THE IMPACT OF THE COVID-19 PANDEMIC ON URBAN MOVEMENT: USING FLOATING CAR DATA TO ANALYSE ROAD-BASED TRAFFIC PATTERNS

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ABSTRACT

The COVID-19 pandemic significantly affected global day-to-day movement patterns. Travel demand was markedly reduced worldwide as a result of governmental directives to reduce the spread of the SARS-CoV-2 virus. The South African government implemented a stepwise lockdown approach according to five Alert Levels, which have guided movement, social gatherings, and economic activities throughout the pandemic. Variation in traffic congestion levels was obvious on urban roads in South African cities, linked to changing Alert Levels. The purpose of this paper is to investigate how the pandemic has impacted urban, road-based movement patterns, and to evaluate if mobility trends are tending towards a "new normal" or returning to pre-pandemic patterns. It is important, particularly for planning authorities, to understand the long-term impacts of the pandemic to know if the observed changes to congestion and trip distribution patterns will be ongoing, or if we can anticipate a general return to pre-pandemic movement patterns. A case study analysis of traffic movement patterns in Cape Town is conducted using traffic volume and commercial floating car data (FCD) to evaluate variation in congestion and trip distribution patterns throughout 2020 and 2021. Analysis revealed the severe impact that lockdown had on traffic and movement patterns. Furthermore, the study determined that while 2021 traffic volume and congestion remained somewhat lower than 2019 levels, trip distribution patterns had returned to a pre-lockdown profile by the end of 2021. This is the first detailed South African study of pandemic related urban movement pattern changes using FCD, also offering a case study into how commercial FCD behaves in Sub-Saharan Africa when evaluating the traffic impact of a significant event.

1. INTRODUCTION

Every facet of life, and certainly each mode of the transport sector has been significantly affected by the COVID-19 pandemic. The governments of most countries around the world implemented a "lockdown" approach, attempting to curb the spread of the SARS-CoV-2 virus (Henry, et al., 2021) (Sharifi & Khavarian-Garmsir, 2020). Movement restrictions were imposed in South Africa according to Section 27 of the 2002 Disaster Management Act, regulating how and where people could travel, restricting public transport activities, and regulating cross-border movement of people and goods (Bruwer, et al., 2021). Lockdown restrictions were applied according to five Alert Levels (ALs) of increasing severity. The most severe level of the South African lockdown, AL5, was implemented on 27 March 2020. Throughout 2020, lockdown severity was gradually eased from AL5 to AL1. During 2021, ALs were adjusted in response to periodic waves of COVID-19 infection spikes. Table 1 summarises the period that each AL was active in 2020 and 2021.

During the most severe lockdown level, AL5, all non-essential services were suspended. Schools were closed and non-essential business activities were required to shut down or continue with employees working from home. Travel for non-essential workers was limited to essential trips for grocery shopping and medical reasons. Movement between municipal districts was disallowed and cross-border movements through air-, land- and seaports were prohibited for all but repatriation trips and essential freight. Public transport operators had to limit the number of passengers per trip to 50% of the vehicle capacity and were only allowed to operate during certain periods of the day (Bruwer, et al., 2021). Public transport, inter-district travel and eventually international travel reopened as lockdown levels eased, however the impact of the pandemic on movement patterns is ongoing. In 2021, there were still periodic constraints particularly on international travel and the number of people that could gather for events, such as religious services, sporting events, concerts, and more.

Table 1: South African Alert Level periods

	AL5	AL4	AL3	AL2	AL1	AL3	AL1	AL2	AL3	AL4	AL3	AL2	AL1
End date	30 Apr 20	31 May 20	17 Aug 20	20 Sep 20	28 Dec 20	28 Feb 21	30 May 21	15 Jun 21	27 Jun 21	25 Jul 21	12 Sep 21	30 Sep 21	ongoing
Start date	27 Mar 20	01 May 20	01 Jun 20	18 Aug 20	21 Sep 20	29 Dec 20	01 Mar 21	31 May 21	16 Jun 21	28 Jun 21	26 Jul 21	13 Sep 21	01 Oct 21

The restrictions placed on our daily activities and travel opportunities have made many people reconsider the norms of traditional movement patterns: “Is it necessary to travel to my place of work on a daily basis?”; “Do I need to travel to an out-of-town meeting that could be dealt with in an email?”; “Do I really want to go to a social get-together / shopping mall / restaurant where I can be exposed to the virus?”, “I’ll just get my groceries delivered…”.

This research paper considers evidence-based inner-city movement pattern changes during 2020 and 2021 with a focus on urban, road-based traffic. The objective of this paper is to assess changes in urban movement patterns to determine if we are reaching what is widely referred to as a “new normal”, or if mobility trends are heading back to pre-Covid-19 patterns. Understanding the long-term impacts of the pandemic is necessary particularly for planning and roads’ authorities to know if the changes to congestion and trip distribution patterns that were observed will be ongoing, or if we can anticipate a general return to pre-pandemic movement patterns. A case study analysis of the traffic patterns in Cape Town is used to determine how urban traffic varied during the pandemic. Typical weekday congestion and trip distribution patterns are compared at various stages of the pandemic to pre-lockdown movement patterns to determine the impact of ALs on mobility. A literature review is conducted to describe changes in movement patterns observed worldwide and the envisaged adjustments that this may bring to urban form. The methodology, data collection and analysis of pandemic related traffic movement patterns in Cape Town are then detailed.

2. IMPACT OF THE PANDEMIC ON TRAVEL PATTERNS

Numerous studies anticipate that the effects of the COVID-19 pandemic on travel patterns will be long-lasting, resulting in a permanent change in mobility norms (Sharifi & Khavarian-Garmsir, 2020). The impact of the pandemic on travel demand, specific transport modes, and anticipated future movement pattern trends that have been reported internationally are discussed below.

