Country selection includes the top 10 largest populations, and the home countries of Delphi panelists.

Lockdown regulation

How then have Sub-Saharan African governments responded to the unfolding pandemic? Responses have taken two main forms: the imposition of lockdown regulations to reduce contagion; and the administration of vaccination programs.

Regarding lockdowns, Figure 7(a-b) illustrates that, while the introduction of lockdown regulations occurred within a small window of time, the adjustment of lockdown levels over time has been variable. Apart from China, where lockdowns were imposed a couple of months earlier, all the selected global and Sub-Saharan African countries introduced restrictions of varying strengths in the first three weeks of March 2020. Lockdown restrictions typically took the form of combinations of: activity-station closures (particularly education and work activities); reductions of public transport service and vehicle capacities; stay-at-home requirements; movement restrictions (domestic and international); and limits on the size of public gatherings (Diouf *et al.* 2020; Elbany and Elhenawy 2021). The figure plots an index measuring the stringency of lockdown regulations, developed by the Oxford Coronavirus Government Response Tracker project. While the initial intent of governments was to adjust stringency levels to match infection risk, the trajectories of the 'stringency index' values relative to new infection cases suggest that, in some countries at least, once 'political capital' was spent, restrictions were adjusted to match both risk and public acceptability. Focusing on the Sub-Saharan countries included in Figure 7(b), it is clear that some countries have endured more stringent lockdown conditions – and the associated economic hardship – longer than others. The stringency index values for Tanzania and Malawi for instance, are significantly lower than for Uganda and Zimbabwe. However, stringency is not necessarily an indicator of compliance. Both the stringency of lockdown regulations, and the capacity to enforce them, is likely to have varied from country to country.

Figure 7: Lockdown stringency index, by country (n=20)



Data source: Our World in Data

Notes: 1. Global country selection includes China as the progenitor country, and the top four countries by number of cases (12 Sep 21).

2. Sub-Saharan African country selection includes the top 10 largest populations, and the home countries of Delphi panelists.

3. The 'lockdown stringency index' is calculated as the mean score of nine response metrics: school closures; workplace closures; cancellation of public events; restrictions on public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls. Scores take a value between 0 and 100 (100 = strictest response).

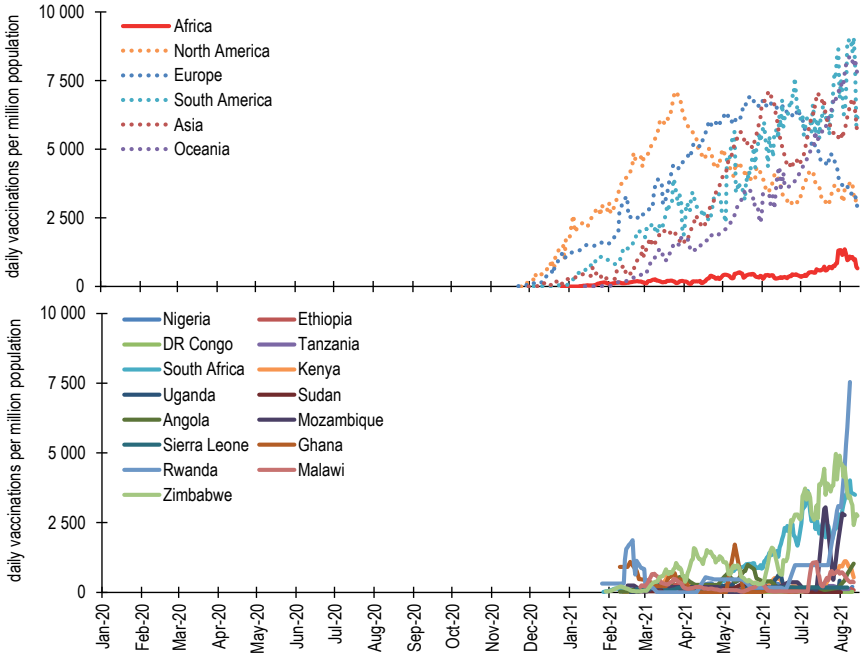
Regarding vaccination programs, Figure 8(a) illustrates that, in aggregate, African governments have administered vaccines significantly slower than governments on other continents. Unpacking the Sub-Saharan African experience in greater detail, Figure 8(b) illustrates that, as in the case of reported contagion, there has been considerable heterogeneity in the roll-out of vaccinations.

At the time of writing, Zimbabwe (19%), South Africa (18%) and Rwanda (13%) had partly or fully vaccinated the largest proportions of their populations, compared to Sudan (1,4%), Tanzania (0,5%) and the Democratic Republic of Congo (0,1%) who had the lowest vaccination rates amongst the countries compared.

Figure 8: Normalised COVID-19 vaccinations, by continent (n=6) and country (n=15)

(a) global

(b) Sub-Saharan Africa



Data sources: Our World in Data; Centre for Systems Science and Engineering

Notes: 1. 'Africa' includes both North and Sub-Saharan Africa.
2. Country selection includes the top 10 largest populations in Sub-Saharan Africa, and the home countries of Delphi panelists.

REVEALED IMPACTS

What insights can be drawn from the available secondary data and the perceptions of the local Delphi panel experts in the first-wave survey regarding the impacts of the pandemic to date? This section discusses impacts on travel patterns (sub-section 4.1), passenger transport operations (sub-section 4.2), and household livelihoods and social inclusion (sub-section 4.3).

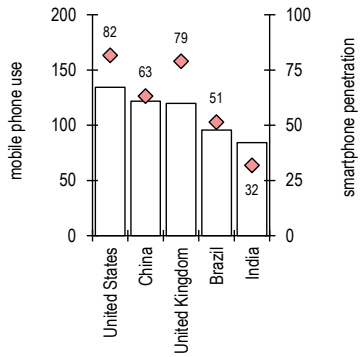
Travel patterns

Comparative quantitative data on the impacts of lockdown restrictions on trip-making have been assembled and shared by technology companies (Apple, Google, and Facebook). Apple data are collected from mode-specific wayfinding requests. Google and Facebook data are collected from the location tracking functionality of smartphones (and other mobile devices), with trip purposes imputed from land-use geography information overlays. The shortcoming of these data is that they are limited to a sample of a subset of the population that uses smartphones. In countries with lower household incomes, this means that the data are skewed towards wealthier socio-economic groups. The extent of this bias varies depending on the extent of smartphone penetration. Figure 9(b) illustrates that while many, if not most, people in the selected Sub-Saharan countries own mobile phones, smartphones are owned by a minority. For example, in Rwanda the latest comparative data indicates that there were 76 mobile phones per 100 people (in 2019), but only 9% of the population owned a smartphone (in 2017). Although 2017 technology diffusion data should be regarded as outdated, the patterns illustrated in Figures 10 to 12 should be interpreted with the above caveat in mind.

Changes in trips to workplaces, compared on a percentage basis before and after lockdown restrictions were imposed, are illustrated in Figure 10. The before lockdown baseline (i.e., the 0 value on the vertical axis) was set as the median value for each day of the week, calculated from daily measurements over a five-week period between 3 January and 6 February 2020. These data suggest that, in the short-term, reduction in trips to workplaces varied in scale across countries. South Africa and Zimbabwe for instance saw a reduction similar to that of the United Kingdom and India (of around 60%), whereas in Mozambique and Tanzania the maximum reduction was considerably lower (at around 25%). The reduction was short-lived in some countries (e.g., Mozambique and Zimbabwe returned to pre-lockdown levels within three or four months), while others remained at below the baseline for the subsequent 18 months (e.g., South Africa and Ghana). The spiked reductions of Uganda, Rwanda, and South Africa mirror the arrival of the second and third infection waves (see Figure 6).

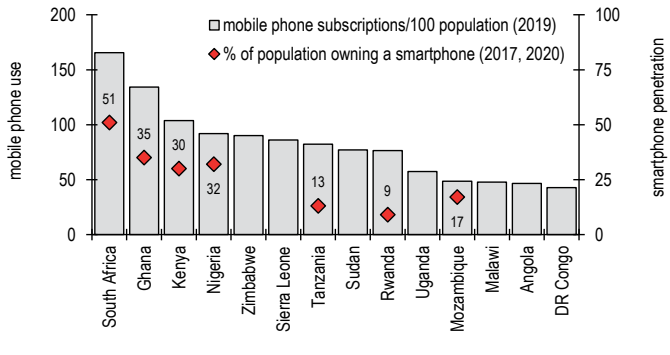
Figure 9: Smartphone penetration, by country (n=19)

(a) global



Data sources:
World Bank Open Data (2019); Newzoo (2020)

(b) Sub-Saharan Africa



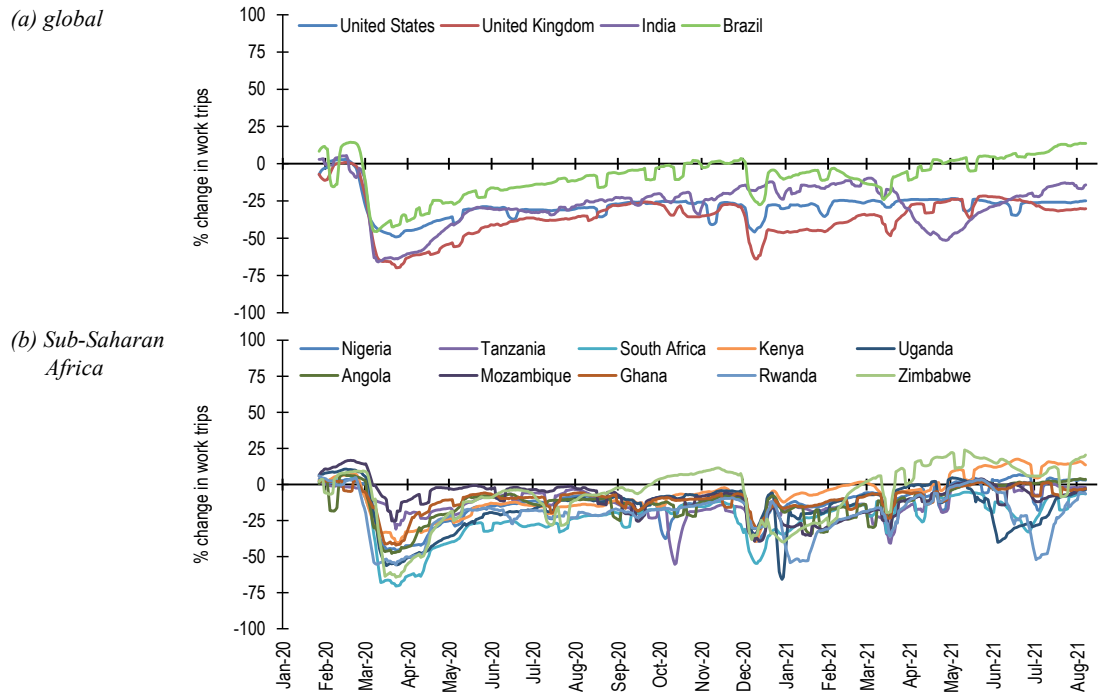
Data sources:
World Bank Open Data (2019); Pew Research Center (2017); Research ICT Africa (2017). Data was not available for Ethiopia.

Changing frequencies for two categories of shopping trips are tracked in Figure 11(a-d). The first (parts a and b) are trips to obtain food and medication supplies essential for household survival. The second (parts c and d) are trips to purchase non-essential items and to participate in other discretionary recreational activities. The figure reveals that shopping trips for essential items returned to baseline frequencies much sooner than trips for non-essential items.

Parts (a) and (b) of the figure reveal short-term reductions in essential shopping trips ranging between 25% and 60%, with a return to, or a surpassing of, baseline levels occurring within three and 13 months. After 18 months, all of the selected global and Sub-Saharan countries had exceeded baseline trip frequencies by between 10% and 70%.

Parts (c) and (d) of the figure reveal short-term reductions in non-essential shopping (and recreation) trips ranging between 25% and 70%, with a return to baseline levels occurring later than essential shopping trips (but slightly earlier than trips to workplaces) for most of the countries observed. For all but Uganda and South Africa, baseline trip making in the selected Sub-Saharan countries had been exceeded after 18 months. In contrast, none of the observed global countries had exceeded baseline levels after 18 months. Accompanying these decreases in shopping trips, significant increases in online retail and urban freight deliveries were observed in the United States and the United Kingdom (UNI Global Union 2020; OECD 2020). While no equivalent data were found for Sub-Saharan African cities, it is reasonable to assume that similar patterns occurred, commensurate to the proportion of households for whom delivery surcharges are affordable.

Figure 10: Change in trips to workplaces, by country (n=14)



Data source: Google COVID-19 Community Mobility Reports

Notes: 1. Global country selection includes the top four countries by number of cases (12 Sep 21).
2. Sub-Saharan African country selection includes the top 10 largest populations, and the home countries of Delphi panelists.
Data was not available for Ethiopia, DR Congo, Sudan, Sierra Leone, and Malawi.

