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Impact of Covid-19 on willingness to share trips

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\section*{ABSTRACT}

This study relied on primary data from transportation users to investigate the impact of the Covid-19 pandemic on shared mobility types. The study used ordinal logistic regression models to explore the relationship between Covid-19 spread-mitigative protocols and the willingness to share trips with family, friends, and strangers. Travellers who were moderately affected by social distancing had [0.356 (95% confidence interval (CI) = 0.189 – 0.669; \( p = 0.0001 \)] times the rate willing to share public vehicles and [0.492 (95% CI = 0.268 – 0.900; \( p = 0.05 \)] times the rate willing to share private cars than commuters who mostly affected. Commuters with a minor extent of means of transportation change at (\( \alpha < 0.0001 \)) significance level had 0.330 times the rate willing to share personal cars with family and friends. At the same time, 0.434 times the rate (\( \alpha < 0.01 \)) willing to share public vehicles with strangers compared to commuters who had a major extent of means of transportation change. The prevalence rates of change were higher during Covid-19 than precovid, showing that the pandemic set an impetus for a modal shift from public to private vehicular use, with a probable effect on willingness to share trips postcovid. Consequently, the study concludes that the transportation regulators could continue to sensitise travellers, regulate passenger spacings, monitor and enforce gears to make shared mobility more appealing to people during and postcovid periods.

\section*{1. Introduction}

The effect of the new coronavirus disease is felt in all spheres of human endeavours (Accenture, 2020), particularly impacting mobility in many unsustainable ways. From the imposed lockdown policy by most governments to travel restrictions, social distancing, and restrictive vehicle-passenger capacity protocols, transportation and the travel industry have felt the impact of the pandemic in no small measure (Oum and Wang, 2020; Babalk, 2020; De Vos, 2020; Carrington, 2020; Mogaji, 2020; Abdullah et al., 2020; Dong et al., 2021; Gaskin et al., 2020; Hensher et al., 2021). For example, in Nigeria, the Lagos State Government pronounced and enforced a reduction in vehicle occupancy for the bus rapid transit (BRT) service to half its carrying capacity and compulsory use of nose masks during the stringent Covid-19 policy (Akoni, 2020). This regime lowered profits for the operators but a consequent increase in transport fares (Olishah, 2020; Mogaji, 2020). The general passenger occupancy and use of nose masks’ characteristics for public transportation precovid and during the stringent and relaxed Covid-19 policy regimes are in Table 1. Many studies have revealed that the implemented Covid-19 spread-mitigative protocols have unintended and unsustainable results for health and mobility. Dong et al., 2021; Gutierrez et al., 2020; Abdullah et al., 2020; Parady et al., 2020, focused on the impacts of Covid-19 on travel behaviour and mode preferences, partly based on personal concerns regarding infections, informing discretionary actions, or the government-imposed protocols which come with compulsory adherence. Irawan et al. (2021) investigated the travel behaviour of Indonesian commuters by considering the influences of information and communication technology (ICT) applications, like e-learning, teleworking, teleshopping, and ride-hailing, among others, before and during the pandemic. As far as detected, as extensive as the studies of the impacts on Covid-19 on transportation have been so far, few have examined behavioural change informed by the willingness to share private or public vehicles during the pandemic. These studies include Borowski et al. (2021), who considered rideshare decision-making during a double emergency of flood evacuation, and Covid-19 in the United States. However, the studies are mainly on public vehicular use (Przybylowski et al., 2021; Said et al., 2021; Jabbari and MacKenzie, 2020; Lamb et al., 2020; Abdullah et al., 2020). Divergent from most others, this present study considered the willingness to share public transportation with strangers and private vehicles with family members.
and friends during Covid-19 and postcovid mobility preferences. Covid-19 study on shared mobility in Nigeria is imperative considering the country is the most populous on the continent coupled with intrac- tally poor transportation infrastructure. For example, the unorganised mass transit buses in Lagos, called molue, under normal situation pre- covid, could lift an excess of 100% passengers above the carrying capacity. Nigeria was, thus, predicted to be the worst hit on the continent due to the crowded nature of public transport occupancy.

Consequently, using Covid-19 spread-containment protocols, the study x-rayed shared mobility styles during the pandemic and the shared travel preferences postcovid, *ceteris paribus*. Specifically, the study examined the willingness to share trips, using public vehicles with strangers or personal cars with family and friends influenced by the Covid-19 spread-mitigate protocols. The sourced data was analysed using the ordinal logistic regression technique. Based on this back- ground, this study makes an original contribution to the understanding of shared mobility styles during Covid in Nigeria. The sectionalisation of the paper is as follows: perspectives related to this study are in section two as a literature review. Section three contains the data source and characteristics and the statistical techniques adopted. The results and discussion are in section four, including the sum- mary of the evidence. Section five concludes.

2. Literature review

2.1. Shared mobility styles

Public sharing of vehicles is mostly via motorcycles, tricycles, taxis, and buses. The services rendered by the operators are considered a legal source of income. However, the private sharing of vehicles is not necessarily towards any remunerable services. The shared commuting or travel behaviour is interestingly not alien to African societies—the age-long culture of being “your brother’s keeper” still flourishes. The poor economies in most African countries necessitate a need for burden- sharing (Bode, 2005; Faiyetole and Adesina, 2017) at the micro-scale, particularly in commuting and travel generally. Globally, shared mobility styles have evolved or morphed over the years, including intentionally reducing the number of vehicles on the roads at any given time, mitigating traffic and parking congestion (Faiyetole and Jegede, 2019). And an attempt to reduce carbon emissions to stem down climate change (Carsharing, 2021; Shaheen et al., 1999).