2.1 Transport Demand and Mode Specific Travel

Worldwide lockdown measures resulted in severe mobility restrictions in nearly all countries (Sharifi & Khavarian-Garmsir, 2020) (Simunek, et al., 2021). Daily trips in the United Kingdom were reported to have declined by 80% during the period with the harshest restrictions (Sharifi & Khavarian-Garmsir, 2020). People also stayed closer to home: in the Netherlands, trip distances reduced overall by approximately 70% (Sharifi & Khavarian-Garmsir, 2020). Similar trends were observed in South Africa during AL5: the number of trips along freeways decreased to between 20 and 30% of typical volumes and trip distances were reduced by between 50 and 80% in most urban areas (Bruwer, et al., 2021). This reduction in the number and length of trips resulted in significantly improved pollutant levels in many cities around the world (Sharifi & Khavarian-Garmsir, 2020).

The overall decrease in travel demand, particularly during the early months of the pandemic, did not impact all transport modes equally. Numerous studies from around the world indicated that non-motorised transport (NMT) trips were found to be the least affected (Sharifi & Khavarian-Garmsir, 2020) (Simunek, et al., 2021). In fact, one study in New York determined that the duration of bike trips had increased, indicating that bicycles were being used for longer trips than usual (Sharifi & Khavarian-Garmsir, 2020).

Globally, public transport ridership decreased the most dramatically of all modes (Sharifi & Khavarian-Garmsir, 2020). Subway trips decreased by up to 90% in New York, with other cities reporting similar levels of decreased public transport usage around the world (Sharifi & Khavarian-Garmsir, 2020). This reduction in public transport ridership reflects a general fear of infection while using public transport. The SARS-CoV-2 virus is spread through respiratory droplets and the highest risk for transmission is in badly ventilated, enclosed spaces (Zhen, et al., 2020). Previous research on the H1N1 influenza virus found that infected persons were six times more likely to have recently used public transport than the non-infected population, indicating a link between transmission of respiratory viruses and public transport usage (Zhen, et al., 2020). Ask Afrika conducted a survey in South Africa in 2020 and established that the public considered public transport to be the greatest risk area for contracting COVID-19. Less than a third of respondents felt that they were safe from contracting the virus when using minibus-taxis (Bruwer, et al., 2021).

In South Africa, passenger rail services were suspended at the start of the pandemic, with a few PRASA services only resuming in July 2020. Bus passenger numbers dropped to 20% of typical ridership at the start of the pandemic, reaching 80% of typical levels towards the end of 2020 (Bruwer, et al., 2021). The taxi industry reported a slightly lower reduction in passenger numbers of between 60 and 70% during AL5, AL4 and AL3, with ridership remaining at about 80% of normal passenger trips towards the end of 2020, similar to bus services. The enduring impacts of the pandemic on public transport ridership in South Africa are yet to be determined.

Behrens and Newlands (2021) performed an investigation of movement patterns in Cape Town using mobility reports prepared by smartphone operators Google and Apple, which indicated that work and retail related trips in Cape Town dropped by 80% during AL5 and then increased gradually as the pandemic progressed. In August 2021, work and recreation related trips were still approximately 25% lower than pre-pandemic levels, while grocery shopping trips had actually surpassed pre-pandemic trip making levels for this purpose (Behrens & Newlands, 2021). The amount of time that Cape Town residents spent at home had also increased significantly, remaining higher than baseline throughout 2021 (Behrens & Newlands, 2021).

2.2 Future Transport Patterns and City Planning

Most businesses that could implement work-from-home arrangements converted quickly to telework practices at the start of the pandemic, with technology applications and widespread high-bandwidth internet availability assisting employees to work remotely on a more permanent basis. There is evidence that many workers are both willing and able to work away from the office (Henry, et al., 2021). A trend towards working remotely has increased steadily in recent years, with research indicating that the number of people working from home for at least half the week doubled between 2005 and 2015 in the USA. The pandemic has drastically increased the number of people working from home to the extent that remote working is purported to become a “new normal” (Henry, et al., 2021).

Insights into how the COVID-19 pandemic will alter urban development suggest that the need for office space in cities may decrease as more people work from home, leading to a change in home design to incorporate a designated home-office space (Kuper, 2021). Businesses might benefit from paying less for office rental, while hosting idea-sharing sessions between remotely working colleagues in less formal settings such as coffee shops or flexible co-working spaces that are closer to home than CBD-based offices. This might provide impetus to the established urban planning strategy of mixed-use developments instead of the more traditional segregation of home and work environments (Kuper, 2021). Many shops are likely to convert to e-commerce retail offerings with at-home delivery (Kuper, 2021) as people limit their trip making, instead relying on online retailers (Simunek, et al., 2021). All of these anticipated changes to our daily activities will likely have a lasting impact on travel demand, particularly a reduction of traffic during the typical daily commute peak periods, and a shift to NMT (Simunek, et al., 2021).

3. METHODOLOGY

3.1 Methodological Approach and Study Area

Various studies have been conducted since the start of the COVID-19 pandemic investigating how movement patterns have changed. Simunek et al. (2021) evaluated the impact of lockdown in the Czech Republic by comparing speeds aggregated in hourly intervals, using speed changes as an indicator of varying traffic levels (Simunek, et al., 2021). A study in New Zealand developed a daily mobility index from cell phone locational data to assess the daily variation in the number of people per zone (Campbell, et al., 2021). While these studies are helpful to determine the extent of movement during the pandemic, they do not indicate how movement patterns changed, which is best evaluated by considering trip distribution.

Trip distribution describes the number of trips made between particular origins and destinations. Typical trip distribution patterns were severely disrupted during the pandemic, particularly during the stricter ALs, because of restrictions placed on which destinations were available (business, entertainment and certain retail facilities had to close) and the distance that people could travel (movement between districts was restricted in South Africa). Differences in trip distribution patterns between and within cities can be evaluated from origin-destination (OD) matrices. Li et al. (2021) evaluated the change in the distribution of trips within 16 cities in the USA at various times during the pandemic by developing OD matrices from mobile phone “digital trace data”. Gibbs et al. (2021) also considered movement patterns between zones using positional data collected from mobile devices over the entire United Kingdom.