Figure 11: Change in trips to shopping activities, by country (n=14)

(a) global:

grocery and pharmacy

(a) Sub-Saharan Africa:

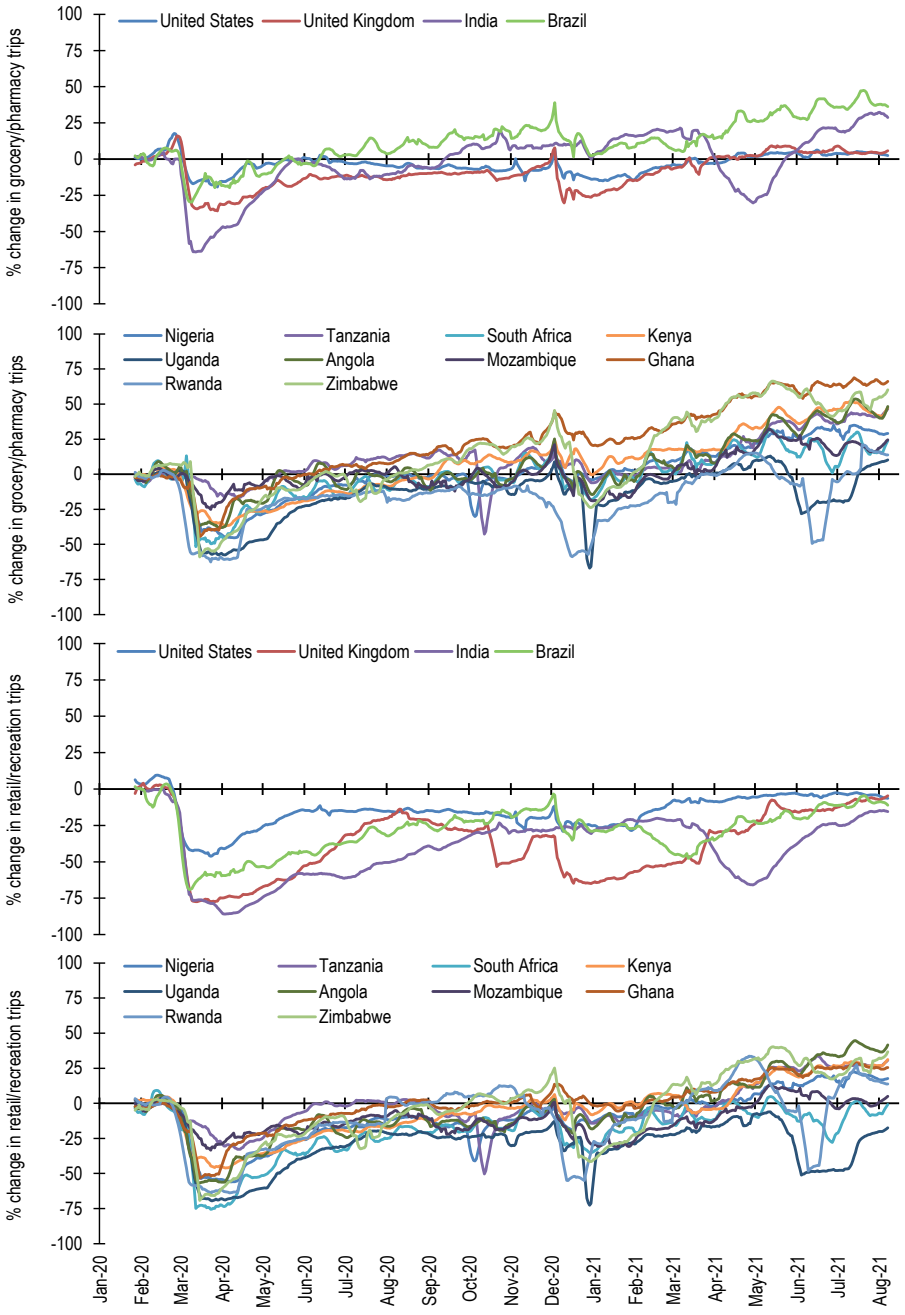
grocery and pharmacy

(c) global:

retail and recreation

(d) Sub-Saharan Africa:

retail and recreation



Data source: Google COVID-19 Community Mobility Reports

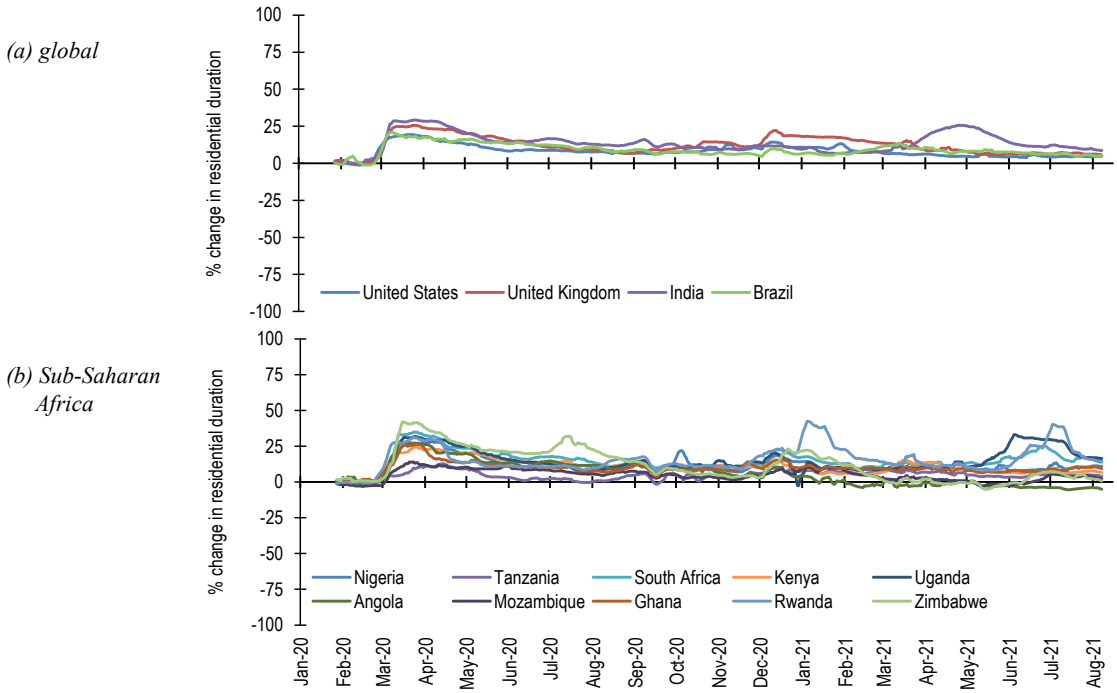
Notes: 1. 'Grocery and pharmacy' trips are to destinations like grocery markets, farmers markets, specialty food shops, drug stores, and pharmacies.
2. 'Retail and recreation' trips are to destinations like restaurants, café, shopping centers, theme parks, museums, libraries, and movie theatres.
3. Global country selection includes the top four countries by number of cases (12 Sep 21).
4. Sub-Saharan African country selection includes the top 10 largest populations, and the home countries of Delphi panelists.
Data was not available for Ethiopia, DR Congo, Sudan, Sierra Leone, and Malawi.

Considering the workplace and shopping-trip frequency patterns presented in Figures 10 and 11 together, with a couple of exceptions (Brazil in the case of work, and Uganda in the case of non-essential shopping), Sub-Saharan African countries have seen a return to (or a surpassing of) baseline trip-making levels earlier than the global comparison countries. This raises the question: if the Sub-Saharan African data were less biased towards the wealthier smartphone-owning population, would the results of this comparison be different? On the one hand, as will be discussed later, poorer households were less able to comply with stay-at-home and movement restrictions, while on the other hand, they had less access to motorised individual mobility to compensate for reductions in public transport service and were more highly impacted by increased unemployment. So, it is not obvious whether the observed return to baseline conditions would have occurred earlier or later if a less biased dataset were available.

Figure 12 presents the corollary of the previous two figures. It illustrates that as trips to out-of-home activities were foregone, or substituted for remote (work, education, social, entertainment, etc.) activity participation, the amount of time people spent at home increased. Apart from Angola, and for a brief period Zimbabwe, all countries continued to show higher-than-baseline time spent at home 18 months from when lockdown restrictions were first introduced.

Figure 13(a-c) presents the perceptions of the Delphi panelists provided in the first-wave survey regarding the impact of lockdown restrictions on travel patterns. Panelists from countries with the least stringent regulations (Tanzania and Malawi) reported the least impact (see part a). Half of the panelists (47%) were undecided on whether the share of individualised private mode use had increased (see part b), but half (47%) perceived the share of walking and cycling to have increased (see part c), which is consistent with other observations in Sub-Saharan Africa (Bird *et al.* 2020) and elsewhere (Axhausen 2020). These perceptions refer to the relative share of modal splits, not to an increase in trip generation. Through an online survey (n=9,394), Barbieri *et al.* (2020, 2021) illustrate that, across 10 countries (including Ghana and South Africa), trip-making by all travel modes declined.

Figure 12: Change in residential duration, by country (n=14)



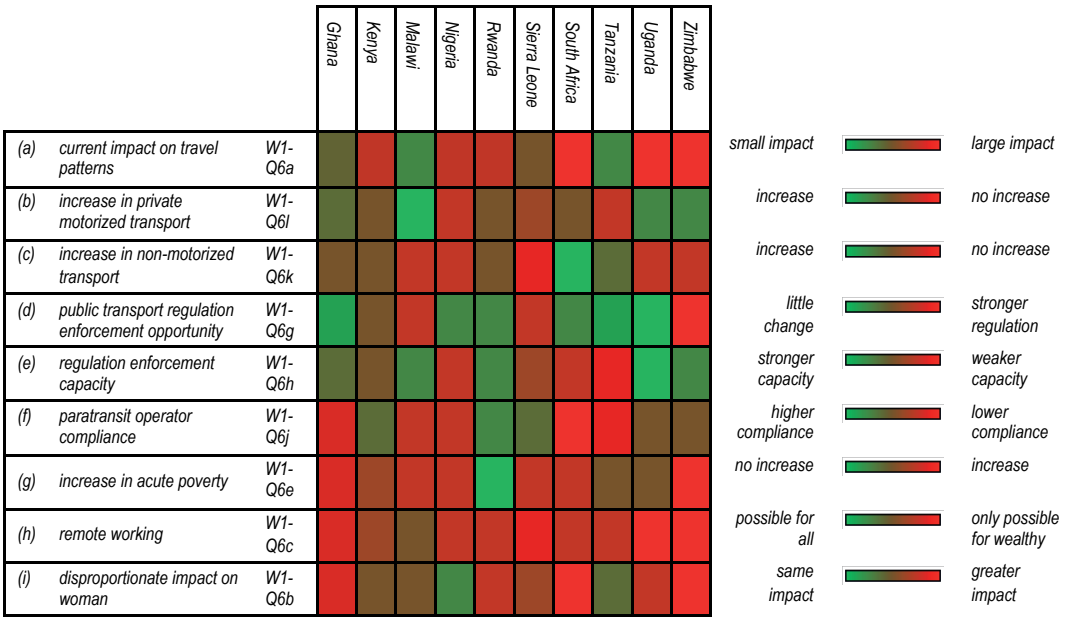
Data source: Google COVID-19 Community Mobility Reports

Notes: 1. Global country selection includes the top four countries by number of cases (12 Sep 21).

2. Sub-Saharan African country selection includes the top 10 largest populations, and the home countries of Delphi panelists.

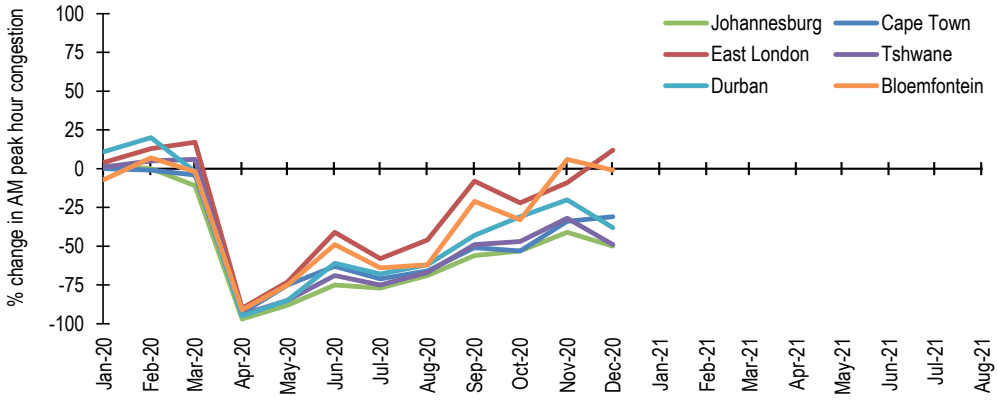
Data was not available for Ethiopia, DR Congo, Sudan, Sierra Leone, and Malawi.