On the whole, the vehicle-sharing methods include carsharing, carpooling, ridesharing, and the public taxi or bus system. Carsharing could involve giving spare seats in vehicles to passengers going the same way on a one-off or regular basis, an arrangement between friends or family or with a total stranger found on the road, or perhaps through a matching service on mobile apps. A carsharing (2021) association, for example, sought to mitigate risks, such as insecurity, by watching over the welfare of registered members who offered such services, which evolved from the setting up of a fleet of vehicles scattered around a city for the use of a group of members (Jorge and Correl, 2013). Typically, carsharing is not for business or financial objectives, rather social and environmental purposes (Carsharing, 2021; Le Vine et al., 2014; Sha- heen et al., 1999). So is carpooling, a practice whereby people living in

| Vehicle type | Precovid (status quo) | Use of nose mask | During Covid-19 (stringent social distancing regime) | Use of nose mask | During Covid-19 (relaxed social distancing policy) |
|--------------|-----------------------|------------------|---------------------------------|------------------|---------------------------------|
|              | Passenger occupancy   | Use of mask      | Passenger occupancy             | Use of mask      | Passenger occupancy             | Use of mask      |
| Motorcycle   | 2                     | Nil              | 1                               | Compulsory       | 1                               | Discretionary   |
| Tricycle     | 4                     | Nil              | 2                               | Compulsory       | 3                               | Discretionary   |
| Taxis        | 6                     | Nil              | 3                               | Compulsory       | 4                               | Discretionary   |
| 18-seater Buses | 18             | Nil              | 9                               | Compulsory       | 13                              | Discretionary   |
| 22-seater Danfo | 22             | Nil              | 13                              | Compulsory       | 17                              | Discretionary   |
| Lagos BRT    | 42                    | Nil              | 21                              | Compulsory       | 26                              | Discretionary   |

Table 1: Public transportation services for shared mobility precovid and during Covid-19 in the study area.
The hard-surface transportation means, such as non-motorised transportation systems, pedestrian systems and bicycles (Bigger, 2019), rails, motorcycles, public and private motor vehicles (Anwar, 2009), are typical of the urban transportation system in Nigeria. Particularly in Lagos, the widely used road network coupled with being the State with the highest population density in Nigeria constitutes a bottleneck regarding the unimaginable traffic situations within the metropolis (Mogaji, 2020; Faiyetole and Fulani, 2020; Nwafor and Onya, 2019; Faiyetole, 2019a). The high population density and high travel intensity in Lagos make it a hotspot for spreading infectious diseases like the novel coronavirus disease. So far, a few Covid-19 studies have explored transportation impacts in Nigeria. Mogaji (2020), for example, focused on Lagos, a locale for the airport (Murtala Mohammed International Airport) with the highest passenger movement (Faiyetole and Yusuf, 2018) thus with the highest travel intensity in Nigeria. Mogaji (2020) administered his questionnaire immediately after phase 1 of the 3-phase economic policy implemented by the PTF. The study revealed that restricted travel correlated more with participants’ economic activities than social and religious activities. The economic and social impacts of the Covid pandemic are consequential upon the drop in ridership occasioned by a drop in travel demands resulting in congestion-busting and reduction in air pollution (De Vos, 2020; Carrington, 2020). Hensher et al. (2021) showed that Covid-19 significantly impacted work travel behaviour, such as the one informed by the lockdown of flexible work-from-home arrangements, which resulted in a short-time reduction in money and time costs evidenced from a Greater Sydney Metropolitan Area study. De Vos (2020) hypothesised that Covid-19 offers the policymakers and transport planners the opportunity to stimulate travel behaviour that uses more sustainable modes (e.g., cycling and walking) during and postcovid era (Babalk, 2020; Gkotsalitsis and Cats, 2020; Rundle et al., 2020; Raunak et al., 2020; Budd and Ison, 2020; King and Krizek, 2020).

The advantage of public transportation over private car use is vital to environmental sustainability. However, the proximity information of the plausibility of being infected by Covid-19 can potentially influence willingness to share trips using environmentally more sustainable public transportation vessels or less-sustainable private car use for urban and long-distance travels (Gutiérrez et al., 2020). Dong et al. (2021) examined the passengers’ perceptions of safety and the feelings of satisfaction using public transportation during Covid, asserting that its psychological effects (Parady et al., 2020) will possibly linger in the postcovid era. Abdullah et al. (2020) showed evidence of a significant shift from public transportation to private and non-motorised modes of transportation due to concerns for Covid-19 infections. For international respondents from more than 15 countries where about (70%) of the respondents were from the south-east Asian countries, Abdullah et al. (2020) showed significant differences in the variables, such as trip purpose, mode choice, distance travelled, frequency of trips, and before and during the pandemic. It was evident that pandemic-related factors (i.e., infection concern, social distancing, sharing of vehicles, passengers wearing nose or face masks) significantly informed the respondents’ modal choices during the pandemic. Frequency of trips for work as a primary trip purpose reduced from (17%) precovid to (5%) during the pandemic, while the number of respondents who commute for work purposes reduced from precovid (58%) to (30%) during Covid-19. Their results further show that the frequency of trips for essential workers reflects who mostly commuted for work during the pandemic. Multinomial logistic regression was applied to reveal that the chances of choosing private relative to public transportation increased with long-distance trips and pandemic-related factors. In contrast, a case of a commuter choosing a non-motorised mode over public transportation was higher for shorter trips and for trips that are for recreational, social, and other purposes (Abdullah et al., 2020). Either using public transportation for commuting purposes or the more seemingly private ridesharing arrangements, the Covid-19 pandemic is bound to bring out a modal shift whichever way (Anwar and Yang, 2017; Abuhamoud and Rahmat, 2010; Kii et al., 2005).

Based on the reviewed literature, it is apparent that the Covid pandemic has impacted transport in many unsustainable ways. Therefore, this study aimed to examine the seemingly potential change in shared mobility styles from public and private vehicle sharing.