This study comprises a case study of the variation in traffic congestion and trip distribution patterns in Cape Town in 2020 and 2021. Cape Town is one of the largest cities in South Africa and is an important economic hub that generally experiences severe traffic congestion, providing a good study area to determine the impact of the COVID-19 pandemic on urban road-based transport. Various traffic measures were evaluated in this case study. Firstly, the change in Average Daily Traffic (ADT) on two of the major freeways in Cape Town (the N1 and N2) was investigated. Secondly, a speed-based measure of congestion was evaluated from TomTom floating car data (FCD), similarly to Simunek et al. (2021), for the entire Cape Town metropolitan area. These first two analyses evaluated changes in the extent of trip making and congestion levels.

Thirdly, an analysis of trip distribution patterns was carried out using OD information from TomTom FCD to evaluate changing trip movement patterns. FCD, also referred to as probe data, is a rich data source that uses anonymous traces of vehicle movements collected from GPS enabled devices such as smartphones and navigation aids. FCD reports speed and trip-routing information on all roads that have carried instrumentalised vehicles. Commercial FCD, provided by commercial traffic data providers such as TomTom, is reported anonymously from numerous probe sources and is readily available to transport practitioners and planning authorities, making this a particularly useable form of traffic data.

3.2 Data Collection and Analysis

Three sets of data were obtained to analyse the impact of the COVID-19 pandemic response in 2020 and 2021: freeway ADT, FCD-based congestion measures and FCD-based OD data. The data collection procedure, analysis periods and analysis methods are described below according to each data source separately.

3.2.1 ADT-Based Traffic Patterns on Freeways

ADTs were obtained from SANRAL at six Vehicle Detection System (VDS) stations on the N1 and N2 every day from 1 January 2019 to 30 November 2021. Monthly aggregated ADT (for weekdays) was calculated and used to evaluate indicative changes in travel demand levels in Cape Town throughout the pandemic as a percentage of 2019 monthly ADT.

3.2.2 City-Wide FCD-Based Congestion

The TomTom Traffic Index is a percentile measure of congestion that indicates the increase in travel time when compared to free flow travel time (Cohn & Kools, 2014). A Traffic Index of 25% indicates that travel time throughout the day will be, on average, 25% longer than during free flow conditions (periods of low flow when speeds are high, typically during the night). The Traffic Index was developed to quantify the congestion level of an entire city, aggregating speed data over all road classes (Cohn & Kools, 2014). Daily

TomTom Traffic Indices were obtained for Cape Town between 01 January 2019 and 31 December 2021 and aggregated per month to compare average monthly congestion in 2019, 2020 and 2021. Additionally, daily Traffic Index values were evaluated for March, April, and May in 2019, 2020 and 2021 to evaluate detailed traffic changes at the start of the pandemic.

3.2.3 FCD OD Traffic Movement Patterns

TomTom uses FCD to evaluate OD information. The TomTom OD output details various traffic pattern metrics, including the distribution of trips according to time of day, trip duration, and trip length. Additionally, aggregated OD pairs between user-defined traffic analysis zones are provided, allowing trip distribution evaluation. TomTom OD FCD was obtained for six, two-week long intervals: pre-lockdown (PL) and five key periods during the pandemic, according to Table 2 (April 2020, and July and November in 2020 and 2021). Typical weekday traffic patterns were determined by aggregating OD data for weekdays during the two-week intervals. Traffic information for a full day was aggregated to determine typical daily trip metrics and trips between particular origins and destinations. OD information was evaluated between 49 traffic analysis zones covering the entire Cape Town Metropolitan Municipal area, as well as portions of Stellenbosch and Drakenstein Local Municipalities.

Table 2: OD data collection periods

Analysis period	10 – 21 Feb 2020	14 – 24 Apr 2020	6 – 17 Jul 2020	09 – 20 Nov 2020	28 Jun – 08 Jul 2021	08 – 19 Nov 2021
Alert Level	PL	AL5	AL3	AL1	AL4	AL1
Designation	PL	Apr.2020	Jul.2020	Nov.2020	Jul.2021	Nov.2021

4. RESULTS

4.1 Variation of ADT on Freeways

The average monthly ADT was estimated from 6 freeway counting stations in Cape Town. Figure 1 describes the change in ADT throughout the pandemic in 2020 and 2021. Monthly ADT is presented as a percentage of 2019 ADT for the same month to allow a comparison of traffic before and during the pandemic. At the start of the pandemic (AL5), traffic on the freeways in Cape Town dropped to only 25% of typical ADT. Traffic levels increased steadily throughout 2020 as ALs were eased, reaching 90% of typical ADT in December 2020. Periods of reduced traffic are clearly discernible in 2021 which are clearly associated with stricter ALs put in place according to COVID-19 infection rates. During periods defined by AL1, Cape Town freeway traffic remained fairly constant at approximately 90% of 2019 ADT. Traffic dropped to 80% of 2019 levels in periods with stricter ALs. These findings indicated that traffic has recovered significantly from the early pandemic period, however, still remains subdued compared to 2019 levels, indicating that consistently fewer trips are being made in the Cape Town urban area. This corroborates the finding of Behrens and Newlands (2021) that work related trips remained lower in 2021 than in previous years.