Figure 13: Perceived impacts on travel behaviour, public transport regulation enforcement and compliance, and livelihoods, by country (Delphi Wave 1, n=15)



W1-Q6a. COVID-19 has had a minimal impact of urban travel patterns, and livelihoods have continued as normal.
W1-Q6l. The mode share of cars and motorcycles has increased because of COVID-19.
W1-Q6k. The mode share of walking and cycling has increased because of COVID-19.
W1-Q6g. Authorities took the opportunity of increased regulatory power during COVID-19 lockdowns to enforce existing public transport regulations more strongly.
W1-Q6h. The capacity of public authorities to enforce lockdown regulations in public transport services is weak.
W1-Q6j. The only way for informal public transport operators to survive the COVID-19 lockdown was to not comply with vehicle occupancy and/or other restrictions.
W1-Q6e. The proportion of the urban population experiencing acute poverty has increased during COVID-19.
W1-Q6c. Remote working during COVID-19 is only possible for a wealthy minority.
W1-Q6b. The mobility and access enjoyed by woman has been worse affected by COVID-19 than men.

Figure 14: Year-on-year change in morning peak-hour traffic congestion, by city (n=6)



Data source: TomTom Traffic Index 2020

Notes: 1. The TomTom congestion index measures congestion delay as a percentage increase on free-flow travel times. The values in this chart therefore indicate the percentage change in the mean monthly peak hour congestion delay from the same month in 2019 to 2020.
2. 2021 data was not available.

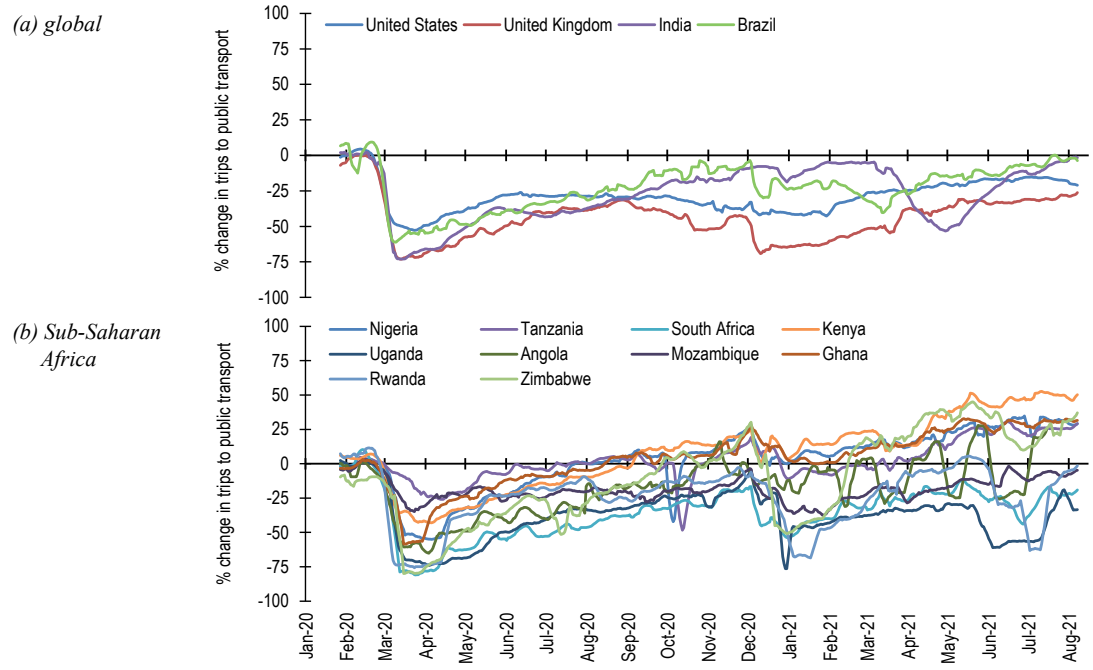
Passenger transport operations

Available comparative secondary data on changes in private transport operations, in the form of the TomTom congestion index, are restricted to South African cities. A comparison of the congestion index data from six cities in Figure 14 illustrates that in the initial months of lockdown morning peak-hour congestion delay declined dramatically (by 87% on average in April-May 2020). Zutari (2020) show corroborating patterns of light-vehicle traffic volumes passing through South African toll roads. Since April 2020, traffic has steadily begun to return. Media reports in mid-2021 suggest that in hyper-congested cities like Kampala, Lagos and Nairobi traffic congestion is near, or at, pre-pandemic levels (Onyango 2021).

More comparative secondary data are available on public transport operations. The most common public transport restrictions in the 11 home cities of the Delphi panelists were reported to be reduced vehicle occupancy (73%), and reduced frequency, if not cancellation, of services (60%). The impact of these lockdown restrictions can be observed in the trips to public transport stations presented in Figure 15(a-b). Apart from Uganda, Rwanda, Mozambique, and South Africa, all the selected Sub-Saharan African countries had surpassed baseline levels after 18 months. In contrast, none of the global comparison countries had surpassed the baseline within this period. Using the same dataset, Brondum *et al.* (2021) analyzed trips to public transport in four country income bands. As a comparison of parts (a) and (b) of Figure 15 suggests, their analysis shows that the low income and lower middle income band countries returned to baseline frequencies earlier than higher income band countries (in December 2020).

The decline in number of passengers indicated in the above figure had an impact on farebox revenue and service viability, and in turn, operator compliance with lockdown restrictions. Brondum *et al.* (2021) note, as do Venter *et al.* 2020, that the data may be skewed in countries where the origins of public transport trips are often not formal public transport interchanges, ranks, stations, or stops. As a result, it is difficult to distinguish between the loss of passengers experienced by formal and informal operators.

Figure 15: Change in trips to transit stations, by country (n=14)



Data source: Google COVID-19 Community Mobility Reports

Notes: 1. 'Transit stations' trips are to destinations like public transport service hubs such as subway, bus, and train stations.
2. Global country selection includes the top four countries by number of cases (12 Sep 21).
3. Sub-Saharan African country selection includes the top 10 largest populations, and the home countries of Delphi panelists. Data was not available for Ethiopia, DR Congo, Sudan, Sierra Leone, and Malawi.
4. Diouf et al. 2020 perform a similar analysis with a different country selection (adding Burkina Faso, Cameroon, Ivory Coast, Mali, Senegal, and Zambia), finding no significant outliers.

Calnek-Sugin and Heeckt (2020) contend that COVID-19 undermined the business model for unsubsidized informal paratransit operators that are reliant upon farebox revenue for viability. Half of the Delphi panelists (47%) reported in the first-wave survey that Sub-Saharan public transport operations became either less, or much-less viable, with the other half indicating either no change (20%) or insufficient evidence to judge (13%). For South Africa, Fobosi (2020), Jennings (2020), Luke (2020) and McLachlan (2020) all report that informal paratransit operators incurred significant losses. This led to various forms of protest and widespread non-compliance with a 70% vehicle-occupancy restriction. As will be described later in section 5.3, the national government removed the vehicle-occupancy restriction for informal paratransit operators eventually. Venter *et al.* (2020) suggest that removing the restriction allowed passenger ridership in informal paratransit services to recover more quickly, because the restriction largely effected a captive market. By contrast, formal bus and train services like the Gautrain operating in South Africa's Gauteng province, often serving a greater choice passenger market, experienced an almost tenfold reduction in ridership. Luke (2020) and Baffi et al. (2021) note that sedan and motorcycle electronic-hailing service providers experienced viability constraints as well, and Scheepers and Bogie (2020) describe how Sub-Saharan African transport network companies pivoted to supplementary courier network services as a mitigation measure.

Figure 13(d-f) presents perceived enforcement and compliance in the 11 home cities of the Delphi survey panelists. The figure illustrates that some governments took the opportunity presented by lockdown conditions to increase their regulatory control over public transport operations (see part d), but that this was not necessarily matched with enforcement capacity (see part e). Most panelists (53%) agreed that compliance with lockdown restrictions amongst informal paratransit operators was low (with 27% indicating they had insufficient evidence to judge).

Livelihoods and exclusion

It has not been possible to monitor the impacts of the pandemic on economic livelihoods in real time, as was possible for trip-making and traffic volumes. However, the emerging fragments of socio-economic data indicate that the unintended impacts of lockdown restrictions have been devastating. Many economies have shed jobs in large numbers and entered into recession, which will have impacted activity participation and mobility as well as the incomes and expenses, and societal inclusion, of households in Sub-Saharan African cities in complex ways.

Figure 13(g) presents the perceptions of the Delphi panelist on the impacts of the pandemic on acute poverty. There was near consensus that the proportion of the urban population experiencing acute poverty has increased. Drawing from several secondary data sources, Teachout and Zipfel (2020) estimated that an additional 9% of the Sub-Saharan African population has immediately fallen into extreme poverty as a result of the pandemic and associated lockdown restrictions. They estimate that, at the end of the first eight weeks of lockdown, 19% of the population could no longer afford their pre-COVID-19 level of food consumption, and 4% of the population was severely food deprived.

Most of the available data on the economic welfare impacts on Sub-Saharan African households is focused on South Africa. Analysing secondary data from an online Statistics South Africa survey, Carlitz and Makhura (2021) found that by the sixth week of lockdown the proportion of respondents reporting hunger increased from 4% to 7%, and the proportion reporting zero income increased from 5% to 15%. Turok and Visagie (2021) analyzed the first and second wave responses (n=7,073 and n=5,676, respectively) in the *National Income Dynamics Study Coronavirus Rapid Mobile (NIDS-CRAM)* survey over a similar period, through the lens of residential location, and found 'spatial asymmetries' that reflect broader societal inequalities. They found the proportion of respondents who reported that their household had run out of money to buy food was 31% in wealthier 'suburbs', and 48% in poorer 'townships'.

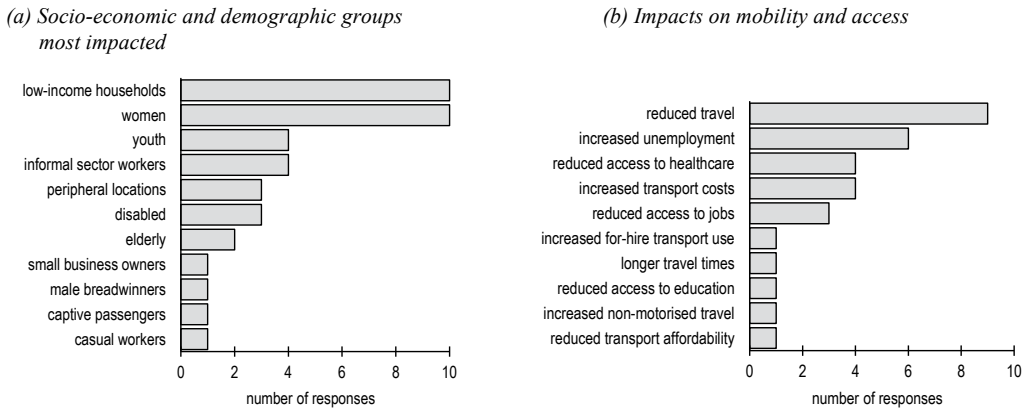
Insights into the extent of job losses can be derived from several metrics. Spaull *et al.'s* (2020) analysis of the NIDS-CRAM data estimated that between 2,5 and 3,6 million South Africans lost their jobs between February and April 2020. Adding a spatial dimension, Turok and Visagie (2021) found that the percentage of adults in paid employment living in 'suburbs' dropped from 58% in February 2020 to 52% in June 2020, and that in 'townships' it dropped from 51% to 42% over the same period. Carlitz and Makhura's (2021) analysis of the Statistics South Africa survey data found 2% of permanently-employed respondents reported losing their jobs in the first six weeks of lockdown, while 5% reported having to close their businesses. For respondents who remained employed during this period, 21% reported reduced income.

Perhaps the most tangible impact on daily household activity schedules was the requirement to stay at home. In a consumer panel survey (n=1,056), undertaken as part of an international comparative study (Balbontin et al. 2021), Venter *et al.* (2021) found that in November of 2020 40% of employees were working five days a week from home. However, as confirmed by the Delphi panelist (see Figure 13(h)), remote working during COVID-19 was only a possibility for a wealthy minority. Using the same residential location categories as Turok and Visagie (2021), Carlitz and Makhura's (2021) analysis of the Statistics South Africa survey data found that in 'suburbs' 88% of respondents were able to work from home, whereas in 'townships' only 5% were able to do so. As a result, low-income households were less able to comply with lockdown restrictions (Peden and Kobusingye 2020; Carlitz and Makhura 2021). Aside from the need to obtain food and water, in a telephonic survey of 20 African Union member countries (n=20 990), PERC (2020) found that the most commonly cited barriers to stay-at-home compliance were fears of running out of money and losing a job.