### 3. Material and methods

The study employed a self-reported method through structured and standardised survey questions randomly administered to respondents. The sample demographics included participants of all ages from two States in Nigeria, namely, Lagos State with (38.01%) and Ondo State (2.18%) cumulative total of the Covid-19 cases as of 26 July 2021 (Statista, 2021). Thus, Lagos State presents the most reported cases of Covid-19, while Ondo State reports few cases. The choice of the study area is a fair representation of the population from States with the highest and lowest reported Covid-19 cases in the country. The study area (see Fig. 1), has a combined population size N = 17,222,300 (Citypopulation, 2016). It translates to a representative sample size n = 402 within 95% confidence interval, using Taro Yamane’s Equation

\[ n = \frac{N}{1 + N(e^2)} \]  

where N is the population size, e is the error margin.

The questionnaire administration to the respondents in the study area used a simple random sampling technique. The questionnaire was distributed to respondents face-to-face at commercial motor parks, residential areas, and streets in the study areas from August to November 2020. Also, a portion of the survey was administered online to fresh graduates participating in the national youth service corps (NYSC) in November 2020. This group of participants came from different parts of the country. Thus, this is essentially a random sampling technique administered in a cluster. The respondents, who were well aware of the Covid-19 containment protocols, i.e., with policy to reduce vehicle passenger occupancy and use of nose mask before boarding a vehicle, enthusiastically participated in the survey and expressed they found the questions very relatable. A few were circumpect and avoided touching the paper questionnaire for fear of being Covid-19 infected despite wearing nose masks to meet them and making hand sanitiser available to boost their confidence. There was a case of a respondent demanding an incentive before filing the questionnaire. This request was not obliged; instead, the respondent enlightened on the importance of the study and how it could potentially influence policy that could benefit all.

#### 3.1. Shared mobility characteristics precovid and during Covid-19 in the study area

Table 1 shows the public transportation service characteristics regarding vehicle occupancy and use of nose mask precovid and during the implementation of the stringent and relaxed Covid-19 spread-containment policies. Salau (2015) reported that about 80% of total daily passenger trips in Lagos are by public transportation, such as BRT, molue, semi-formal minibus, i.e., danfo, et cetera. And that trip makers in Lagos increasingly rely on private or public shared cars, such as Uber, for their travel purposes. During the first phase of the lockdown, when the containment policy was stringent, as the vehicular occupancy reduced by 50%, the fare increased by about 46% (Olisah, 2020).
However, the transport operators failed to comply with the promulgated policy to increase revenue. In Akure, the capital city of Ondo State, the taxi system is more prominent. Due to dwindled income from the Covid-19 occupancy protocol, the taxi drivers circumvent the policy by carrying more than the allowed passengers, even without protective gear. This noncompliance with the containment policies concerns transport users when sharing vehicles with strangers.

3.2. Specifics of the questionnaire

Consequently, the passengers, who mostly use public transport or share vehicles with strangers or even people they are familiar with, tended to be more cautious when travelling and sharing vehicles for fear of contracting Covid-19. Thus, specific verbiages for the dependent variables (trip sharing), the willingness to share trips questions, were (i) if your usual mode of transportation is the private car, how has Covid-19 impacted your willingness to share your car with friends and family? The family and friends were together to dichotomise strangers from those you are familiar with, despite recognising that family members could have a higher willingness to share vehicles with themselves than with friends. (ii) If your usual mode of transportation is the public mode, how has Covid-19 impacted your willingness to share with strangers? Those together with questions on Covid-19 spread-mitigative protocols, such as social distancing and surgical or nose masking, were Likert-type, ranked from 1 (do not affect), 2 (mildly), 3 (neutral), 4 (moderately) to 5 (mostly affects). Regarding the restrictive vehicle-passenger capacity policy, the options were 1 (reduction in the number of passengers), 2 (usual number of passengers), and 3 (increase in the number of passengers). There were questions to elicit information on the precovid and preferred means of transportation during covid or subsequently, with options, such as 1 (public vehicle), 2 (private cars), 3 (train), 4 (motorcycle), 5 (bicycle), and 6 (walking). The predictor variables

Fig. 1. Map of the study area of Lagos (Red) and Ondo (Yellow) showing the percentage of Covid-19 confirmed cases in the two States relative to the total for the country as of 26 July 2021. The other red text, the Federal Capital Territory, equally contributed above 10% as Lagos (Highly Impacted States). In comparison, the yellow text States had <10% as Ondo (Lowly Impacted States). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
included the precovid and Covid-19 commuting (Kung et al., 2014; Marchetti, 1994) or trips and the precovid and preferred means of transportation (Rodrigo, 2020; Rodrigo et al., 2006; Nurdan et al., 2007) due to Covid-19. These variables reveal how Covid-19 has impacted general travel behaviour in the study area. Further predictor used is the employment type, which shows whether a respondent is an essential worker who must commute to render service or not, helping to reveal the justification for their travel behaviour. Although the study area was in two States, Lagos and Ondo, an open-ended question on where the respondent was residing at the time of the first wave Covid lockdown opened the questionnaire, followed by a question on the participants’ ages, as a confounding variable, with options from $<18, 18–20, 21–30, 31–40, 41–49,$ and $50>$ in years. Supplemental material Covid-19 questionnaire shows the details.

3.3. Data analytical techniques

The data was sourced via the administered questionnaire and subjected to three statistical methods. First, descriptive statistics were applied, which showed the participants’ demographical characteristics. Including information on respondents’ States and regions of residences during Covid-19 first wave lockdown, albeit already in Lagos and Ondo States when completing the questionnaire. An overview of these demographical characteristics informed the need to test the relationship between every two variables and suggested a bivariate (Spearman) correlation test that estimates the strength and direction of the linear relationship between any two variables. A strong correlation between dependent variables suggests multicollinearity when conducting ordinal or multinomial regression analysis. Considering the dependent variables were all Likert ordered data informed the appropriateness of the application of ordinal logistic regression (ORL: PLUM) analysis. All the statistical analyses were by using IBM SPSS Statistics Version 23.

