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Analysis of Road Transport Response to COVID-19 Pandemic in Nigeria and its Policy Implications

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Abstract

The COVID-19 pandemic presents a serious global health challenge to humanity in recent times. It has caused fundamental disruptions to the global transportation system, supply chains, and trade. The impact on the transport sector resulting from lockdowns has led to huge losses in revenue. At the moment there are limited studies of the road transport sector response to the COVID-19 pandemic. This paper fills this gap using Nigeria as a case study area. A mixed method involving both qualitative and quantitative research was employed. Principal Component Analysis and Multiple Criteria Analysis were used to analyze the data. The results suggest that road transport operators strongly (90.7%) believe that 51 adopted new technologies/innovations, processes, and procedures will keep them and passengers safe from the COVID-19 pandemic in Nigeria. A breakdown shows that observing the lockdown directive is perceived by road transport operators as the most effective response to the pandemic. The breakdown continues in descending order thus: COVID-19 safety protocols, environmental sanitation, and promotion of hygiene, information technology, facemask, and social distancing. Others are public enlightenment, palliative, inclusion, and mass media. This indicates that non-pharmaceutical measures are very effective in the fight against the pandemic. This finding leverages support for the application of non-pharmaceutical guidelines in containing the COVID-19 pandemic in Nigeria.

Keywords

planning and analysis, transportation demand management, general, pricing, pricing elasticity of demand, pricing models, structural equation modeling, public transportation, bus transit systems, all-door, general, safety, transportation safety management systems, general, safety planning, sustainability and resilience, transportation and sustainability, air quality and green house gas mitigation, general, policy analysis, traffic modeling

The COVID-19 pandemic is considered the worst global health calamity of the century and the greatest challenge that humanity has faced since World War II (*1*). The pandemic has fundamentally disrupted individuals' lives, families, organizations, transportation, supply chains, markets, and global trade. The global transport industry, which is hardest hit by the pandemic, has witnessed huge losses in revenue because of a tremendous decline in patronage (*2*). Informal road transport service providers were highly affected by the pandemic. They suffered massive losses in revenue because of city lockdowns. Also, transport workers on the front line caught the virus as they struggled to provide essential services.

The overarching challenges have been how to keep transport operators and transport users safe, and at the same time ensure that the supply chains and mobility networks are operational and solvent. There are difficulties in finding answers to the challenges posed by the pandemic. However, innovative solutions have sprung up around the world to address the challenges. These solutions range from allocation of more road infrastructure to bike users in some cities like Bogota, to the Cool App

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in Malta that allows drivers to pool multiple deliveries from stores and small businesses into the same vehicle to increase efficiency (*3*).

Although road transport accounts for over 90% of freight and passenger movements in Nigeria, road transport operators are faced with poor road infrastructure. Despite this daunting challenge, Nigeria has responded to the COVID-19 pandemic by relying mainly on road transport to render essential services. New technologies/innovations, processes, and procedures were employed by the road transport sector to respond to the pandemic. Incidentally, no study has examined the unique experiences and innovative technologies and approaches employed by road transport in containing the pandemic in Nigeria. This is a critical research gap. There is no gainsaying the need to redress the research gap identified. Therefore, the goal of the study is to examine the road transport response to the COVID-19 pandemic in Nigeria. The road transport sector referred to in this study comprises freight and the public transit system. This study will answer the following research questions: first, what are the new technologies/innovations processes and procedures employed by the road transport sector to respond to the pandemic in Nigeria? Second, how effective are the new technologies/innovations, processes, and procedures in keeping road transport operators and users safe from the pandemic in Nigeria? The research aims to inform future road transport policy in Nigeria as well as feed into the global clearinghouses for information relating to COVID-19 pandemic containment mechanisms, especially for low-income countries. The containment mechanisms suggest wider operational and policy changes in Nigeria and other low-income countries.