Figure 16(a) presents the perceptions of the Delphi panelists regarding which socio-economic and demographic groups experienced the greatest impact on their welfare. Low-income households and women top the ranking. Numerous authors have argued that women were more likely than men to have lost their jobs, and that this hardship was compounded by increased demands to provide family care (Casele and Posel 2021; Jennings *et al.* 2020; Jennings and Arogundade 2021; Porter *et al.* 2021). Analysing the NIDS-CRAM data from a gender perspective, Casale and Posel (2021) found that employment of adult South African women declined by 10 percentage points between February and April 2020 (from 46% to 36%), whereas adult male employment dropped by five percentage points (from 59% to 54%).

The Delphi panelists highlighted reduced accessibility (particularly to work, healthcare and education activities) as a feature of the impact of lockdown regulations on economic welfare (see Figure 16(b)). Disproportionality in impacts on accessibility is illustrated by Bird *et al.* (2020), who estimated that lockdown restrictions in Nairobi resulted in five times fewer job opportunities within one hour for people reliant on non-motorised modes, than people with access to cars. The lockdown period may therefore have lasting economic effects that make vulnerable and excluded segments of the population more vulnerable and excluded.

Figure 16: Perceived impacted groups (Delphi Wave 1, n=15)



W1-Q2. Which passengers (in terms of household income, gender, age, and residential location) have been most affected by COVID-19 lockdown regulations, and what have the main impacts on their mobility and access been?

CASE STUDIES

The evidence and perceptions of impacts discussed in the previous section revealed both similarities and heterogeneity in experiences. The purpose of this section is then to explore this similarity and heterogeneity across four cases (see Table 1). The case study unit is both a city and a country, because some available data are not disaggregated to the city scale.

Criteria for case selection included:

- a case with relatively more (Harare/Zimbabwe) and less stringent lockdown regulations (Accra/Ghana);
- because wealthier households were found to be more susceptible to remote activity participation disruptions, a case with relatively higher (Cape Town/ South Africa) and lower (Kampala/Uganda) mean personal income; and
- a case from each of the eastern (Kampala/Uganda), southern (Harare/Zimbabwe) and western regions (Accra/Ghana) of the subcontinent.

Information on each case studied was drawn from secondary quantitative data, a review of previous studies, and the local Delphi panelist(s). Each case is described in terms of: its lockdown regulations; revealed impacts on travel patterns, operations, and livelihoods; and prospects for recovery in mobility and access levels.

'Stomp reflex' in Harare/ Zimbabwe

On 17 March 2020, the Zimbabwean government declared COVID-19 a national disaster and the country entered a national lockdown two weeks later (Dzobo *et al*. 2020). This lockdown involved the closure of educational facilities, non-essential shops, restaurants, and recreational facilities, as well as stay-at-home and public transport restrictions (Haider *et al*. 2020). As illustrated in Figure 17(a), during most of the pandemic the Zimbabwean lockdown has been strict, with an initial stringency index value of 88%. Stringency dipped in February of 2021 but has increased again since then.

Table 1: Case city and country characteristics

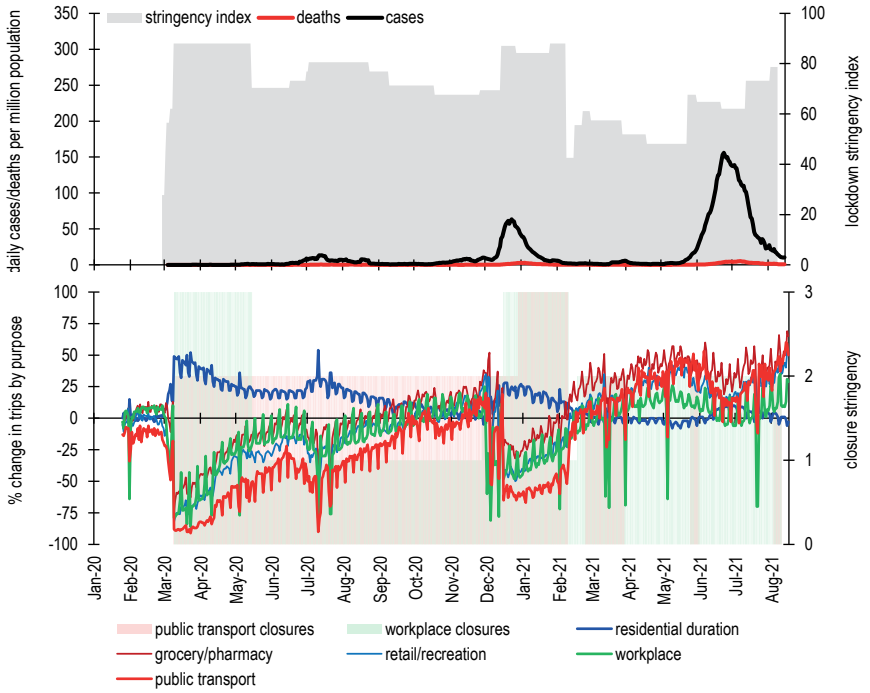
		Harare Zimbabwe	Kampala Uganda	Cape Town South Africa	Accra Ghana
Mean stringency index (Mar20-Aug21)	(country)	71	67	58	48
GDP/capita/annum (USD)	(city)	-	2 655	9 910	3 388
	(country)	1 128	817	5 091	2 328
Gini coefficient	(country)	0,443	0,428	0,630	0,435
Population	(city)	1 529 920	1 680 000	4 005 000	2 557 000
	(country)	14 862 927	45 741 000	60 142 978	31 072 945
Population density (population/hectare)	(city)	18	87	16	15
Urban population (%)	(country)	32	25	67	57
Life expectancy (years)	(country)	62	63	64	64
Mobile phones/1 000 population	(country)	901	574	1 656	1 343
Smartphone ownership (%)	(country)	-	-	51	35
Internet users (%)	(country)	25	-	68	53
Motor cars/1 000 population	(country)	120	8	170	30
Passenger transport services	(city)	bus minibus paratransit sedan paratransit	minibus paratransit motorcycle-taxi	train bus rapid transit bus minibus paratransit sedan paratransit	bus minibus paratransit motorcycle-taxi

Data sources: Our World in Data; World Bank Open Data; Pew Research Center; World's Capital Cities; Statistics South Africa; ODI; CIA

Figure 17: Normalised Harare and Zimbabwe COVID-19 impacts

(a) cases, deaths, and lockdown

(b) trip-making, and closures



Data sources: Our World in Data; Google COVID-19 Community Mobility Reports

Notes: 1. Stringency index, closure, and COVID-19 case and death data are at a country level (Harare accounts for 10,3% of the national population). Trip-making and residential duration data are at a city level.

2. Workplace closure levels: 3=required for all; 2=required for some; 1=recommended; 0=no measures

3. Public transport closure levels: 3=required closing; 2=recommended closing/reduced volumes; 0=no measures

Zimbabwe has experienced three infection waves, each one significantly worse than the last. At the peak of the third wave in June-July 2021, 156 daily cases and 5.2 daily deaths per million were reported (Our World in Data, 2021). During the first two waves, workplace closures were required for all, but since then closures are only required for some workplaces (Our World in Data, 2021). Up until the second wave, it was only recommended that public transport should close, but during the second wave all public transport was prohibited.

In Harare, a ban was placed on the operation of all ~8,000 minibuses (known as *kombis*) and ~500 shared taxis (known as *mshikashika*) everywhere in the city, unless the vehicle was registered with the state-owned bus company (Zimbabwe United Passenger Company [ZUPCO]). Since the ban of unregistered informal transport operators, ZUPCO buses have struggled to serve the increased number of passengers. Passengers report that before the ban the waiting time for a bus was five minutes, compared to an hour or longer after the ban (Aljazeera, 2021). A Zimbabwean Delphi panelist believes the ban is unsustainable:

"... the informal transport sector is banned and therefore recovery is out of the question. However, I am of the view that the informal public transport sector will bounce back post COVID-19 pandemic, when the current arrangements put in place by Government start to show shortcomings." (Panelist 14)

Figure 17(b) illustrates that impacts on trip-making for different purposes in Harare has fluctuated with lockdown stringency. Residential duration increased by ~50% at the beginning of the lockdown, and continued to stay above baseline levels until March 2021. Trips to public transport stations declined rapidly (by ~80%) in March 2020 and again in January 2021, correlating with the beginning of the lockdown and the later closure of all public transport, respectively. In February 2021 trips to public transport stations increased above the baseline. Trips to workplaces, to grocery stores/pharmacies, and to retail/recreation facilities have all followed a similar pattern: a significant decline at the beginning of the lockdown followed by a gradual increase towards pre-pandemic levels (with downward spikes at the time of the first, second, and third waves).

The lockdown has had substantial negative consequences. Extreme poverty is estimated to have increased from 34% in 2019 to 49% in 2020, and approximately 500 000 people have lost their jobs (IMF 2021; Green 2020). According to a Delphi panelist, the population groups most adversely affected by the lockdown in city were:

"... low-income groups, mainly women from 30 to 50 years... They reside principally in high-density areas and rely on public transport to and from work. Transport was completely cut off from their intended destinations, invariably the workplace. The livelihoods of those adversely affected by lockdown have been severely impacted. These people generate their income from informal activities, and they could not access the places they conduct business as well as sourcing the goods for resale. These people could not afford to pay rent as well as buy basic food stuffs. Those in gainful employment either lost their jobs or had their salaries drastically reduced." (Panelist 14)

Speaking about the ability of the bulk of the impacted population to move to online platforms to earn an income, the same Delphi panelist stated:

"I cannot foresee a significant online or virtual interactions uptake. Only a few professionals, mainly in the private sector such as banking, legal, and accountancy firms may opt to continue working from home. These people have access to a car." (Panelist 14)

The authoritarian approach to locking down public transport– referred to elsewhere as a 'stomp reflex' (Kemp 2021) – suggested a government agenda of eliminating informal operators from the city, rather than one of protecting the health of citizens, as suggested by the Delphi panelist:

"Currently in Harare, [informal public transport] is not allowed to operate, and stringent measures have been put in place to ensure that informal transport does not come back on the roads. Government is determined to eradicate the informal public transport system ..." (Panelist 14)

Cases of police brutality towards kombi operations not complying with lockdown regulations have been reported, in one instance resulting in the death of a child (Chibamu 2021). The lockdown damaged the fabric of the city's public transport system and, as a result, the recovery of mobility and access levels will probably be slower than would otherwise have been the case.

'Revamped regulation' in Kampala/Uganda

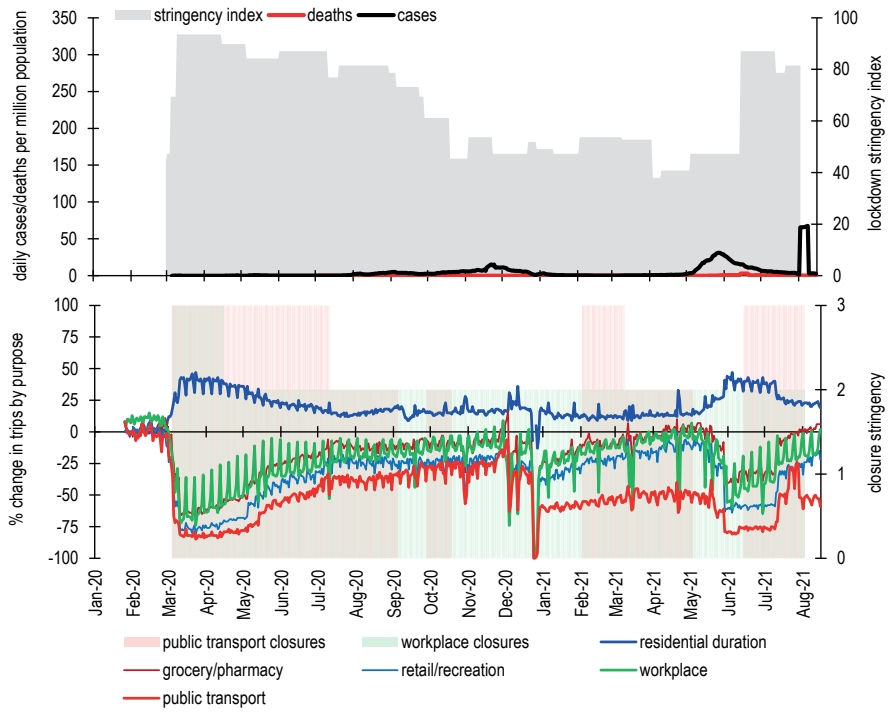
Uganda's lockdown started on 1 April 2020 and involved the closure of educational facilities, public transport, and non-essential businesses, as well as a night curfew and stay-at-home restrictions. Only vehicles transporting goods were allowed to operate. Transporting people was banned. Public transport remained banned for over three months and, when it returned, it was only allowed to operate at 50% capacity. Food stores were permitted to stay open (Jennings *et al.* 2020).