3.4. Survey demographics

The participation rate was 100% ($n = 402$), probably because the Covid-19 pandemic transportation policies, such as the reduced vehicle occupancy, were relatable to all the respondents and therefore found the study timely. Table 2 shows the descriptive statistics for the demographical characteristics of the survey participants. They were mostly from southwestern Nigeria (85.8%), with Ondo and Lagos States having the highest turnout of 43.8% and 35.1%, respectively, with 78.9% of the total respondents. The ages were from $<18$ to $50>$. About 43% of the participants were between 21 and 30 years old, followed by 17.4% aged between 31 and 40 years whereas, $50>$ years old respondents made up 9.7% of the total study participants. Nearly 33% were business owners or self-employed. In comparison, 21.9% were essential workers, nurses, doctors, food sellers, security personnel, or others offering critical services during the lockdown period. The study showed that during the precovid period, 45.5% of the study participants used public vehicles as their primary means of transportation; however, owing to the Covid-19 pandemic, there was a preference for private car use at 49.8%, while the inclination towards personal vehicle use over public transportation vessels is consistent with existing literature, such as Abdullah et al. (2020). Like the preferences for private cars owing to the Covid-19 outbreak, there was equally an increase in the preferences for motorcycle means of transportation, this time, 0.8% marginal. The bicycle as a sustainable means (De Vos, 2020) of transportation shows a preferential increase, albeit marginal, from precovid 0.7% to 1.2% during Covid, regarding non-motorised transportation mode. Conversely, riding bicycles as a healthy way of life, walking shows a preferential decrease to 3.7% from the 5.0% precovid period. Remarkably, the participants’ preferences for the rail system rose by 0.5% from the precovid era. Regarding the travel restrictions protocol, the study shows a 3.1% decline from precovid to the Covid commuting period, from Monday to Friday, typical weekdays

### Table 2

Descriptive statistics for the demographics of the survey respondents ($n = 402$) for whom data were available for analysis.

| S/N | Characteristics | Code value | Percentage | Cumulative percentage | Remarks |
|-----|-----------------|------------|------------|-----------------------|---------|
| A1  | State resident during the lockdown | | | | |
| 1   | Lagos           | 1          | 35.1*      | 35.1                  | Sufficient |
| 2   | Ondo            | 2          | 43.8*      | 78.9                  | Insufficient |
| 3   | Ekiti           | 3          | 3.7        | 80.6                  | Insufficient |
| 4   | Ogun            | 4          | 2.2        | 82.8                  | Insufficient |
| 5   | Osun            | 5          | 1.7        | 84.5                  | Insufficient |
| 6   | Abuja           | 6          | 2.7        | 87.2                  | Insufficient |
| 7   | Kwara           | 7          | 0.7        | 87.9                  | Insufficient |
| 8   | Kogi            | 8          | 0.7        | 88.6                  | Insufficient |
| 9   | Delta           | 9          | 1.0        | 89.6                  | Insufficient |
| 10  | Edo             | 10         | 1.5        | 91.1                  | Insufficient |
| 11  | Akwa Ibom       | 11         | 0.7        | 91.8                  | Insufficient |
| 12  | Cross River     | 12         | 0.5        | 92.3                  | Insufficient |
| 13  | Benue           | 13         | 0.2        | 92.5                  | Insufficient |
| 14  | Oyo             | 14         | 1.2        | 93.5                  | Insufficient |
| 15  | Niger           | 15         | 0.5        | 94.2                  | Insufficient |
| 16  | London          | 16         | 0.2        | 94.4                  | Insufficient |
| 17  | Rivers          | 17         | 0.5        | 94.9                  | Insufficient |
| 18  | Nasarawa        | 18         | 0.2        | 95.1                  | Insufficient |
| 19  | Plateau         | 19         | 4.5        | 99.6                  | Insufficient |
| 20  | Other States    | 20         | 20.7       | 99.6                  | Insufficient |
| A2  | Regional residence during the lockdown | | | | |
| 1   | South-West [S/N=1, 2, 3, 4, 5 & 14] | 22         | 85.8*      | 86.8                  | Sufficient |
| 2   | North-Central [S/N=6, 7, 8, 13, 15, 18 & 19] | 33         | 9.7        | 95.5                  | Insufficient |
| 3   | Niger-Delta [S/N=9, 10, 11, 12 & 17] | 44         | 4.2        | 99.7                  | Insufficient |
| 4   | UK [16]         | 55         | 0.2        | 99.9                  | Insufficient |
| 5   | Other Regions   | 66         | 14.1       | 99.9                  | Insufficient |
| B   | Age of the respondents | | | | |
| 1   | $<18$           | 0          | 6.7        | 6.7                   | |
| 2   | 18–20           | 1          | 8.2        | 14.9                  | |
| 3   | 21–30           | 2          | 43.3       | 58.2                  | |
| 4   | 31–40           | 3          | 17.4       | 75.6                  | |
| 5   | 41–50           | 4          | 14.7       | 90.3                  | |
| 6   | Above 50        | 5          | 9.7        | 100.0                 | |
| C   | Employment type | | | | |
| 1   | Essential Workers | 0         | 21.9       | 21.9                  | |
| 2   | Non-essential Workers – public | 1         | 11.7       | 33.6                  | |
| 3   | Non-essential Workers – private | 2         | 12.7       | 46.3                  | |
| 4   | Self-employed / Business owners | 3         | 32.8       | 79.1                  | |
| 5   | Unemployed      | 4          | 20.9       | 100.0                 | |
| D   | Precovid means  | | | | |
| 1   | Public vehicle  | 0          | 45.5       | 45.5                  | |
| 2   | Private car     | 1          | 32.3       | 77.8                  | |
| 3   | Motorcycle      | 3          | 15.4       | 93.2                  | |
| 4   | Bicycle         | 4          | 0.7        | 93.9                  | |
| 5   | Walking         | 5          | 5.0        | 98.9                  | |
| 6   | Train           | 6          | 0.7        | 99.6                  | |
| 7   | No response     | 7          | 0.2        | 99.8                  | |
| E   | Preferred means owing to Covid | | | | |
| 1   | Public vehicle  | 0          | 27.9       | 27.9                  | |
| 2   | Private car     | 1          | 49.8       | 77.7                  | |
| 3   | Motorcycle      | 3          | 16.2       | 93.9                  | |
| 4   | Bicycle         | 4          | 1.2        | 95.1                  | |
for most workers. The commuting style drastically changed, such that 40.8% from 19.7% went out less than five days during the usual 5-day working week, which implied that the ‘don’t-go-to-work’ policy was effective. The dip in the commuting period during weekdays owing to Covid is generally consistent with the commuting dip observable during recessions (Herriges, 2017; BLS, 2014). Consequently, the participants reduced their everyday commuting from 43% precovid to 14.9% during the Covid-19 period, and 13.9% had resorted to going out more during the weekends, plausibly to satisfy their motion needs in the form of directed travels (Hook et al., 2021). There were noticeable increases in the fortnightly and monthly scheduled commuting owing to the Covid-19 outbreak. Overall, the protocols regarding travel restrictions and lockdown were primarily complied with during the first wave of the new coronavirus pandemic, supported by Abdullah et al. (2020) and Mogaji (2020).