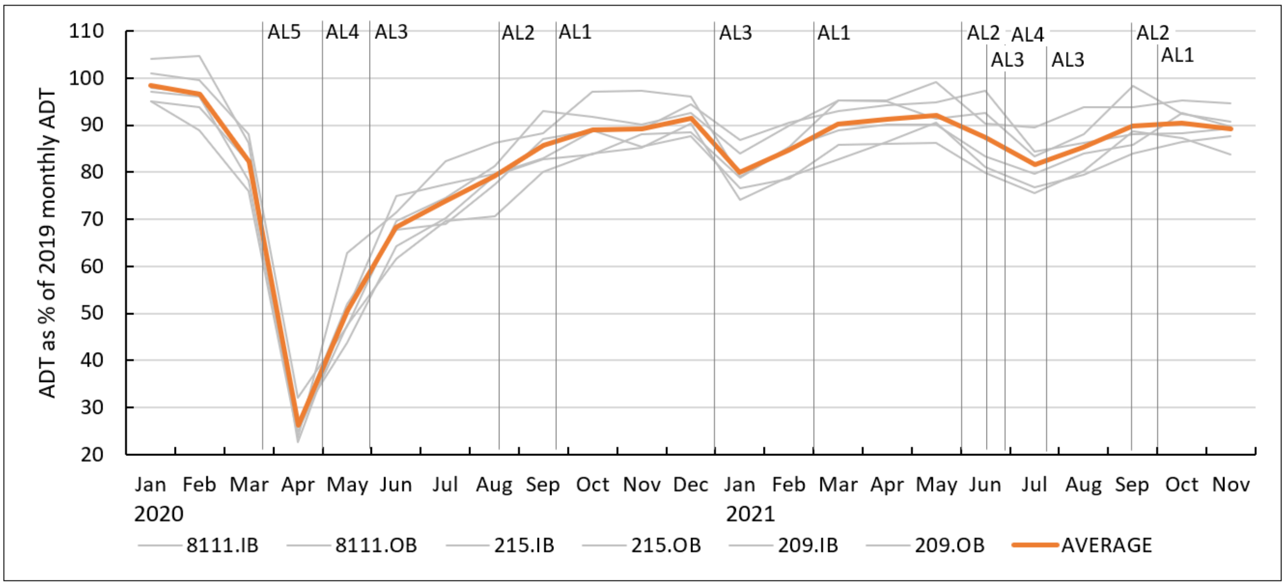

Figure 1: Monthly ADT in 2020 and 2021 as a percentage of 2019 monthly ADT

4.2 Variation in Congestion Levels

TomTom Traffic Index values are calculated from travel times measured on all classes of urban roads, evaluating congestion over the entire road network. Daily TomTom Traffic Index values were averaged per month to describe a monthly congestion measure for the entire Cape Town urban area throughout the pandemic. Figure 2 compares levels of congestion throughout 2020 and 2021 to typical 2019 monthly congestion levels (2019 congestion values repeated over the 24 month period).

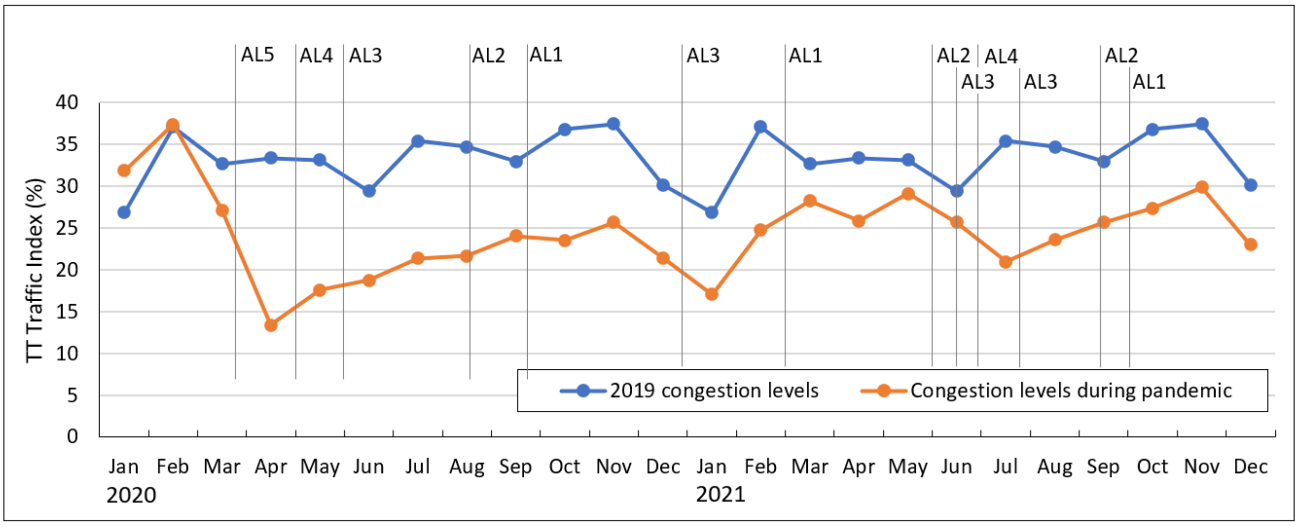

Figure 2: Monthly variation in TomTom Traffic Index throughout 2020 and 2021

In April 2020 (AL5), daily congestion plummeted from a typical level of 33.4% to just 13.4%. As ALs eased, a gradual increase in congestion can be observed up to November 2020, however, congestion remained much lower than in 2019. Congestion in December and January is typically lower than the rest of the year, and this is reflected in December 2020 and January 2021 as well. In February 2021, congestion bounced back to a level similar to November 2020, while South Africa was still in AL3, indicating that movement restrictions were perhaps less effective in 2021 than in 2020. Congestion dropped again suddenly in July 2021, reaching levels similar to July and August 2020 (which is corroborated by traffic patterns indicated in Figure 1). This traffic impact is related to the third wave of COVID-19 infections in South Africa in June – July 2021, accompanied by the strictest lockdown since May 2020 (AL4). This would indicate that infection rate is a significant movement deterrent. Congestion gradually increased as the year progressed, however, remained below 2019 levels, indicating fewer trips were carried out, similar to the findings described in Figure 1.

Evaluation of daily variation in congestion provides detailed analysis of movement patterns. Figure 3 summarises daily congestion in March, April and May in 2019, 2020 and 2021, reflecting the impact of the early pandemic response. Congestion measured from the first Monday of March in 2019, 2020 and 2021 is depicted. Fine, solid vertical lines indicate successive Mondays and bold, dashed lines indicate the first day of each month. In 2019, weekday congestion remained constant at 40%, reducing over weekends to around 20%. Localised disruptions to weekly traffic patterns are caused by public holidays, notably 21 March 2019, 19 and 22 April 2019, 1 May 2019, and the National and Provincial Government Elections on Wednesday 08 May 2019. The readily observable disruption in congestion on these days confirms that congestion measures can effectively track changes in travel demand.