This lockdown was one of the strictest in Sub-Saharan Africa, with an initial lockdown stringency index of 94. The stringency decreased by over 20 units between the two infection waves, but later returned to near initial levels. The severity of this lockdown appears to have had early success in containing the virus, as can be seen in Figure 18(a). Daily cases of new infections only started to rise above five per million in August 2020 (Hong and Schellhase, 2020), and the highest number of daily cases recorded was 68 per million in August 2021.

Figure 18: Normalised Kampala and Uganda COVID-19 impacts

(a) cases, deaths, and lockdown

(b) trip-making, and closures



Data sources: Our World in Data; Google COVID-19 Community Mobility Reports

Notes: 1. Stringency index, closure, and COVID-19 case and death data are at a country level (Kampala accounts for 3,7% of the national population). Trip-making and residential duration data are at a city level.

2. Workplace closure levels: 3=required for all; 2=required for some; 1=recommended; 0=no measures

3. Public transport closure levels: 3=required closing; 2=recommended closing/reduced volumes; 0=no measures

As illustrated in Figure 18(b), residential duration increased by ~50% at the beginning of the lockdown and has remained significantly above the baseline over the remainder of the period studied. Trips to workplaces, grocery stores/ pharmacies and retail/recreational facilities all followed a similar pattern: an initial sharp decrease of ~60% below the baseline, followed by a gradual increase with fluctuations associated with the first and second infection waves. At the time of writing, trip-making for most purposes was still significantly below the baseline. The view of a Delphi panelist in Uganda is that this suppression of trips is unlikely to endure after the pandemic:

"I do not see [virtual interactions substituted for real interactions]. Virtual interactions are facilitated by Internet availability. In my country this has been made worse with heavy taxation on Internet access." (Panelist 03)

Trips to public transport stations decreased by ~78% at the start of the lockdown, and have remained at a level 25% to 50% below the baseline since then. Public transport has been completely open, or operating with reduced capacities, for much of the time since the lockdown started, with the exception of the months of March to September 2020 (the start of the pandemic and lockdown) and the months of February, July, and August 2021, when public transport services were completely suspended. In Kampala, the city authority used the increased enforcement capability associated with lockdown regulations to ensure minibus compliance with the route specifications of operating licenses. Increased enforcement by security personnel resulted in the fatal shooting of a non-compliant motorcycle-taxi (known as *boda-boda*) rider (Pedan and Kobusingye, 2020). The heavy enforcement of the transportation lockdown in Kampala is illustrated by the following Delphi panelist response:

"Minibus-taxis ..., boda-bodas, and buses (for inter-city movements) were all stopped. Even private vehicle movements were limited to proven emergency movements. Only bicycle use and walking was allowed. These regulations have been heavily enforced with roadblocks mounted on all highways and at district boarder points. Local level enforcements have been enforced by routine local Defense Force foot patrols. Culprits have been harshly punished." (Panelist 03)

The lockdown has also had damaging effects on livelihoods, and the mobility of the poorer population has reduced due to declining disposable income. The population groups that were most affected included:

"...those who are heavily reliant on public transport and stay far away from the city centers where their work is situated. Women are the most affected ... The other group affected is the disabled that relies on public transport. Walking in Uganda was not restricted. However, most businesses that generate income for the low-incomed section of the population – who normally walk to work – were closed down. (Panelist 03)

Despite extensive lockdown regulations and their enforcement, there have been some constructive outcomes. The Kampala Capital City Authority (KCCA) took advantage of the temporary large-scale switching from minibus public transport (known as *matatus*) to walking and cycling modes, to upgrade some of the city's infrastructure and improve public transport facilities (e.g., an upgrade of the Old Taxi Park, a large *matatu* terminus in the city center). A major road in the city was also converted into a 2 km-long non-motorised transport corridor (Mimano, 2021).

When public transport closures were lifted, KCCA imposed new regulations on *boda-bodas* and *matatus*. Minibuses had to re-register with the authority and were assigned specific routes, which Mimano (2021) suggests brought order to the previously chaotic network. Motorcycle-taxis had to register and operate their services through an online platform that allowed for contact tracing (Diouf et al. 2020).

In the case of Kampala, the prospects of a swift recovery of the population's mobility and access are mixed. The heavy lockdown may have negatively impacted livelihoods more than necessary, but opportunities to make lasting improvements to the city's public transport infrastructure were exploited.

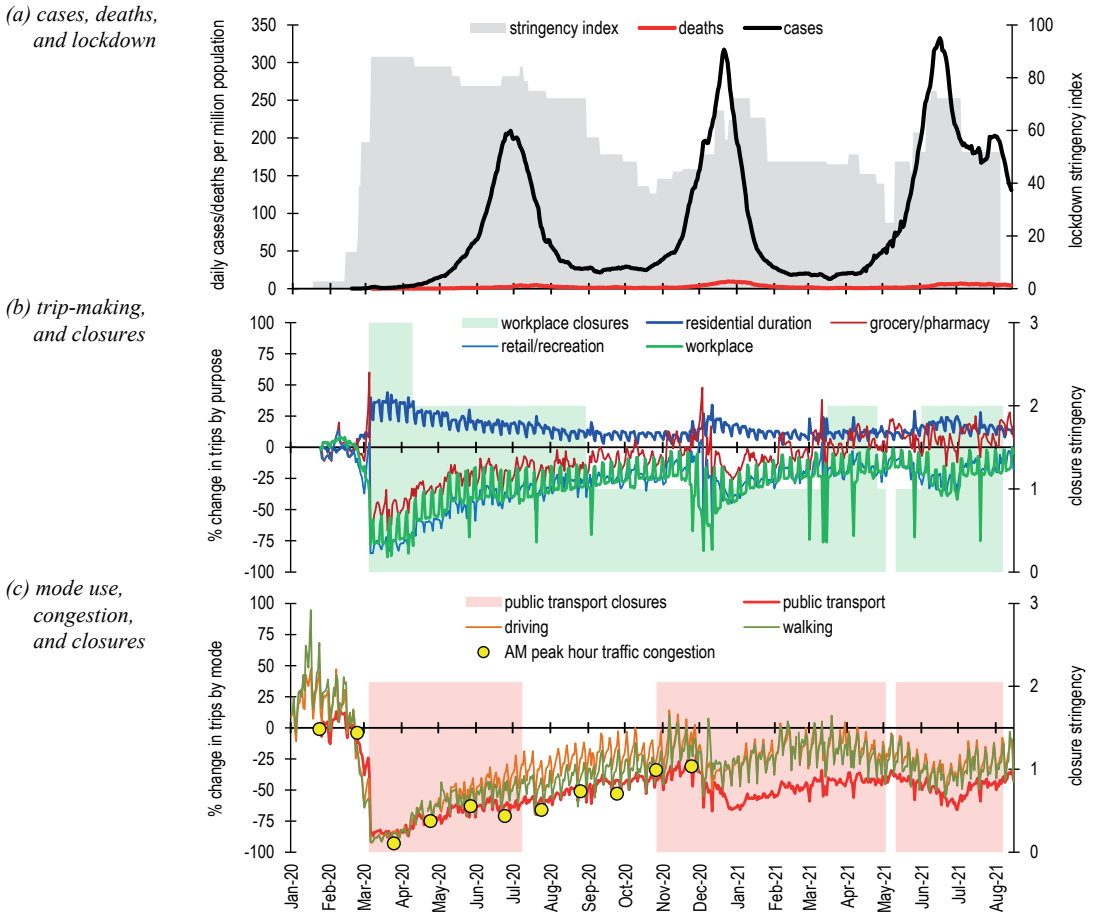
'Lockdown reflex' in Cape Town/South Africa

Despite imposing one of the more stringent lockdowns on the continent, which began on 26 March 2020 with an initial stringency index of 88, South Africa has recorded the highest number of COVID-19 cases in Sub-Saharan Africa, recording over 320 daily infections per million at the peak of its third wave. Lockdown regulations were set at five levels of severity. The first and most stringent level (5) ended on 31 April 2020. This lockdown severely limited people's movement. All public transport was suspended, except for those transporting essential workers, and service providers were only allowed to operate within a limited service span and at limited occupancy. All movement outside of the home, including exercise, was prohibited, apart from essential grocery shopping and medical trips (Jennings, 2020).

During the initial Level 5 lockdown restrictions, all train services were suspended and only essential workers were carried by formal bus or informal minibus-taxi services operating at 50% vehicle capacity. From 1 May 2020, the country began to move to lower lockdown levels. At Levels 4 and 3, minibus-taxis were permitted to operate at 70% capacity on the condition that all occupants wore masks and sanitized and all windows remained open. At Level 2, train services resumed at 70% capacity, and formal bus and minibus-taxi services were permitted to operate at 100% vehicle capacity (Bruwer *et al.* 2021). The lower lockdown levels allowed for higher degrees of individual movement and non-essential businesses and shops were permitted to open.

As illustrated in Figure 19(b), trips to work and retail/recreational facilities in Cape Town followed a familiar trend, with a sharp initial decrease (~80%), and a gradual increase towards the baseline as the lockdown levels decreased. Trips to grocery stores/pharmacies followed the same trend, except for spikes at the beginning of the lockdown and in December and April associated with panic shopping and holidays. Residential duration also followed a common pattern: an initial increase of ~40%, following by a gradual decrease. In August 2021, residential durations were still ~15% above the baseline.

Figure 19: Normalised Cape Town and South Africa COVID-19 impacts



Data sources: Our World in Data; Google COVID-19 Community Mobility Reports; Apple Mobility Trends Reports; TomTom Traffic Index 2020

Notes: 1. Stringency index, closure, and COVID-19 case and death data are national (Cape Town accounts for 7,2% of the national population).
2. Workplace closure levels: 3=required for all; 2=required for some; 1=recommended; 0=no measures
3. Public transport closure levels: 3=required closing; 2=recommended closing/reduced volumes; 0=no measures
4. Trip-making and travel mode use data are for the Western Cape province (Cape Town accounts for 64% of the provincial population).
5. The TomTom congestion index measures congestion delay as a percentage increase on free-flow travel times. The values in this chart therefore indicate the percentage change in the mean monthly peak hour congestion delay from the same month in 2019 to 2020. 2021 data was not available.

Walking, driving, and morning peak congestion levels all followed a similar trend: a sharp decrease, followed a gradual fluctuating increase (see Figure 19(c)). The initial closure of public transport for non-essential workers is reflected in an ~85% reduction in trips to public transport stations. These trips began to move towards base levels as the lockdown severity decreased, but with dips in conjunction with the second and third infection waves.

Decreased passengers and farebox revenue put public transport operators under financial strain. In the case of train services, a decline in service levels that started prior to the pandemic was exacerbated. Between 2015 and 2000, passenger volume decreased by 15% annually (Onderwater 2021). When train services started operating again during Level 2 restrictions (at 70% capacity), passenger trips were particularly low (98% lower than in

July 2021) (Bruwer *et al.* 2021). During the second wave the 70% vehicle occupancy restriction was re-imposed on minibus-taxis (Jennings *et al.* 2020) but was short-lived due to high non-compliance and protests. Despite efforts by both the government and the national minibus-taxi council to provide financial compensation for reduced ridership levels, minibus-taxi operators found it difficult to remain viable at reduced capacity (Bird *et al.* 2020). Venter et al. (2020) argue that the considerable political power of the South African minibus-taxi industry was evident during this time.

The Red Dot and Blue Dot initiatives, launched in May 2020, under which minibus-taxi associations collaborated with the Western Cape Government reflect potentially positive regulatory responses. The Red Dot initiative engaged minibus-taxi operators in providing transport for essential healthcare workers and COVID-19 patients (Western Cape Government 2020), while the Blue Dot initiative (ongoing at the time of this publication) incentivises improved minibus-taxi compliance and service quality (Londt 2021). A further positive outcome was a temporary decrease in fatal road crashes during lockdown restrictions. Easter holiday fatalities, for instance, decreased by 83% in 2019 compared to 2020 (Bruwer *et al.* 2021).

The lockdown in Cape Town, and South Africa as a whole, has had a devasting effect on the economy and the livelihoods of citizens. Many businesses, particularly those dependent on physical exposure to customers like restaurants, were forced to permanently close due to lack of income. As mentioned earlier, around three million people are estimated to have lost their jobs between February and April 2020, and that the country's GDP was reduced by 16% (Turok and Visagie, 2021). In the words of a Delphi panelist in Cape Town, those worst affected by the lockdown were:

"... public transport users, who were resident in areas where they were unable to walk to places of employment, food, healthcare (thus mostly people living in lower-income areas). Women were more affected [than] men - for various reasons, among which include being the primary purchasers of food/household items/mobility of care. Further, if women had been working outside of the house, this often involved domestic or care work, and employers were reluctant to have in their homes people who travelled on public transport. Because in the early days of lockdowns (in SA), informal trade was prohibited, women had to travel further to purchase food. Primary health and routine health treatments were neglected, as women were less able to take people in their care to such (where vehicle capacities were reduced, and costs increased, this affected people particularly who travel with those in their care). Private car owners were best off, of course." (Panelist 09)

In the case of Cape Town, the recovery of the population's mobility and access will be impeded by negative impacts on livelihoods. It is possible that the long-term economic damage and suffering caused by what Turok and Visagie (2021) refer to as the 'lockdown reflex' will outweigh the loss and suffering caused by the virus itself.