### 4. Results and discussion

#### 4.1. Correlation strength of the transportation variables

The study considered two dependent variables accentuated from implementing the Covid-19 spread-mitigative protocols: the willingness to share – for private cars users – with friends and families and the willingness to share – for public vehicles users - with strangers. The Covid-19 spread-mitigative protocols of interest to this study include 1) social distancing, 2) surgical or nose masks use, 3) travel restrictions, and 4) restrictive vehicle-passenger capacity. The important predictors, including age, employment type, preferences for means of transportation precovid and covid-time, and commuting rates, were subjected to a pairwise correlation test. As shown in Table 3, the willingness to share private cars with family and friends and desire to share for public vehicles revealed significant relationships with three of the four Covid-19 spread-containment protocols except for the travel restrictions protocol. The willingness to share, though, indicates significantly correlated relationships with the age, employment type, and transportation means; the correlation coefficients between the willingness to share with the public and the Covid-19 spread-mitigative protocols are more substantial than the results presented for willingness to share with family and friends. Travel restrictions protocol shows a weak negative but significant correlation with age. There is a significant but weak correlation between precovid commuting and travel restriction. The results show a significant relationship between the protocol regarding the maximum number of passengers allowed in a vehicle and the covid commuting variable.

The ages of the participants show a weak but positive correlation with social distancing and nose masking protocols. Expectedly, a strong and positive correlation between social distancing and nose masking adherence before boarding a vehicle (r = 0.657, p < 0.01) was evident, which agrees strongly with their Cronbach’s alpha (0.804), indicating a high level of internal consistency for the scale (0.7) (Minglong, 2010) for these two Covid-19 spread-mitigative protocols. The correlation coefficient for precovid transportation and preferred means of transportation due to the Covid-19 outbreak is (0.497) while (0.218) for precovid commuting and the covid commuting variables. Overall, the correlation matrix contributed to the variable choices made for the regression tests, whereby I chose the weakly correlated predictors, such that there is no multicollinearity.

#### 4.2. Willingness to share trips

This section delineates the passengers willing to share vehicles with family and friends and those willing to share vehicles with the general public. Knowledge of personal hygiene or understanding of the Covid-19 status of a family could lower the guard by the family to rideshare with themselves than to share with the public passengers. The same goes for friends with a similar level of familiarity. In this light, the need to dichotomise family and friend passengers and strangers is logical. The Chi-squared estimates for these models are shown in Table 4. Both models show significant p-values. The willingness to share vehicles with strangers (p = 0.003) better fits the data at α = 1% than the willingness to share with family and friends. It implies that, although both models are significant, strangers on public transport consider it riskier to share vehicles with others, consistent with Gaskin et al. (2020) and Abdullah et al. (2020).

| S/ N | Characteristics | Code value | Percentage | Cumulative percentage | Remarks |
|------|----------------|------------|------------|-----------------------|---------|
| 5    | Walking        | 5          | 3.7        | 98.8                  |         |
| 6    | Train          | 6          | 1.2        | 100                   |         |
| G    | Precovid commuting |         |            |                       |         |
| 1    | Monday-Friday  | 0          | 23.1       | 23.1                  |         |
| 2    | <5 days btw Mon-Fri | 1          | 19.7       | 42.8                  |         |
| 3    | Weekends       | 2          | 6.5        | 49.3                  |         |
| 4    | Everyday       | 3          | 43         | 92.3                  |         |
| 5    | Fortnightly    | 4          | 2.2        | 94.5                  |         |
| 6    | Monthly        | 5          | 5.0        | 99.5                  |         |
| H    | Covid commuting |           |            |                       |         |
| 1    | Monday-Friday  | 0          | 20.1       | 20.1                  |         |
| 2    | <5 days btw Mon-Fri | 1          | 40.8       | 60.9                  |         |
| 3    | Weekends       | 2          | 13.9       | 74.8                  |         |
| 4    | Everyday       | 3          | 14.9       | 89.7                  |         |
| 5    | Fortnightly    | 4          | 4.7        | 94.4                  |         |
| 6    | Monthly        | 5          | 5.2        | 99.6                  |         |
|      | No response    | .          | 0.5        | 100                   |         |

| Characteristics Code | Value | Percentage | Cumulative Percentage | Remarks |
|----------------------|-------|------------|-----------------------|---------|
| G                    |       |            |                       |         |
| Precovid commuting   |       |            |                       |         |
| Monday-Friday        | 0     | 23.1       | 23.1                  |         |
| <5 days btw Mon-Fri  | 1     | 19.7       | 42.8                  |         |
| Weekends             | 2     | 6.5        | 49.3                  |         |
| Everyday             | 3     | 43         | 92.3                  |         |
| Fortnightly          | 4     | 2.2        | 94.5                  |         |
| Monthly              | 5     | 5.0        | 99.5                  |         |
| No response          | .      | 0.5        | 100                   |         |