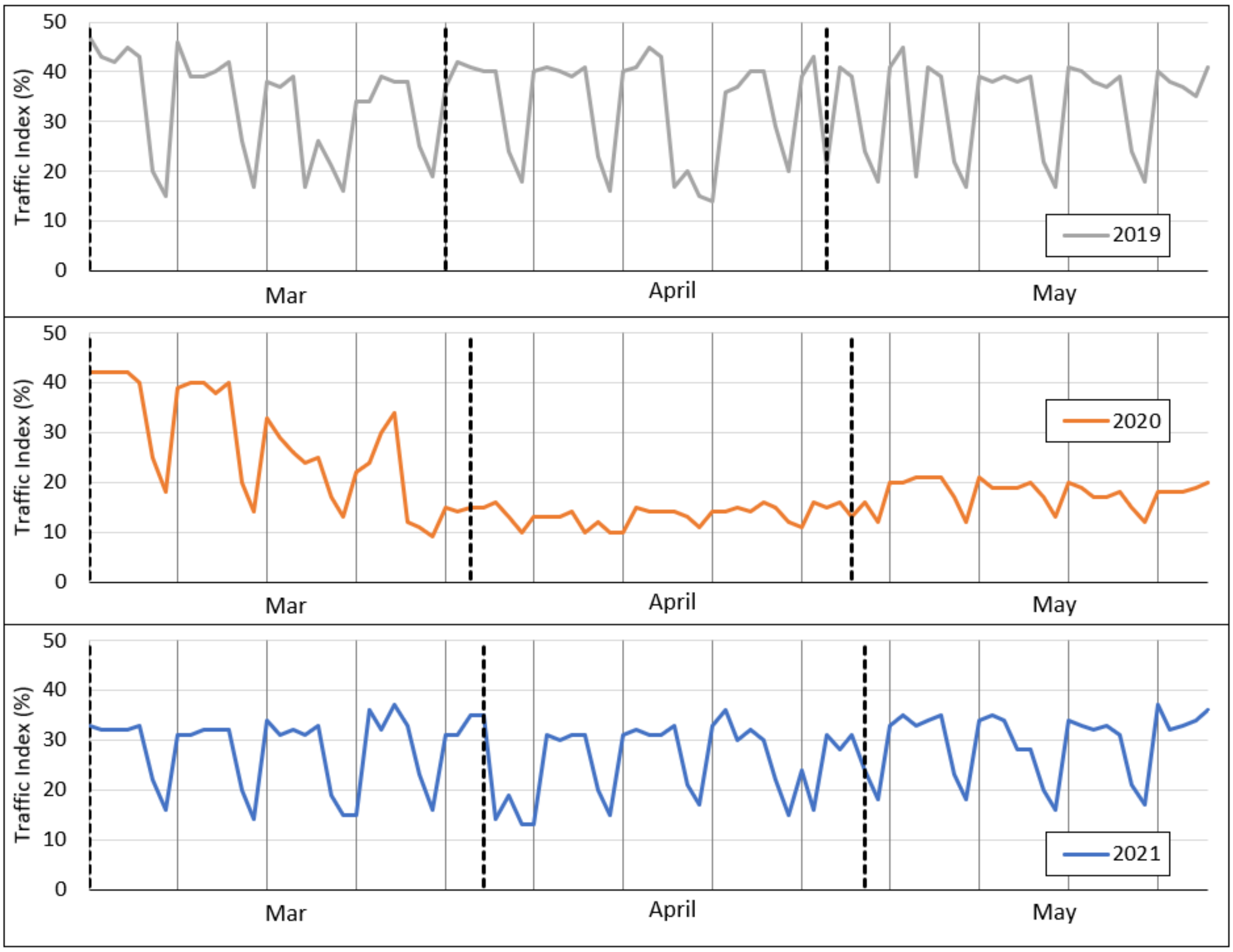

Figure 3: Daily variation in TomTom Traffic Index in March, April and May

In stark contrast to 2019 traffic patterns are the daily congestion patterns observed in 2020. The first two weeks of March indicate typical traffic. President Ramaphosa announced a "national state of disaster" on Sunday 15 March 2020. A week later, it was announced that the country would enter a lockdown from Friday 27 March 2020. The impact on traffic was immediate, observable in Figure 3 as lower congestion on Monday 16 March 2020. Congestion continued to drop throughout the third week of March. In the fourth week of March, traffic congestion increased steadily, peaking on Thursday 26 March 2020, as people scurried to prepare for the ensuing lockdown. Traffic congestion remained very subdued throughout the next five weeks and interestingly, typical weekly traffic patterns, clearly identifying weekday from weekend traffic, disappeared. Slightly increased weekday congestion and weekend congestion lulls were again evident in May 2020, indicating a nominal return to more typical work-week traffic patterns, albeit at greatly reduced levels. Weekday congestion in 2021 resumed typical patterns, however, daily congestion decreased from 40% in 2019 to just over 30% in March, April, and May 2021.

4.3 Variation in Trip Distribution Patterns

Sections 4.1 and 4.2 considered changes to the extent of trip making in Cape Town during 2020 and 2021. In this section, a movement pattern study was carried out, firstly by considering trip metrics (trip making according to time of day, trip duration, and trip length) evaluated from FCD OD data, and secondly, through analysis of aggregated OD pairs.

4.3.1 Trip Metrics Evaluated From OD Patterns

Indicative trip metrics such as the distribution of trips made according to time of day, trip duration, and trip length, can be evaluated from OD information. These metrics detail trip-making patterns in an urban area. Figure 4 describes average trip metrics for Cape Town at various intervals during the pandemic in 2020 and 2021. All trips reported to TomTom by various sources of in-vehicle probe devices are included in this data, which is representative of trips on all classes of roads. Trip patterns were determined from data collected for the full 24 hours per day of weekdays during the different analysis periods (Table 2).