'Light touch' in Accra/Ghana

A stringent lockdown in Ghana began on 30 March 2020 (with a stringency index of 86), but only lasted for just over three weeks. This lockdown included closure of educational facilities and a stay-at-home restriction that permitted people to only leave their homes to obtain essential items or services (Flowminder, 2020). At this lockdown level, public transport (in the form of buses and minibuses known as *tro-tros*) was allowed to operate at 67% vehicle occupancy. This capacity restraint continued for some time after the initial stringent lockdown was eased.

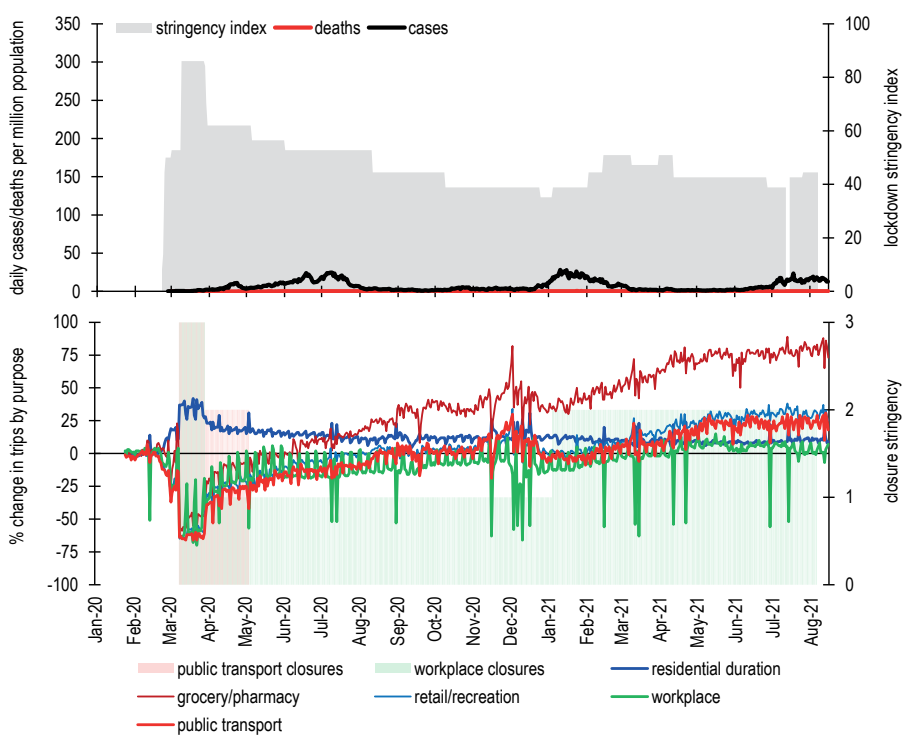
Since the initial stringent lockdown, restrictions have been moderate, varying between 40 and 50 on the stringency index. Despite its less-restrictive lockdown, Ghana only recorded 28 new infections per million per day and 0.4 daily deaths per million at the peak of the second wave, which is low in comparison to other Sub-Saharan African countries. Like the other countries studied, Ghana has experienced three infection waves.

In Accra, residential duration and trips to work, public transport stations, and shops initially followed the same pattern as in other countries: residential duration peaked initially, and the aforementioned trips decreased significantly below the baseline. However, residential duration returned to near pre-pandemic levels a few months after the lockdown was lifted, and all categories of trips recovered relatively quickly.

Figure 20: Normalised Accra and Ghana COVID-19 impacts

(a) cases, deaths, and lockdown

(b) trip-making, and closures



Data sources: Our World in Data; Google COVID-19 Community Mobility Reports

Notes: 1. Stringency index, closure, and COVID-19 case and death data are at a country level (Accra accounts for 8,2% of the national population). Trip-making and residential duration data are at a city level.

2. Workplace closure levels: 3=required for all; 2=required for some; 1=recommended; 0=no measures

3. Public transport closure levels: 3=required closing; 2=recommended closing/reduced volumes; 0=no measures

"Since the easing of the lockdown restrictions, every aspect of life, including public transport use and travel behaviour, has returned to pre-COVID-19 levels with little variations, if any." (Panellist 8)

The initial decrease in trips of ~65% at the beginning of lockdown quickly returned to a near baseline level, and after March 2021 most of these trip-types rose to above the baseline value, with trips to grocery stores and pharmacies being ~80% over the baseline 18 months later. Trips to public transport stations, retail/recreational facilities and workplaces have also recovered to above baseline values. The fact that trips to workplaces returned to pre-pandemic levels quickly suggests that there has been limited remote working. As stated by a Delphi panelist from Accra:

"... only for certain personnel of public agencies/private companies who (i) are equipped with laptops that they can bring home and (ii) have a reliable Internet connection at home. It is mostly the case for the richest segment of the population, who tend to stay in central areas of the city (i.e., do shorter trips) and use private modes of transport ..." (Panelist 12)

Although the lockdown in Accra was less restrictive than in other cities there has still been a negative effect on the economy. During the lockdown, many people reliant on public transport were unable to work:

"The public transport captives, which includes the urban poor and the low-waged workers, are the most affected of all passengers. The lockdown regulations have meant they are restricted in terms of access to their routine activities and means of livelihood." (Panelist 08)

However, overall, the effect on the economy and people's livelihoods appears not to have been as severe as in the other cities studied:

"Here in Accra, life seems to be going on as usual, regardless of the pandemic. COVID-19 has not prevented people (especially those being referred to as 'poor') from engaging in their day-to-day activities. In fact, the pandemic is even more the reason why they will persevere in their hustle, because they need to earn an income and still find a way to live through the already harsh economic conditions that existed before COVID-19." (Panelist 12)

In the case of Accra, the prospects of mobility and access recovery appear better than in the preceding cases studied. The country was fortunate not to experience high COVID-19 infection and death rates. The 'light touch' approach to lockdown did not damage the economy and livelihoods as much, and the public transport system has remained largely intact.

FUTURE IMPACTS

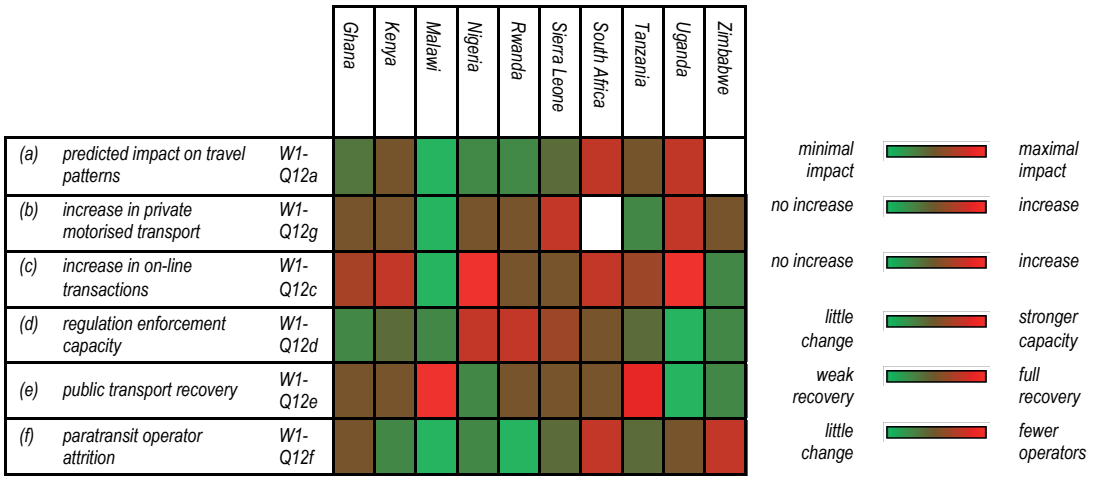
As discussed in sub-section 2.3, the rationale for conducting a Delphi survey was that it is a method suited to exploring possible futures in circumstances where past experiences do not provide a sound basis for the development of mathematical forecasting models. In sub-section 2.4, a set of theoretical perspectives ('self-perception theory, 'land rent theory', a 'regulatory cycle', and 'time geography') for use in conceptualising possible future impacts and in interpreting available evidence was discussed. This section draws from the majority view of the Delphi expert panel in the second-wave survey, and from the identified theoretical perspectives, to discuss likely future impacts of the pandemic on urban transport in Sub-Saharan Africa. The impacts, which are envisaged to be relevant in multiple Sub-Saharan African contexts, are discussed in terms of: changes in travel patterns (sub-section 6.1); disruptions to passenger transport operations (sub-section 6.2); and impacts on household livelihoods and social inclusion (sub-section 6.3).

Travel patterns

As discussed earlier, Bem's 'self-perception theory' provides a useful lens through which to consider the long-term impacts of temporarily imposed lockdown restrictions on patterns of trip generation and trip substitution. Applying this theory, the imposed (or at least encouraged) increase in remote activity participation during more stringent lockdown periods – provided the experience is good – can make attitudes towards remote working, schooling, and shopping more positive, and subsequently lead to enduring trip substitution after activity destinations are fully opened and restrictions on movement are removed.

Based on first-wave survey perceptions, a proposition was formulated to test this theoretical perspective in the second-wave survey. The first-wave survey did not establish a majority view on whether travel behaviour patterns will return to what they were before the pandemic

Figure 21: Predicted impacts on future travel behaviour, and public transport regulation enforcement and recovery, by country (Delphi Wave 1, n=15)



W1-Q12a. Once COVID-19 has passed, travel behaviour patterns will resume to what they were before.
W1-Q12g. The mode share of individualised travel via cars and motorcycles will increase after COVID-19 has passed, because of disruptions to public transport service capacity.
W1-Q12c. There will be greater online shopping and personal business transactions across the entire population after COVID-19 has passed
W1-Q12d. The regulatory and enforcement capacity of public transport authorities will be stronger than before, after COVID-19 has passed.
W1-Q12e. Public transport operations will recover to what they were before the COVID-19 pandemic started.
W1-Q12f. There will be fewer illegal or unregulated public transport operators after COVID-19 than before.

(50% yes, 36% no, and 14% undecided, see Figure 21(a)). In contrast to studies elsewhere (Barbieri *et al.* 2021), there was also uncertainty on whether individualised private motorised transportation would increase (21% yes, 28% no, and 50% undecided, see Figure 21(b)), and on whether there will be greater online shopping and personal business transactions after COVID-19 has passed (34% yes, 33% no, and 33% undecided, see Figure 21(c)).

The first-wave survey nevertheless established a consensus view that a relatively small portion of a city's population that will have the resources to engage productively with remote activity participation platforms (see Figure 13(h)), and a majority view that the activities most likely to be participated in remotely would include work and business meetings (identified by the most panelists), followed by shopping, and tertiary education. A proposition was formulated as follows:

There are likely to be post-pandemic increases in remote working, shopping, and education as a result of COVID-19 disruptions, but this will only be possible amongst a wealthy minority of the population in Sub-Saharan African cities with the resources necessary to do this. While this segment of the city population will enjoy greater time-space flexibility to cope with hyper-congestion, city-wide impacts from remote activity participation on traffic congestion and passenger volumes will be small.

There was no disagreement with this proposition: 12 (86%) panelists agreed (43% agreed strongly). The two panelists who abstained were based in Nairobi. The accompanying explanation indicated that there are confounding contextual dynamics in Nairobi that make it difficult to predict the causes of future changes, even if it is evident that remote activity participation has increased and congestion levels have returned to base conditions:

"In Nairobi, traffic congestion is back to [the] pre-COVID situation. However, there is an increase in remote working, shopping, and education. Part of the congestion is attributed to the ongoing Nairobi expressway construction – therefore confounding the observations." (Panelist 02)

The other theoretical perspective identified earlier that provides a lens through which to consider long-term disruption to trip patterns is Alonso's 'land rent theory'. Applying this theory, the emergence of large-scale 'hybrid' work practices and increased online retailing, entertainment, and dining as a result of COVID-19 stay-at-home restrictions might decrease the sensitivities of some business and commercial land uses to the cost of physical access. This would enable them to survive on less accessible, cheaper land (or at least to reduce their land area requirement), and thereby disrupt the 'bid rents' of competing land-use activities in city centers. This might lead to new land uses emerging in the place of some shops, offices, theatres, restaurants, and parking garages, which would in turn change the distribution of trip attractions and productions across cities and alter travel patterns.