Table 2 (continued)

Table 3 shows the ordinal logistics regression results for the demographic variables, age, state of residence, and employment type, and the Covid-19 spread-mitigative protocols. The ORs for the age groups (21–30 years old) and (30–41 years old) associated with the increases in the odds of participants willing to share vehicles with the public passengers are respectively [2.673 (1.048–6.817), Wald χ² (1) = 4.240, p = 0.039] and [2.936 (1.072–8.040), Wald χ² (1) = 4.389, p = 0.036]. See Supplemental material A for the exact Wald and the p-values. However, the perception of vulnerability to Covid-19 is lower for each of the age groups for willingness to rideshare with family and friends than for willingness to share vehicles with the public. Except for the highest age group (50 years old and above) who are more defenceless to the new coronavirus disease (Yanez et al., 2020; Crimmins, 2020). Understandably, this age group showed no significant interest in sharing vehicles with public passengers feeling more comfortable commuting with family and friends considering their susceptibility. The result showed that the Ondo State residents in southwestern Nigeria were significantly associated with a high odds ratio for willingness to share vehicles with public passengers than for willingness to share with their family and friends. It again can be hinged on the participant’s perception that commuting is safer with family and friends than riding with public passengers, and very plausibly because the case rate in Ondo state is meagre. This result agrees with the dynamics shown from the descriptive statistics for precovid means (private: 32.3%, public: 45.5%) and the preferred means of transportation due to the Covid-19 outbreak (public: 27.9%, private: 49.8%) and with existing literature (Abdullah et al., 2020). According to Gaskin et al. (2020), the Covid-19 preference pattern, skewed towards public transportation, has more cases and deaths. The same odds pattern is noticeable in Lagos, the south-west, and the Niger-delta except for the country’s North-central region. Generally, the participants act cautiously before boarding public vehicles and even private ones, and this travel behaviour is different for different places. Notably, the perception of risk [1.298 (0.661–2.549)] by the essential workers willing to carshare with friends and family is highest among the pool of workers.
Table 3
The correlation matrix showing likely multicollinearity of variables.

| Variables                                      | Age    | Employment type | Precovid means | Preferred means due to covid | Precovid commuting | Covid commuting | Travel restrictions protocol due to covid | Restrictive vehicle capacity due to social distancing | Social distancing adherence before boarding | Surgical or nose mask use adherence before boarding | Willingness to share with family and friends | Willingness to share vehicles with strangers |
|------------------------------------------------|--------|-----------------|----------------|-----------------------------|------------------|--------------|----------------------------------------|-----------------------------------------------|--------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| Age                                            | 1.000  | -0.383**        | -0.007         | -0.027                      | 0.089            | -0.148**     | -0.133**                               | -0.027                                        | 0.153**                                | 0.116*                                        | 0.215**                                       | 0.092                                         |
| Employment type                                | -0.383**| 1.000           | -0.109*        | 0.035                       | -0.171**         | -0.015       | -0.013                                 | -0.029                                        | -0.065                                  | -0.068                                        | -0.134**                                      | -0.027                                        |
| Precovid Means                                 | -0.007 | -0.199*         | 1.000          | 0.497**                     | -0.070           | 0.032        | 0.003                                  | 0.041                                         | -0.017                                  | -0.033                                        | 0.110*                                        | -0.062                                        |
| Preferred means due to covid                  | -0.027 | 0.035           | 0.497**        | 1.000                       | 0.040            | 0.017        | 0.051                                  | -0.030                                        | 0.100*                                  | 0.013                                         | 0.150**                                       | 0.064                                         |
| Precovid Commuting                            | 0.089  | -0.171**        | -0.070         | 0.040                       | 1.000            | 0.218**     | 0.128*                                 | 0.030                                         | 0.024                                  | 0.010                                         | -0.006                                        | 0.036                                         |
| Covid commuting                                | -0.148**| -0.015          | 0.032          | 0.017                       | 0.218**          | 1.000       | 0.089                                 | 0.134**                                       | 0.028                                  | 0.023                                         | 0.016                                         | 0.029                                         |
| Travel restrictions protocol due to covid     | -0.133**| -0.013          | 0.003          | 0.051                       | 0.128**          | 0.089       | 1.000                                 | 0.028                                         | 0.003                                  | -0.019                                        | -0.028                                        | 0.023                                         |
| Restrictive vehicle capacity due to social distancing | -0.072 | -0.029          | 0.041          | -0.030                      | 0.030            | 0.134**     | 0.028                                 | 1.000                                         | -0.237**                                | -0.142**                                      | -0.115*                                       | -0.116*                                       |
| Social distancing adherence before boarding   | 0.153**| -0.065          | -0.017         | 0.100*                      | 0.024            | 0.028       | 0.003                                 | -0.237**                                       | 1.000                                  | 0.657**                                       | 0.275**                                       | 0.394**                                       |
| Surgical or nose mask use adherence before boarding | 0.116* | -0.068          | -0.033         | 0.013                       | 0.010            | 0.023       | -0.019                                | -0.142**                                       | 0.657**                                | 1.000                                         | 0.305**                                       | 0.324**                                       |
| Willingness to share with family and friends  | 0.215**| -0.134**        | 0.110*         | 0.150**                     | -0.006           | 0.016       | -0.028                               | -0.115*                                       | 0.275**                                | 0.305**                                       | 1.000                                         | 0.183**                                       |
| Willingness to share vehicles with strangers  | 0.092  | -0.027          | -0.062         | 0.064                       | 0.036            | 0.029       | -0.116*                              | 0.394**                                       | 0.324**                                | 0.183**                                       | 1.000                                         |
Regarding the travel restrictions protocol, the OR to be restricted within the states of residence is highest (1.452 (0.431–2.506)) for participants travelling with private vehicles and lowest for travellers within their immediate locality [0.796 (0.431–1.470)] among the public vessels users. Travel restriction is significantly associated [0.512 (0.294–0.889), Wald $\chi^2 (1) = 5.652, p = 0.017$] with passengers willing to travel on public vehicles within the states.