Literature Review

This review is a compendium of independent study perspectives on the COVID-19 pandemic. Many of the studies examined the impact of COVID-19 on transportation systems across the globe. Overall, the studies suggest that the COVID-19 pandemic poses a serious challenge to the public transportation system. In their study, Zhang and Hayashi found that commuters' adverse reactions to crowded public transport during the COVID-19 pandemic have resulted in automobile dependency across cities worldwide (*4*). Consequently, there was a shift in attitude from the use of public transport to a private vehicle, thereby leaving public transit more vulnerable than ever. This attitude results in worsening traffic congestion and the polarization of transport systems between commuters who can afford the use of car mode and those that are captive to public transport modes despite the risk. The study suggests that "the support of policymakers is germane to ensuring greater resilience and sustainability of the transport systems" (p. 5). Similarly, Gutierrez et al. found that the COVID-19 pandemic poses new difficulties in providing safe and reliable public transport services, creating barriers for the promotion of sustainable and healthy urban mobility, and has exacerbated inequity in some countries (e.g., Spain) (*5*). The study suggests that "future studies should focus on how to mitigate the pandemic and create sustainable and human-scale cities" (p. 9).

Furthermore, Tirachini and Cats assess the relationship between COVID-19 and public transportation (*6*). They found that the pandemic poses a greater challenge for public transportation systems worldwide. They argue that "the perception of public transport as unhealthy due to the pandemic will gain ground and might be sustained even in the aftermath, resulting in the formation of new habits" (p. 7). This perception is dangerous because public transport services are germane to cities' prosperity and functionality. Moreover, the study recommends that "it is critical to avoid contributing to stereotyping the use of public transport as unhealthy, which may outlive the pandemic itself and hinder the long term prospects of public transportation services" (p. 9). Similarly, Wielechowski et al. assessed the changes in public transport mobility in Poland resulting from the outbreak of the COVID-19 pandemic (*7*). They found that "there exists a significant negative relationship between challenges in mobility in public transport and the stringency level of government anti-COVID-19 policy" (p. 4). This relationship implies that the forced lockdown to contain the pandemic played a major role in promoting social distancing in Poland's public transportation system. However, government restrictions, rather than the level of spread of the pandemic, account for the decreased mobility. Moreover, the study found that there are "changes in mobility in public transport depending on the level of stringency of anti-COVID-19 regulation policy" (p. 8)

The work of Nian (*8*) correlates with previous studies (*5–7*) on the impact of COVID-19 on public transportation. The study found that the number of taxi trips dropped sharply during the pandemic period in megacities (*8*). The level of speed, travel time, and spatial distribution of taxi trips were significantly impaired by the pandemic. Furthermore, "the spatial correlation between taxi trips was gradually weakened after the outbreak of the pandemic and the consumption travel demand of people significantly decreased whereas the travel demand for community life decreases drastically" (p. 7). The outcome of this study provides references for "the optimization of epidemic control policies and recovery of public transport in megacities during the post-epidemic period" (p. 8).

Studies on the impact of the COVID-19 pandemic on public transit in the United States of America show interesting outcomes. Qi et al. found that there has been a decline in public transit ridership in areas with predominantly medium-income households, educated households, high unemployment rate, and Asian population during the pandemic in the U.S.A. (*9*). On the other hand, areas with a high poverty rate and Hispanic population have experienced smaller reductions in public transit ridership. The findings of this study provide the basis for the formulation of appropriate policy to boost the public transit system based on "the better understanding of the causes and patterns of changes in public transit ridership due to the pandemic" (p. 6). Similarly, Medlock et al. found that public transit ridership in several U.S. metropolitan areas is strongly affected by the COVID-19 and policy responses to the pandemic (*10*). Also, the threat of pandemic transmission shows a negative impact on ridership larger than its adverse effect on employment. The study avers that the pandemic will cause a decline in the demand for public transport in favor of lower-density alternative transport modes. This scenario presents serious implications for fuel use, congestion, accident rate, and air quality.