Based on first-wave survey perceptions, a proposition was formulated to test this theoretical perspective in the second-wave survey. The first-wave survey did not establish a large majority view on whether businesses will maintain greater online or virtual business operations after the pandemic (53% yes, 40% no, and 7% undecided), and whether this will impact city center land rents and land-use distributions. As illustrated in the following two diverging perspectives:

Referring to Nairobi: *"Many are expected to maintain online and virtual operations with drastic effect on the rental businesses. Many offices are not occupied, other renters have moved to better and cheaper premises, while others have fully shifted to working from home. This applies to both middle- and high-income groups, including international agencies, many who are still working abroad."* (Panelist 15)

Referring to Kigali: *"Most of the businesses will resume physical operations …. I see not much effect on city center land rents and land use distributions. Possibly what I see might grow is home deliveries of goods that gained momentum during COVID-19 times."* (Panelist 01)

As indicated earlier, the first-wave survey did nevertheless establish a consensus view that a portion of a city's population will have the resources to engage productively with remote activity participation platforms, and that economic impacts have been severe. A proposition was thus formulated as follows:

While there are likely to be post-pandemic increases in remote working and shopping amongst a wealthy minority, there is unlikely to be a large enough shift to remote business and retail activity to significantly disrupt land use distributions in Sub-Saharan African city centers.

Changes in post-pandemic city-center land-use mix will more likely be the result of business attrition resulting from COVID-19-induced, or accelerated, economic recession. These changes may be significant in countries hardest hit economically.

There was consensus on this proposition: all panelists agreed (29% agreed strongly). One panelist did, however, offer the following caveat:

"This is the general truth, although there wasn't much business attrition in Dar es Salaam except those linked to international trade." (Panelist 07)

Passenger transport operations

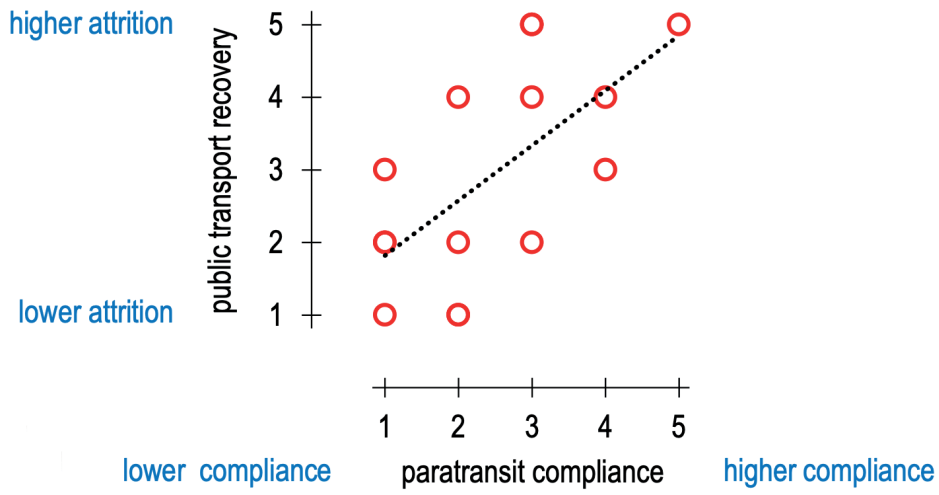
As discussed earlier, Gwilliam's 'regulatory cycle' provides a useful lens through which to consider the long-term disruptive effects of lockdown regulations on public transport operator attrition and changes in service mix. In terms of this conceptualisation, the reduced financial viability resulting from reduced ridership and farebox revenue during the pandemic, if unmatched by sufficient compensatory state subsidy, might nudge a change in cycle phase and lead to a growth or decline in informal operators.

Based on first-wave-survey perceptions, a proposition was formulated to test this theoretical perspective in the second-wave survey. The first-wave survey did not establish a majority view on whether public transport operations will recover to pre-pandemic levels (47% yes, 40% no, and 13% undecided, see Figure 21(e)). It did, however, establish a (weak) majority view that, despite efforts to assert greater control during the pandemic, the regulatory and enforcement capacity of public transport authorities will not be strengthened in the long-term (53% agree, 20% disagree, and 27% undecided, see Figure 21(d)), and that there will not be a thinning of illegal or unregulated public transport operators (53% agree, 20% disagree, and 27% undecided, see Figure 21(f)). A (moderate) correlation (p=0,6351) was found between predictions of public transport service recovery and perceived operator compliance: the stronger the perceived non-compliance, the stronger the predicted resilience (see Figure 22). Common perspectives on paratransit recovery are illustrated below:

Referring to Blantyre: *"Already the paratransit is going back to normal operations with normal carrying capacities. There are more entrants into paratransit, not because of COVID-19, but because of lack of formal public transport, hence an opportunity for paratransit operators. I do not envisage any long-term impact on the current services."* (Panelist 04)

Referring to Harare: *"The informal sector will bounce back. The bus company will no longer be able to provide a reliable efficient and demand-responsive service and there will [no] justification [to] not allow minibuses to operate."* (Panelist 14)

Figure 22: Correlation between perceived operator compliance, and predicted public transport recovery (Delphi Wave 1 and 2, n=15)



W1-Q12e. Public transport operations will recover to what they were before the COVID-19 pandemic started.
W1-Q6j. The only way for informal public transport operators to survive the COVID-19 lockdown was to not comply with vehicle occupancy and/or other restrictions.

A proposition was thus formulated as follows:

While impacted by reduced fare box income during the pandemic, and experiencing some attrition, the informal public transport sector will be sufficiently agile and atomized to recover service supply to pre-COVID-19 levels when passenger demand increases. The informal public transport operators will be more resilient, and will recover quicker, than formal public transport operators burdened by service level agreements and labor regulations.

There was no disagreement with this proposition: 10 panelists (72%) agreed (43% agreed strongly). However, there were three panelists who were undecided, and one panelist abstained. The accompanying explanations indicate that the reason for doubt was an absence of formal public transport undertakings in the city to compare paratransit with:

"In Malawi ... there is no formal public transportation within the cities. ...Informal public transport is conspicuously surviving, albeit [with] emerging competition from other [informal transport] modes e.g., motorcycles and small engine sedan vehicles." (Panelist 04)

"In Kenya, we have only informal public transport systems. These systems are likely to recover with the relaxation of COVID-19 ... [and] social distancing. The vehicles now carry to full capacity, while charging increased fares (raised during COVID-19)." (Panelist 02)

Mimano (2021) and Calnek-Sugin and Heeckt (2020) suggest that a positive outcome of the social distancing imperatives during the pandemic may be a renewed willingness to adopt cashless fare collection in paratransit services, where previous attempts to do so have failed to endure beyond pilot phases (Tinka and Behrens 2019). Similar arguments can be made for ride-sourcing and ride-matching platforms.

Livelihoods and exclusion

As discussed earlier, Hägerstrand's 'time geography' provides a useful lens through which to consider reduced mobility and access, and associated impacts on livelihoods and economic and societal inclusion. Applying this theory, the increased capability constraints amongst the most vulnerable and marginalised households (i.e., the reduced ability to pay for private and public mobility) resulting from job losses, and reduced incomes stemming from the pandemic's impact on the local economy, might reduce activity participation 'domains' and increase social exclusion.

Based on perceptions expressed in the first-wave survey, a proposition was formulated to test this theoretical perspective in the second-wave survey. The first-wave survey did not establish a majority view on whether access and mobility (and associated livelihood) impacts would be disproportionate across socio-economic groups (36% yes, 29% no, and 36% undecided). As illustrated in the following two diverging perspectives:

Referring to Cape Town: *"It seems that public transport and the minibus-taxis sector (except for strikes) are back to 'normal', but people who depended on rail will have a challenge (which was already in the pipeline). Reduced mobility is more likely to be an outcome of reduced income rather than reduced options."* (Panelist 09)

Referring to Blantyre: *"In terms of transport, no. I believe the situation will go back to normal. Of course, some will have lost their jobs but in regard to transport I do not think much will change."* (Panelist 04)

The first-wave survey nevertheless established a majority view that the proportion of the urban population experiencing acute poverty has increased (73% yes, 14% no, and 13% undecided), and that women have been more adversely impacted by COVID-19 with respect to mobility and access than men (60% yes, 14% no, and 27% undecided). A proposition was thus formulated as follows:

There are likely to be increases in economic hardship resulting from COVID-19 disruptions, and poorer households will travel less than they did before the pandemic started. But this reduction in (motorised) mobility will be due to increased unemployment, reduced informal sector markets, and reduced household income, rather than trip substitution resulting from shifts to remote activity participation. Social exclusion amongst poor and vulnerable households, particularly women, will increase as a result.

There was majority agreement with this proposition: 10 panelists (72%) agreed (22% agreed strongly). Two panelists disagreed. The accompanying explanations suggest that the basis for disagreement was limited disruptions during less stringent lockdowns:

"There was almost no disruption to public transport in Dar es Salaam during COVID-19, at least up to this third wave of delta virus." (Panelist 07)

"Here in Accra, life seems to be going on as usual, regardless of the pandemic. COVID-19 has not prevented people (especially those being referred to as 'poor') from engaging in their day-to-day activities." (Panelist 12)

A further two panelists abstained. The accompanying explanations suggest that households developed coping strategies to deal with transport system disruptions:

Referring to Sierra Leone: *"While poorer households are likely to travel less, many in Sierra Leone are substituting to walking. For longer travels (e.g., to attend, family programs or other ceremonies in distant places) they can put resources together and send one or two representatives to attend."* (Panelist 11)

Referring to Blantyre: *"I know of some women in the low-income category who are willing to travel more frequently and cover more distance to employment than they did before the pandemic. And the link between social exclusion, gender, travel and employment may not be a simple one to establish."* (Panelist 04)

POLICY IMPLICATIONS

Although incomplete and biased, the available evidence presented in section 4 has suggested that the largest impacts of the pandemic on mobility and access in Sub-Saharan African cities have taken the form of:

- lower trip generation due to increased remote activity participation;
- decreased accessibility due to reduced transport service availability;
- decreased operator viability due to decreased ridership and farebox revenue; and
- increased social exclusion due to decreased travel capability.

The case studies presented in section 5 have suggested that lockdown regulations induced shifts in relations between public transport authorities and public transport operators. In some cases (Harare/Zimbabwe and Kampala/Uganda) the regulatory authority appears to have emerged stronger, while in others (Cape Town/South Africa) the informal operators appear to have emerged more powerful.

It was concluded in section 6 that the largest long-term urban transport impacts felt by city populations will likely take the form of:

- increased remote activity participation and fewer work and business trips, but limited to better-resourced households;
- disrupted trip distributions, as the mix of city-center land uses is impacted by business attrition;
- reduced transport service availability due to operator attrition, particularly amongst unsubsidized formal operators; and
- reduced accessibility of vulnerable groups due to decreased economic welfare.

What then are the policy implications of these revealed and predicted impacts and shifting power relations, and how should transport policymakers and practitioners respond, or 'build back better,' to use the mantra that has emerged during the pandemic? This section discusses these responses in terms of how Sub-Saharan African transport authorities might: adjust their policies and planning practices in response to disrupted travel patterns (sub-section 7.1); aid passenger transport system recovery (sub-section 7.2); and mitigate livelihood and social exclusion impacts (sub-section 7.3).

Adjusting to disrupted travel patterns

With regard to adjusting policies and planning practices in response to disrupted travel patterns, **three interventions are recommended.**

Support digital connectivity

The first intervention, as advanced by the United Nations (2020), is for Sub-Saharan African governments to seize the opportunity presented by accelerated digitalization during the pandemic to improve digital connectivity in the form of investments in Internet access and various forms of digital service delivery. Lyons and Davidson's (2016) conceptualisation of a 'triple access system' offers a useful way for transport authorities to consider incorporating a 'digital connectivity' dimension into their city transport plans. Investing in digital infrastructure will support 'hybrid work', 'blended learning', and other forms of online interaction. Transport authorities can complement digital infrastructure investments with travel demand management strategies that promote remote activity participation (e.g., flexible work hours and days, and neighborhood workstations).

Plan for (deeper) uncertainty
The second intervention is to adopt transport planning practices suited to uncertainty. Conventional forecast-led, or 'predict and provide', approaches to city transport planning fail to capture the uncertain nature of travel demand, and can entrench undesirable trends. The pandemic has highlighted the limitations of long-range demand forecasting as a basis for planning city transport system improvements. No city's travel demand forecasts would have anticipated the pandemic's disruption of travel patterns. Chatterjee *et al.* (2021) argue a transition is needed in transport planning and appraisal, from 'predict and provide' to 'decide and provide'. The latter sets out a preferred future and charts a course towards it that allows for uncertainty, rather than being forecast-led. Uncertainty becomes an opportunity for transport planners to shape the future, rather than to simply respond to a prediction. The 'decide and provide' approach involves testing the robustness of plans with scenario-based representations of uncertainty. Further research is needed on the technical dimensions of this approach and what would be appropriate in a Sub-Saharan African context.