Figure 4.a describes the number of weekday probe trips made per hour. It should be noted that the number of trips indicated in this figure is the number of probe trips reported to TomTom, and while they are assumed to represent general trip patterns on the road network, do not indicate actual trip numbers. Pre-lockdown trip patterns indicate a typical urban trip pattern: a morning peak hour from 07:00 to 08:00, followed by a lull in trips until midday, a steady increase in trip making up to the afternoon peak hour from 16:00 to 17:00, and lastly a rapid decrease in trips until midnight. In April 2020, this pattern was completely disrupted. No morning peak was evident. Trips increased gradually throughout the day, reaching 27% of PL afternoon peak hour trips. Trip numbers bounced back to about 60% of daily PL trips by July 2020 (AL3), however, trip patterns were still non-typical with an insignificant morning peak, proportionately more trips than typical being made between 12:00 and 16:00, and no clear afternoon peak. This would indicate that home-work trips were not occurring as frequently during the pandemic, likely due to many people working from home, or not working. Similar trip patterns are evident again in July 2021 (AL4) when stricter lockdown restrictions impacted trip-making. Morning trips were still particularly subdued, and midday / afternoon trips were higher than usual, however, traffic did display a distinct afternoon peak.

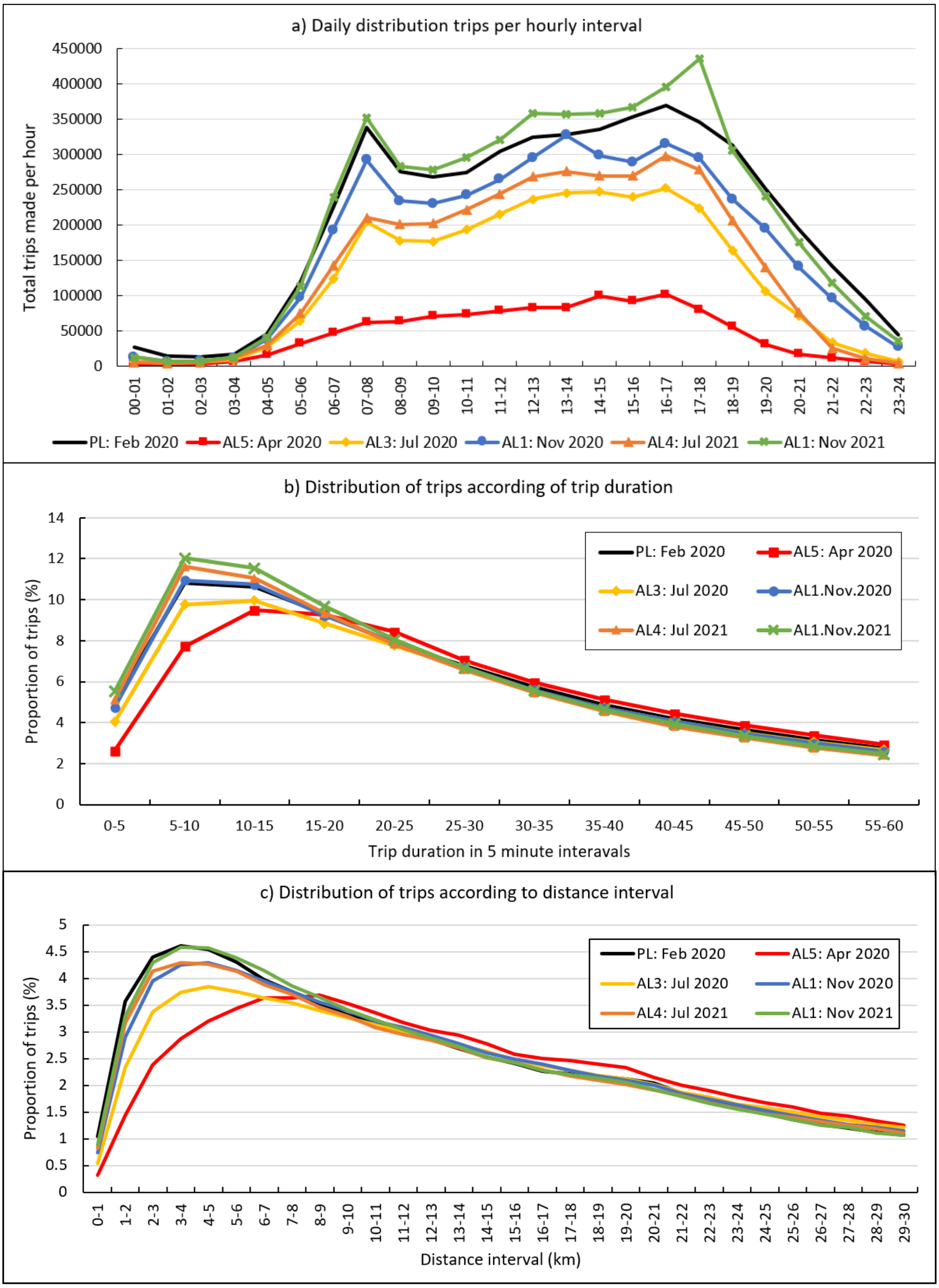

Figure 4: Distribution of trips per hour (a) duration (b) and distance (c)

Trips in November 2020 (AL1) represented more typical weekday trip patterns, with a distinct morning peak having re-emerged. The afternoon peak is however lower than would be anticipated considering PL trip making, and there is a distinct peak between 13:00 and 14:00. November 2021 (AL1) traffic was certainly the most similar to PL traffic with a defined morning peak, a morning lull in traffic, and a significant afternoon peak. The higher trip numbers in November 2021 cannot be taken to indicate that more trips were being made than in February 2020 because numbers of probes are known to increase annually at a faster rate than actual trips due to additional probe sources being added to FCD input. The anomalous afternoon peak late in 2021, occurring an hour later than in the PL period, cannot be explained from FCD alone, and requires further research to evaluate the reason for this later and highly significant peak.