Interestingly, Habib and Anik analyze public discourse on Twitter on the impacts of COVID-19 on public transport modes and mobility behavior (*11*). The study reveals that commuters are avoiding public transport in favor of private cars, bicycles, or walking. In addition, the study found cycling, walking, telecommuting, and online schools as possible solutions to COVID-19 mobility problems. Besides, the protection of transit workers and commuters is critical to lifting the lockdown. Moreover, mask-wearing, phased reopening, and social distancing are effective reopening strategies. The findings of this study are useful tools for policymakers to formulate appropriate policies based on the holistic understanding of public opinions on transportation services during the pandemic. The findings of the American Public Transportation Association (*12*) examination of the impact of COVID-19 on public transit funding needs in the U.S.A. are consistent with the existing studies. The study found that there is a decline in public transit ridership by 79% compared with 2019 levels at the start of the pandemic. Although public transit ridership increased from June to December 2020, the patronage is still about 65% below pre-pandemic levels. The study opines that a decrease in transit revenue will cause annual funding shortfalls ranging between 13 billion and 15.1 billion dollars per annum from 2021 to 2023. Lui et al. also examine the impact of the COVID-19 pandemic on public transit demand in the U.S.A. (*13*). The study found that cities with more essential workers and vulnerable population tend to maintain higher transit demand levels during the pandemic. This implies that public transit is a necessity during the pandemic when transit systems witness a high level of discretionary demand. The study avers that "this should motivate policymakers and taxpayers to reconsider the role of transit systems not as a business, but as critical infrastructure for a community" (p.17).

Some of the studies have provided strong empirical evidence on the impact of COVID-19 lockdown on urban mobility. Aloi et al. found that there was an overall decline in urban mobility by 76% as a result of the COVID-19 lockdown in Santander, Spain (*14*). The private car witnessed a less important decline in mobility, whereas public transport users decreased by 93%. Moreover, they found a 60% and 67% reduction in NO_2 emissions and traffic accidents, respectively. The study recommends that "times of entering workplaces and educational establishments can be scaled to minimize the rush hour factor that results in high vehicle occupancy on the public transportation system" (p. 8). In the same vein, da Haas et al. examined the influence of COVID-19 lockdown on work and travel behavior in the Netherlands (*15*). They found that 80% of people reduced their outdoor activities, with a stronger decrease for older people. Besides, 44% of workers started to increase the number of hours working from home, whereas 30% of them have more remote meetings. Moreover, 27% of home workers are expected to work from home more often in the future. Most of the workers reported positive work experiences, whereas students and school pupils were mostly unhappy with following education from home. Furthermore, the study found that the number of trips and distance traveled dropped by 55% and 68%, respectively, when compared with the fall of 2019. Active transportation (walking or cycling) gained in popularity, thus indicating that 20% of people cycle and walk more and 20% expect to fly less in the future. People are currently more positive toward the private car and far more negative toward public transportation. The findings indicate that "the coronavirus pandemic might result in structural behavioural changes" (p. 9).

Studies on the impact of COVID-19 on transport systems in low and middle-income countries showed interesting outcomes. Koehl examined the challenges and prospects of COVID-19 on urban transport in low and middle-income countries (*16*). The study found that "cities in these countries could experience a sustained drop in demand for commuting transport due to a combination of enduring economic crisis and changing work habits" (p. 6). This could lead to a behavioral shift concerning crowded spaces and public transport in particular. Furthermore, the study shows that there is "a tendency for a shift to investing in infrastructure on active transport modes in the populous middle-income countries" (p.

5). This shift in investment will sustain hygiene, social equity, reduce air pollution, minimize fatal accidents, and enhance levels of physical activity. Porter examined the impact of COVID-19 on women in transport in low-income countries (*17*). She found that the pandemic caused loss of income through restrictions on public transport operations. She opined that substantial percentages of women who make their livelihoods in the informal transport sector in low-income countries were not served by emergency aids that were provided to aid the vulnerable. In addition, she suggests that "consideration needs to be given to the design and delivery of financial social protection measures for women so that their livelihoods can be maintained, to ensure that they can continue to be users or workers in the transport system" (p. 5). Mogaji examined the impact of COVID-19 on transportation in Lagos, Nigeria (*18*). He found that the pandemic disrupts transportation, economic, social, and religious activities. The disruption caused by the pandemic differs significantly among economic, social, and religious activities. It hinders business, travel, social, and religious activities, and causes an increase in the cost of transportation. He opines that "mitigation measures should follow strictly the COVID-19 safety protocols developed by the health authorities" (p. 6).