None of the options showed a significant correlation regarding restrictive vehicle capacity protocol, but the odds ratio is higher for public vehicle use. For example, in Ondo state, the taxi drivers hardly complied with the policy to reduce the number of passengers boarding their vehicles, obviously for profit reasons. The results, thus, revealed that the odds of a participant boarding a vehicle with a reduced number of passengers is rather higher than boarding a vehicle with an increased number of passengers. The social distancing protocol showed evidence of a significant ascent gradient from ‘does not affect’ [0.114 (0.045–0.288), Wald $\chi^2 (1) = 20.967, p < 0.0001$] to moderately [0.356 (0.189–0.669), Wald $\chi^2 (1) = 10.281, p = 0.001$] for public transportation users, while only moderately ordered option showed significance for the private car users [0.492 (0.268–0.900), Wald $\chi^2 (1) = 5.296, p = 0.021$] despite revealing ascent gradient. For the surgical masking protocol, however, there are significantly associated odds ratios only for ‘do not affect’ [0.285 (0.120–0.680), Wald $\chi^2 (1) = 8.014, p = 0.005$] and mildly [0.270 (0.105–0.691), Wald $\chi^2 (1) = 7.448, p = 0.006$] ordered options for private car users. In contrast, there is an insignificant ascent gradient for public transportation users and nose masks use. The participants’ willingness to share vehicles appreciably impacted the extent of preferences for means of transportation. The transportation users who are willing to share vehicles, either way, are significantly associated with their preference for a change of transportation means, as shown in Table 2. The results reveal that the odds ratio to commute during the first wave Covid-19 was higher for public transportation users than for private users for every parameter considered.

### 4.3. Summary of evidence

The participants in the age bracket (41–50 years old) had [2.936 (95% CI, 0.1072–8.040)*] times the rate willing to share public transportation compared to the age group (<18 years old) due to the Covid-19 pandemic, while the same age group had [2.390 (95% CI, 0.899–6.354)] for willingness to share a private vehicle with family and friends. The incidence rates reduced significantly for participants willing to commute in private vehicles in Lagos state (0.473) and Ondo state (1.304). Essential workers have (1.298) times a willingness to rideshare with family and friends than unemployed study participants. The non-essential private workers had the highest odds rate for the public vessels (1.304). Most participants trying to travel outside the States felt the impact of the travel restriction policies. The odds rate is higher for finding vehicles with fewer passengers, particularly for commuters willing to share transportation vessels with the public (0.618) compared to those with increased passengers. Regarding social distancing protocol, the neutral ordered option had a (0.220 (95% CI, 0.104–0.465) ****) times the participants willing to share public transportation vessels compared to the participants who chose the mostly ordered option. Regarding how the participants felt about the social distancing protocol and commuting with private cars, the moderately ranked-choice had a

### Table 4

Goodness of fit for the models.

| Models                                      | Pearson Chi² | df  | p      |
|---------------------------------------------|--------------|-----|--------|
| Willingness to share vehicles with strangers| 1,427.904    | 1.284 | 0.003 |
| Willingness to share vehicles with family and friends | 1,405.838 | 1.280 | 0.008 |

### Table 5

Odds ratios (95% CI) from ordinal logistic regression models for willingness to share with family and friends and desire to share with the public, adjusted for some demographics and covid protocols.

| Covariates | Level | Willingness to share vehicles with strangers | Willingness to share vehicles with family and friends |
|------------|-------|---------------------------------------------|-----------------------------------------------------|
| Age        | <18 years old (ref.) | – | – |
|            | 18–20 years | 2.094 | 0.779 |
|            | 21–30 years | 2.010 | 0.927 |
|            | 31–40 years | 2.673 | 1.823 |
|            | 41–50 years | 2.936 | 2.390 |
|            | 50 years old (ref.) | – | – |
| Residence  | Lagos state | 5.168 | 0.473 |
|            | Ondo state | 9.306 | 1.304 |
|            | South west | 5.183 | 5.142 |
|            | Niger delta | 8.033 | 6.808 |
|            | North central | 2.035 | 0.826 |
| Employment | Essential workers | 0.968 | 1.298 |
|            | Non-essential public | 0.623 | 1.065 |
|            | Non-essential private | 1.140 | 1.284 |
|            | Self-employed / business | 0.569 | 0.639 |
|            | Unemployed (ref.) | – | – |
| Travel restrictions | Locality | 0.796 | 1.277 |
|            | Local govt. area | 0.731 | 1.403 |
|            | State | 0.512 | 1.452 |
|            | Country (ref.) | – | – |
| Restrictive vehicle capacity | Reduction in number | 0.618 | 0.487 |
|            | Usual number | 0.447 | 0.309 |
|            | Increase in number (ref.) | – | – |
| Social distancing | Does not affect | 0.114 | 0.518 |
|            | Mildly | 0.172 | 0.911 |
|            | Neutral | 0.220 | 0.546 |
|            | Moderately | 0.356 | 0.492 |
|            | Mostly (ref.) | – | – |
| Surgical Masking | Does not affect | 0.431 | 0.285 |
|            | Mildly | 0.571 | 0.680 |
|            | Neutral | 0.712 | 0.691 |
|            | Moderately | 0.720 | 0.675 |
|            | Mostly (ref.) | – | – |
| Extent of means of transportation change | No change | 0.285 | 0.358 |
|            | (0.156–0.521)** | – | – |