Figures 4.b and 4.c describe proportion of total daily probe trips made according to trip duration and trip length respectively. The trips described in these figures exclude internal trips within traffic analysis zones, which explains the low number of short probe trips. Before the pandemic, the majority of trips (just over 20% of trips) were between 5 and 15 minutes long, and most trips corresponded to a trip distance of between 2 and 5 km. These patterns shifted significantly at the start of lockdown. In AL5, there were proportionately more longer trips being carried out, with most trips taking between 10 and 20 minutes and covering distances of 7 to 10 km. Of course, longer trips could be carried out in a shorter time because of the much lower congestion levels associated with AL5. As ALs progressed, trip duration and lengths quickly reverted back to patterns similar to the PL period, with proportionately more shorter trips being carried out again. The proportion of trips defined according to trip distance in November 2021 are practically identical to patterns observed in February 2020 (refer to Figure 4.c), with trip duration overall shorter in November 2021 than in February 2020 (refer to Figure 4.b), explained by the lower traffic congestion observed towards the end of 2021 in comparison to PL levels. A separate analysis of internal trips within zones indicated that the proportion of internal trips increased during the severe lockdown (AL5). The FCD OD output indicates that while 62% of 3 to 4 km long trips were internal in the PL analysis period, 78% of 3 to 4 km long trips were internal trips during AL5, indicating a trend to stay closer to home at the start of the lockdown, as reported by Bruwer, et al. (2021)

4.3.2 Changes in Origin-Destination Patterns

The number of trips made between particular origins and destinations describes trip distribution. The disruption of movement patterns can be inspected by comparing OD pairs observed from FCD, similar to studies carried out by Li et al. (2021) and Gibbs et al. (2021). Figure 5 portrays the most common trips occurring in Cape Town (OD pairs with proportionately the highest number of FCD reported trips). ODs are described by desire lines linking specific origin and destination zones at four periods: February 2020 (PL), April 2020 (AL5), July 2020 (AL3) and November 2021 (AL1). Links drawn in dark red indicate the OD pairs with the highest proportion of trips, changing to yellow as trip numbers decrease.

Before the pandemic (Figure 5.a), the OD pairs representing the routes with the highest proportion of trips are mainly concentrated around the CBD (Region 1), surrounding neighbourhoods (Regions 2,3 and 4) and the Southern Suburbs (Regions 7, 15, 16, 26). Cape Town International Airport (Region 48), Century City (Region 5), Durbanville (Region 19) and Bellville (Region 20) also generate a fair number of trip origins and destinations.

In April 2020 (AL5 – Figure 5.b), total trips decreased significantly, as indicated in Sections 4.1 and 4.2, and the OD pairs with the highest proportion of trips also changed dramatically as can be observed by comparing Figures 5.a and 5.b. Trip movement to and from the CBD decreased significantly, with minimal movement between the Southern Suburbs and the CBD as well as far reduced movement to the CBD from areas further away. The airport was no longer indicated as a significant OD node.