Consolidate non-motorised transport gains
The third intervention is to consolidate the gains in non-motorised transport use that resulted from lockdown restrictions on motorised transport. Many authors have identified this as a key policy response on the grounds that non-motorised modes are resilient, affordable, healthy, and integral to passenger access to public transport services (Brondum *et al.* 2021; Diouf et al. 2020; Welle and Avelleda 2020). Others have suggested that there is scope for Sub-Saharan African cities to adopt the 'tactical urbanism' practiced elsewhere during the pandemic (Dalkmann and Turner 2020; Jobanputra and Jennings 2021; Samuel and Abubaker 2020). This would involve experimenting with temporary street pedestrianisation and bicycle lanes. Such 'pop-up infrastructure' can be abandoned, or relocated, if there are unintended adverse impacts.

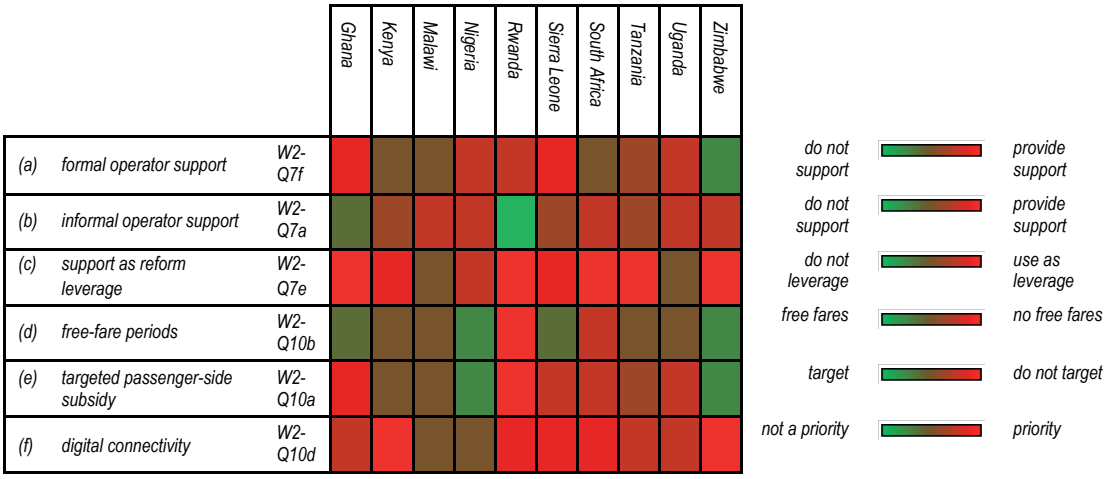
Aiding transport service recovery

With regard to aiding passenger transport system recovery, three policy interventions are recommended.

Support formal public transport operator recovery
The first intervention is to create, or prolong, financial support packages for formal public transport operators. In some cities, ridership is likely to recover slowly as the pandemic subsides (McLachlan 2020a) and public transport operators may need financial support to maintain service levels. Support from national or provincial governments could reduce the risk that service providers will fail financially, by compensating operators for the loss of farebox revenue until full ridership returns (Dalkmann and Turner 2020; Diouf *et al.* 2020; Welle and Avelleda 2020). The second-wave Delphi survey established a (small) majority view that formal public transport operators should temporarily receive financial support (57% yes, 7% no, and 36% undecided, see Figure 23(a)). The large undecided response may indicate uncertainty about the ability of governments to afford this. It is possible that the pandemic may have lasting effects on the capability of the state to effectively plan, fund and regulate public transport services, and therefore may impact the long-term trajectory of public transport development in parts of the region. Capital-intensive investments in formal mass transit services may prove be less attractive to policymakers concerned with implementation capacity and resilience to fluctuating ridership and farebox revenue. Further research is needed to explore the impacts of the pandemic on public sector implementation capacity in different contexts.

Support informal public transport operator resilience
The second intervention is to create, or prolong, financial support packages for informal public transport operators, for the same reasons that apply to formal operators. However, it should be noted that the (small) majority view in the second-wave Delphi survey was that informal public transport operators will not require state financial support to survive (21% yes, 57% no, and 21% undecided, see Figure 23(b)). Such support, where it is needed, could take numerous forms. McLachlan (2020b) argues that the cost of vehicle financing for the owner, and the cost of fuel for the driver, are the two most significant costs to manage for informal operators. A government intervention aimed at reducing the cost of vehicle financing, and reducing the fuel price for licensed vehicles, would be one way of providing support. Others suggest that support could take the form of license payment, operating-fee waivers, or operating-deficit subsidies to compensate for losses incurred because of restrictions (Bradlow 2020; Calnek-Sugin and Heeckt 2020; Dalkmann and Turner 2020; Diouf *et al.* 2020). Subsidies would also serve to reduce the risk of fare increases to offset farebox losses.

Figure 23: Recommended public policy interventions to aid public transport recovery, and to mitigate social exclusion (Delphi Wave 2, n=14)



W2-Q7h. Formal public transport operators will require a temporary injection, or increase, of operating subsidy to survive beyond the pandemic.
W2-Q7a. Without an injection of subsidy, compensating for fare revenue losses during COVID movement restrictions, informal public transport operators will not survive.
W2-Q7e. Any capital or operating financial support provided to informal public transport operators should be used to leverage reform in business and operating practices.
W2-Q10b. To maintain a minimum level of (motorised) access for peripheral communities, there should a short period of free-fare formal public transport travel in the AM and PM.
W2-Q10a. To mitigate social exclusion, free or discounted public transport tickets/vouchers should be distributed directly to targeted poor and vulnerable population groups.
W2-Q10d. Establishing affordable universal digital access should become a public policy priority to enable marginalised communities engage in remote activity participation.

Leverage better quality, greener services

The third intervention is to use whatever financial support is forthcoming for public transport operators as leverage for reform. There appears to be a broad consensus, both in the literature reviewed (Bird *et al.* 2020; Calnek-Sugin and Heeckt 2020; Dalkmann and Turner 2020; Diouf *et al.* 2020) and in the second-wave Delphi survey (85% yes, 0% no, and 14% undecided, see Figure 23(c)) that financial support provided to informal public transport operators should be used as leverage for introducing reforms that lead to safer, better-quality, and greener services. Diouf *et al.* (2020) identify possible reforms as: acquiring electric vehicles; deploying new technologies (e.g., cashless fare collection, and fleet management) to improve the efficiency of operations; and requiring improvements in service comfort, affordability, and coverage. However, Venter *et al.* (2020) caution that, in the South African context, non-compliance with lockdown restrictions demonstrated an asymmetrical power relationship that will make securing the collaboration of vested interests in any intended reforms difficult to achieve. Further research is needed to explore the impacts of the pandemic on the political economy of public transport regulation in different contexts.

Mitigating social exclusion

With regard to mitigating livelihood and social exclusion impacts, **two policy interventions** are recommended.

Measure and monitor transport disadvantages

The first intervention is to develop ways of measuring, and then monitoring, changes in transport disadvantage and social exclusion. As the economic ramifications of the pandemic play out, it will be important for city transport planning authorities to monitor how the accessibility of vulnerable groups to key livelihood activities changes, so that reliable data are available to inform mitigation strategies. Further research is needed to assist practitioners in developing methods of doing this. Gutiérrez *et al.* (2020) contend that the big data sharing precipitated by the pandemic, twinned with a more intense application of information technologies and geographical information systems, offers an unprecedented opportunity to undertake longitudinal analysis of the effects of the pandemic on mobility and access at multiple spatiotemporal scales.

Target vulnerable groups

The second intervention is to provide those households deemed to be transport disadvantaged or socially excluded with targeted mitigating support. Possible policy measures explored with the Delphi panel included: passenger-side subsidies; periods of free-fare formal public transport; 'mobility on demand' services; and affordable digital connectivity. The second-wave Delphi survey established varying degrees of support for these interventions, indicating that appropriate packages of interventions will need to be context specific. Periods of free-fare access to formal public transport in the morning and afternoon peaks received little support (21% yes, 36% no, and 43% undecided, see Figure 23(d)). Free or discounted public transport vouchers received (small) majority support (50% yes, 14% no, and 36% undecided, see Figure 23(e)). Investing in affordable universal digital connectivity, along the lines of the 'triple access system' discussed earlier, was supported by a clear majority of panelists (79% yes, 0% no, and 21% undecided, see Figure 23(f)). 'Mobility on demand' services for vulnerable passengers also received strong support (86 yes, 7% no, and 7% undecided).

CONCLUSION

This paper set out to: identify the revealed impacts of the COVID-19 pandemic on urban transport in Sub-Saharan African cities; consider the long-term disruptive impacts of the pandemic on mobility and access in this context; and identify implications for policy and practice.

Regarding impacts, it was found that the number of COVID-19 infection cases and deaths in Sub-Saharan Africa has been significantly less than in other global regions. But possibly not as low as the available data suggests, because testing rates in the region have been low, and comparative data are not available to gauge whether 'excess deaths' have spiked higher than in other parts of the world. Stringency index data indicates that, while all of the selected Sub-Saharan African countries introduced lockdown regulations at the same time, there was significant variation in the level of restrictions enacted and their duration.

Although incomplete and biased towards certain socio-economic groups, the available evidence does indicate that the mobility and access impacts of these lockdown regulations varied across Sub-Saharan contexts. Trip-making appears to have returned to base-condition levels much sooner in some countries in the region than in the selected international comparison countries. Eased traffic congestion externalities were probably also relatively short-lived. The evidence indicates that the largest impacts on mobility and access in the more highly affected Sub-Saharan African cities have taken the form of:

- lower trip generation due to increased remote activity participation among the wealthy, and due to reduced economic activity among the poor;
- decreased accessibility amongst passengers reliant on public transport due to reduced service availability;
- decreased transport service-operator viability due to decreased ridership and farebox revenue; and
- increased social exclusion due to increased economic hardship and decreased travel capability, disproportionately for low-income households and women.

Regarding anticipated long-term urban transport impacts, multi-wave consensus-seeking in the Delphi expert survey led to the formation of propositions that did not depart significantly from the trends revealed above. In these propositions, it is expected that the largest impacts felt by Sub-Saharan African city populations will take the form of:

- reduced travel by, and accessibility for, low-income households (particularly women) residing in peripheral locations, due to decreased economic welfare;
- reduced transport service availability due to operator attrition, particularly amongst unsubsidized formal operators;
- increased remote activity participation and fewer work and business trips for a minority of higher-income households, with the extent of this impact depending largely on how extensively 'hybrid work' business practices become embedded; and
- disrupted trip distributions as the mix of city center land-uses changes, more in response to business attrition in a COVID-19-induced, or accelerated, economic recession than to disrupted bid rents.

Prospects of mobility and access recovery are likely to vary across the region. The four case studies illustrate that some urban populations have been severely affected, and the quality and availability of their passenger transport services was reduced, while others have experienced relatively little impact. It is likely that mobility and access in Accra, for instance, with its less-stringent lockdown regulations and smaller economic disruption, will recover more quickly than Cape Town and Harare with their more stringent lockdown regulations and, at times, heavy disruptions of daily economic life and livelihoods.

Regarding implications for urban transport policy and practice, it is argued that the disruptive impacts of the pandemic on trip substitution, which have been the focus of much policy debate elsewhere, should assume less importance in the Sub-Saharan African context. Policy should of course respond to such disruptions, to nudge

changes in desired directions, but this should not be the primary motivation for intervention. The evidence considered in this study indicates that the major impact of the pandemic in the Sub-Saharan African context will be on economic welfare rather than on disrupted business operating practices, leading to increased poverty, a shrinking middle class, small-business closures, and an enlarged informal sector. No matter how minor the disruptions to trip-making during the pandemic, no country will be immune from long-term global economic impacts. Therefore, urban transport policy attention in Sub-Saharan Africa should focus on mitigating these impacts. An important implication for transport planning practice is developing ways of measuring, and then monitoring, changes in transport disadvantage and social exclusion. As the economic ramifications of the pandemic are felt, it will be important for city transport planning authorities to monitor how the accessibility of vulnerable groups to key livelihood activities changes, so that reliable data are available to inform mitigation strategies. Investment in affordable 'digital connectivity' as a means of complementing accessibility derived from spatial proximity and physical mobility and buttressing resilience should be among the mitigation strategies considered.

A further implication for transport policy relates to providing financial support to public transport operators to help them survive the period of reduced ridership and farebox revenue. Financial support to informal public transport operators should be used as leverage for introducing reforms that lead to better integrated, safer, higher-quality, and greener services.

A final, more fundamental, implication for transport planning practice emerging from the pandemic is the need to develop city transport planning practices that are better able to deal with uncertainty. The pandemic has highlighted the limitations of long-range travel demand forecasting as a basis for planning city transport system improvements. A shift to a more flexible 'decide and provide' transport planning process, in which a robust course is charted towards a preferred future, capable of negotiating uncertainty along the way, would be beneficial. If the coronavirus mutates into new strains that render the existing vaccines ineffective, disruptive pandemics like the one we are enduring now may occur again.

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