(continued on next page)
pandemic could shift modal preferences in Nigeria signals to the and traffic congestion from the unsustainable choices. That Covid-19 covid. This study highlights how an unwillingness to share mobility with vehicles with strangers. Passengers are more willing to rideshare with

Thus, it is apparent from this study that the pandemic has set a mo

portation systems for livability and sustainability. Entrenched through

Table 5 (continued)

Covariates Level Willingness to share vehicles with strangers Willingness to share vehicles with family and friends

|               | Willingness to share vehicles with strangers | Willingness to share vehicles with family and friends |
|---------------|---------------------------------------------|------------------------------------------------------|
| Minor change  | 0.434 (0.238–0.791)**                       | 0.330 (0.180–0.601)**                                |
| Neutral       | 0.367 (0.196–0.685)**                       | 0.342 (0.182–0.642)**                                |
| Moderate      | 0.575 (0.323–1.024)                         | 0.472 (0.262–0.849)**                                |
| Major change  | –                                           | –                                                   |

Odds ratios of the self-reported willingness to carpool or share vehicles as ‘does not affect,’ ‘mildly,’ ‘neutral,’ ‘moderately,’ or ‘mostly affects’; ref. denotes reference category; p-values for odds ratios that are statistically significant are indicated with asterisks (* <0.05; **<0.01; ***<0.001; ****<0.0001).

[0.492 (0.268–0.900)*] times the OR of the participants who considered the mostly ordered option.

Noncompliance to the use of surgical or nose mask policy does not deter family and friends from sharing private cars, such that the OR for ‘does not affect’ [0.285 (0.120–0.680)*] is more for participants who chose the mostly ordered option. While for participants willing to share vehicles with the public, the moderately ranked-choice had the incidence rate (0.720) times the ‘mostly’ ordered choice rate. Participants’ willingness to share private cars with family and friends constituted a no change effect on modal choices of the odds ratio [0.358 (0.198–0.650)***] than the rate of a significant change effect. In contrast, it contributes a minor change effect of OR [0.434 (0.238–0.791)***] times the significant change effect for the participants willing to share public vehicles with other passengers consistent with the result of Abdullah et al. (2020).

The evidence has shown that the Covid-19 spread-containment protocols might have caused an unintended preferential modal shift from a more sustainable societal practice (public transportation mode) to a more unsustainable (total carbon emission-wise) one as in the use of private vehicles. Despite the Covid-19 health issues touching on the sustainability of lives and health (WHO, 2020; Tandon, 2020), the use of mass transit vehicles is essential for the environment in terms of less carbon released into the atmosphere (Rodrique, 2020; Hook et al., 2010; Tang et al., 2018). A shift from public to private vehicular use could negatively impact the environment since more cars are needed to convey the teeming commuters and trip makers. While sustaining human lives with the Covid-19 spread-containment policies, it is imperative to sustain the environment through more holistic policies. Policies that lessen the spread of the virus and mitigate an unnecessary shift to a less sustainable transportation mode. In line with Faiyetole (2019b), this study has shown that Covid-19 spread-containment protocols are responsive policies, which seek to tie the fabric and building blocks of the transportation systems for livability and sustainability. Enrenched through transportation preferences that could substantially impact travel behaviour and practices, postcovid.

5. Concluding remarks

The study makes an empirical contribution to the literature by exploring the impact of the Covid-19 pandemic on the willingness to share trips with family and friends using private cars or on public vehicles with strangers. Passengers are more willing to rideshare with family and friends in private cars than share trips with public strangers. Thus, it is apparent from this study that the pandemic has set a momentum phase, an impulse, that could excite the modal shift from the public to a more private means of transportation, ceteris paribus, post-covid. This study highlights how an unwillingness to share mobility with strangers could potentially impact the environment through emission and traffic congestion from the unsustainable choices. That Covid-19 pandemic could shift modal preferences in Nigeria signals to the international community, especially those with similar socioeconomic characteristics, such as population density, transportation infrastructure, and transport intensity. Takeaways from the study are that shared mobility has a two-pronged face. It is ideal for a sustainable transport system, and it is an avenue for introducing, spreading, or contracting infectious diseases. It is thus imperative to keep encouraging shared mobility for sustainability in transportation and promoting communal and personal hygiene with reasonable spacing when sharing vehicles, especially with strangers. Summarily, the contributions in the study show that the Covid-19 mitigative policies had impacted travel behaviour, especially as it relates to shared mobility. Thus, the study recommends that the transportation managers regulate reasonable spacing between passengers and continue to sensitise, monitor and enforce the hygiene level and protection of travellers, especially in public transportation, to make shared mobility more appealing to the generality of the people postcovid.

The study’s limitations include an attempt in question 1 of the questionnaire at delineating the State where the respondent was residing during the first wave of Covid lockdown from the study area, where the physical administration of the questionnaire took place. As shown in Table 2, that singular error made it seem that most respondents lived outside the study areas when they completed the questionnaire. However, the error was corrected by only quantifying the respondents residing in the study area during the first wave Covid lockdown. Thus, a caveat is that the referential quantification for the Niger-Delta and North-Central, for their insufficient number of respondents from the provinces, may likely have presented inaccurate results for the two regions.

Future works could examine Covid-19 second wave, perhaps, the third or fourth, on its impacts on willingness to share trips more exhaustively around the country. Considering respondents’ geographical, social and interpersonal peculiarities.

Uncited references.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trip.2022.100544.

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