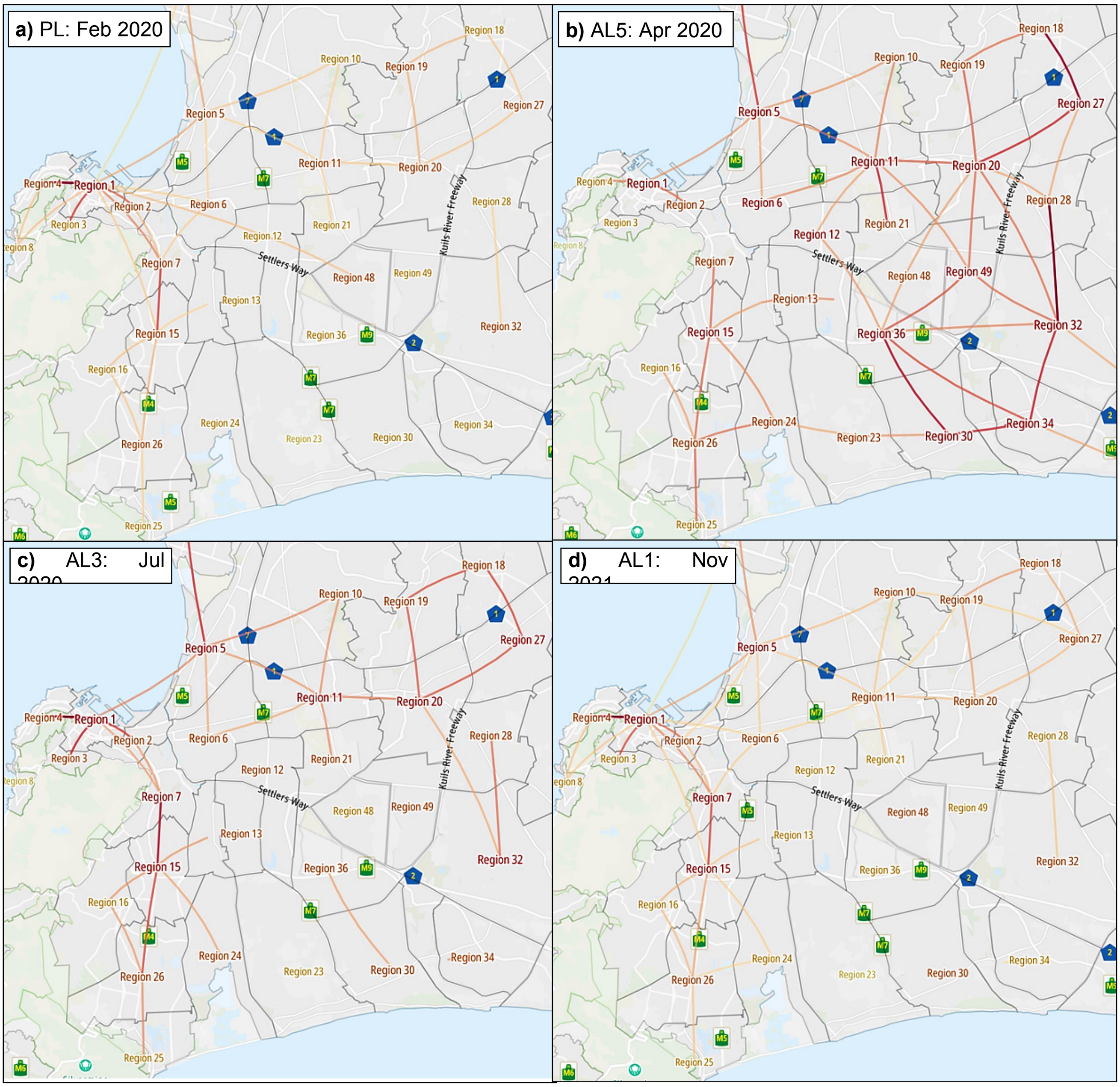

Figure 5: Changes in dominant OD pairs during 2020 and 2021

Interestingly, in AL5, the highest proportion of trip ODs were observed in areas that did not feature as major PL trip origins and attractions such as Mitchell's Plain (Region 30), Khayelitsha (Region 34), Nyanga (Region 36) and Blue Downs (Region 32). All of these zones are defined as low-income residential areas with high-density, informal housing. Additionally, areas with significant industrial activity and satellite business centres, such as Epping Industrial (Region 12), Goodwood/Parrow (Region 11), Bellville (Region 20), Kuils River (Region 28) and Brackenfell (Region 27), also indicated a higher proportion of OD trip ends than before the lockdown. This does not imply that these regions experienced higher numbers of trips, rather that the proportion of trips to and from these areas was higher compared to other OD pairs. This indicates that there was a lower reduction in trips to and from low-income areas, satellite business areas and industrial areas than high-income residential areas (the Southern Suburbs) and the CBD. This could be because essential service manufacturing in industrial areas continued, requiring travel by blue-collar staff from low-income areas, while people in affluent areas could work from home. It may also indicate a lack of essential services and shopping opportunities in low-income residential areas, requiring residents to travel further than people living in higher income areas to access necessary services. Further research is required to determine why low-income areas had proportionately higher trips to external zones than higher income areas during AL5.

Trip patterns in AL3 in July 2020 (Figure 5.c) showed a return of higher OD paired trips between the CBD and Southern Suburbs but maintained a high proportion of trips to Regions 11, 20, 27 and 32 in comparison to PL trip patterns. Trip patterns in November 2021 (Figure 5.d) are practically identical to trip patterns observed before the pandemic, except that the airport (Region 48) is still not included as a high trip producer/attractor, indicating that air travel had certainly not recovered to pre-pandemic levels by the end of 2021.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussion of Findings

The objective of this paper was to assess changes in daily movement patterns of urban, road-based trips to determine if a “new normal” for trip making has been reached, or if movement patterns have returned to a pre-Covid profile. A case study analysis of Cape Town congestion levels and trip distribution patterns in 2020 and 2021 was conducted to answer these questions by evaluating changes in ADT levels, congestion, and origin-destination reported trip patterns.

The number of trips being undertaken in Cape Town in 2021 has remained lower than typical 2019 travel demand levels, as determined by analysis of both monthly ADT and congestion levels. ADT during periods at AL1 and with low COVID-19 infection rates remained consistently 10% lower than traffic during the same months in 2019. Congestion also remained lower throughout 2021 than in 2019 on a month-by-month basis, indicating that there is less traffic on the roads. The reduction in the number of trips may be due to increased numbers of people working from home, and the fact that the majority of schools continued to operate with fewer children per classroom throughout 2021, with groups of learners alternating days spent at the school premises. Certainly, movement pattern changes have been enabled by the profusion of internet-based communications applications. The AL5 lockdown also provided a significant push towards mainstream acceptance of a “work-from-home” environment. Working from home and increased e-commerce has likely added to the reduction in overall trips.

While actual trip volumes remain lower than in 2019, our trip making habits of numerous short trips, travelling for work, and the time of day at which we travel, have returned to typical, pre-pandemic patterns. We are again making more short trips and travelling to places of work, as indicated by the re-emergence of typical morning and afternoon peak hour traffic. This is likely perpetuated by the fact that much of the South African economy is based on labour intensive commercial and industrial practices, requiring that workers travel to areas of work. Perhaps the slogan of the long forgotten yellow pages, “let your fingers do the walking” will eventually become a reality, with the internet and electronic communications platforms, rather than the landline, taking over our mobility needs. This reality, however, may still be some way into the future according to the outcome of this research paper.

5.2 Recommendations for Further Research

The extent to which job-losses and reduced economic activity, as a result of the pandemic, has impacted traffic has not been evaluated in this paper and should be considered in future research. The authors are acutely aware that this paper focused predominantly on changes in mobility that occurred within the subset of the population with access to private transport, as the study focussed on road-based traffic and trip patterns reported by FCD. The group most severely affected by the pandemic were surely the urban poor, who are often labour-intensive workers that cannot move to online working away from the workplace. This is also the subset of the population who are public transport captive. Changes in public transport provision were not considered here but should be researched in future publications.

While actual trip volumes remain subdued, our trip making habits have been found in this research to have returned to patterns typical of pre-pandemic traffic. More research is needed to determine why the primary OD patterns changed so dramatically from PL to AL5 to answer questions such as *"who continued to travel"*, and *"who stayed at home and why?"*. The substantial return to typical traffic patterns displayed by OD pairs does however show that trip-making patterns have largely returned to normal. It will, however, be necessary in future research to consider if certain trip purposes are now more or less prevalent, for example to determine if retail related trips have been replaced with e-commerce activities and whether morning work-related trips to office-based work opportunities have been reduced in favour of working-from-home. The impact of the outcome of these studies will certainly affect trip generation rates and the distribution of trips.

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