Several studies examine the socioeconomic disparities in the U.S.A. caused by the COVID-19 pandemic. Hu and Chen found that the socioeconomic disparities resulting from the COVID-19 pandemic have a 95% significant effect on the transit system, which results in a 72.4% decline in ridership in Chicago, U.S.A. (*19*). Furthermore, there was a higher decline in ridership in regions with more commercial lands, and a higher percentage of white, educated, and high-income earners, whereas smaller declines were experienced in regions that offer more job opportunities in trade, transportation, and utility sectors (p. 7). In addition, regions with more COVID-19 cases and deaths witnessed a smaller decrease in transit ridership. The study opines that a timely understanding of the reduction in transit ridership during the pandemic will enable transit agencies to adjust services across different socioeconomic groups and spaces to contain the spread of the virus. In the same vein, Paul et al. examine the relationship between the socioeconomic disparities and the COVID-19 pandemic in the U.S.A. (*20*). The study found that "the prevalence of the disease and death rate correlated highly with the socioeconomic conditions often going beyond local population distributions especially in rural areas" (p. 8). Besides, the pattern of the spread of the disease and death shows asymmetries separately in urban and rural areas, and are manifesting highly in counties with a non-white population. The findings of this study provide the empirical basis for the formulation of appropriate policy for tackling a future outbreak of pandemic arising from SARS.COV-2 in America.

Gainier et al. examine the socioeconomic disparities in social distancing during the COVID-19 pandemic in the U.S.A. (*21*). The study found that the extent of adoption of social distancing is heterogeneous among counties in the U.S.A. Counties with a higher population below the poverty level and essential workers show slower and less intense social distancing. However, socioeconomic inequalities seem to influence the extent of adoption of social distancing across the counties, thus causing wide-ranging variation on the impact of the pandemic in communities across the United States. The study avers that the inequalities may exacerbate the existing health disparities which should "be addressed to ensure the success of ongoing pandemic mitigation efforts" (p. 6). Also, Perry et al. found that the COVID-19 pandemic has disproportionately threatened the economic security of vulnerable and disadvantaged groups in Indiana, U.S.A. (*22*). This is because pre-pandemic food and housing insecurity were positively associated with most indicators of a pandemic-driven economic precarious situation. The study discloses that unemployment status before the pandemic was significantly related to having been fired or suffering unemployment as a result of the COVID-19 pandemic. Tan et al. suggest that income inequality within the U.S.A. counties accounts for greater disease prevalence and death caused by the COVID-19 pandemic (*23*). Consequently, this highlights the large disparities that exist in health outcomes arising from income inequality in the U.S.A. The study recommends targeted interventions toward addressing income inequality to flatten its curve and burden.

There is evidence from existing studies that human mobility influences COVID-19-related deaths. Hadjidemetriou et al. examine the impact of government measures and human mobility trends on COVID-19-related deaths in the UK (*24*). They found that human mobility gradually decreased as the government was announcing more measures to contain the pandemic, and it stabilized at a scale of around 80% after the lockdown was imposed. The reduction had a significant impact on reducing COVID-19-related deaths, thus providing crucial evidence in support of such government measures. The study recommends, "some level of travel restrictions and social distancing measures may need to continue to reduce the risk of resurgence in the transmission of COVID-19 in the UK" (p. 9).

Several studies show the policy implications of COVID-19 for the transportation sector. Among these studies is Delkmann and Turner's work that examines the opportunities for policy-making in Africa with regards to the COVID-19 urban transport response (*25*). The study found that most current policies that originated from the global north are not always applicable to

the situation in African countries. They opined that "African countries should develop its own specific set of policies and regulations to tackle the effects of COVID-19 on urban transport" (p. 6). The study suggests that such policies should focus on seven major areas. These include COVID-19 response, formal transport operations, informal transport operations, taxi operations, active transport, accompanying policies, and fiscal policies. The study advocates "a long-term action that uses the opportunity presented by the pandemic for transport sector reform and an inclusive low-carbon transformation" (p. 8) Similarly, Budd and Isan propose a new concept of responsible transport to help inform and shape transport policy and practice responses to the COVID-19 pandemic (*26*). They opined that "the novelty of this proposal lies in the fact that it incorporates not only environmental considerations concerning sustainability but also encompasses considerations of individual and community health and well-being" (p. 9). They argue that "Responsible Transport" delivers safe, secure, and equitable mobility that embeds social, economic, and environmental well-being at the heart of post-COVID transport policy, planning, and operations, and enables individuals to make considered transport choices. They revealed clearly that "any transition toward Responsible Transport will occur in a rapidly changing policy and service environment" (p. 5). In another study, Dalkmann et al. call for collective action for international transport stakeholders to respond to the COVID-19 pandemic (*27*). They opine, "such a collective action should ensure the establishment of a wider coalition that can speak with a single voice to coordinate and act on policy advocacy and ensure that the COVID-19 is combined with delivering on the Paris Agreement and Sustainable Development Goals" (p. 7).

It is apparent, given existing literature perspectives, that there is a rapidly growing knowledge base on the impact of the COVID-19 pandemic on transportation and its policy implications. However, there is a lack of studies on the assessment of response to the pandemic in the road transport sector, especially in low-income countries. This study brings the overlooked literature perspective to bear in the process of knowledge production.

Overview of COVID-19 Pandemic in Nigeria

Nigeria locates approximately between latitudes 4° 15 and 13° 55 north of the equator, and longitude 2° 451 and 14° 35 east of the Greenwich Meridian. It is bound by the Republic of Benin at the west, the Niger Republic at the north, and Cameroon at the east. It has a total area of about 923,700 square kilometers comprising 36

Figure 1. Map of Nigeria.
Source: AnnaMap.com.

federating States (see Figure 1). It is the most populous country in Africa, with a population of 200 million people (*28*).

Nigeria shares in the global COVID-19 pandemic outbreak from China in 2019. It confirmed the first incidence of COVID-19 in the country on February 27, 2020. This was when an Italian citizen tested positive for the virus in Lagos. Subsequently, the report of the Italian infecting someone who had contact with him in Ewekoro, Ogun State appeared on March 9, 2020 (*18*). The spread of the pandemic within few months throughout the country caused deaths among Nigerian citizens.

In response to this, the government introduced various palliative measures to contain the pandemic. These measures include national lockdown, closure of airports and international borders, increased testing, hospitalization and treatment of patients, development and implementation of safety guidelines, public enlightenment, and provision of palliatives to cushion the effects of lockdown. In addition, the Nigerian Centre for Disease Control (NCDC) and the Presidential Taskforce on the COVID-19 pandemic assumed the responsibility of coordinating the Federal Government's response in controlling the pandemic.

Despite the Government's responses, the pandemic continued to spread across the 36 States and the nation's capital city, Abuja. The number of confirmed cases rose from the first incidence case on February 28, 2020, to 87,510 cases on December 31, 2020. By the year-end of 2020 available statistics indicate the death of 1,289 persons, active cases of 12,508 patients, and the recovery of 73,713 cases (*19*). In addition, there are 166,254 confirmed cases of the disease, with 2,071 deaths and

Table 1. COVID-19 Pandemic Incidence Among Selected Countries in North America, Europe, South America, Africa and Asia at May 30, 2021

Country	Total cases	Number of death	Total number of recovered cases	Total cases per one million people	Death per one million people
U.S.A.	28,376,037	608,975	27,767,062	102,245	1,830
India	34,023,241	323,580	25,227,740	19,934	232
Brazil	16,392,657	459,171	14,811,266	76,627	2,146
France	5,646,877	109,290	5,303,607	36,338	1,671
Turkey	5,228,322	47,134	5,083,099	61,395	553
Russia	5,063,037	121,208	4,670,484	54,617	827
UK	4,477,705	127,768	4,284,613	65,647	1,873
Italy	4,216,406	126,085	3,845,087	69,774	2,087
Argentina	3,702,422	79,693	3,252,843	81,245	1,698
Germany	3,682,623	88,940	3,471,800	43,812	1,058
Iran	2,900,325	79,914	2,425,033	34,052	939
South Africa	1,654,551	56,293	1,551,520	27,583	938
Canada	1,374,275	25,440	1,308,932	36,126	669
Egypt	259,540	14,950	190,254	2,492	144
Nigeria	166,254	2,071	156,546	789	10
Kenya	170,929	3,158	116,133	3,109	57
Ghana	93,775	784	91,853	2,962	25
China	91,077	4,636	86,107	63	3
New Zealand	2,670	26	2,623	534	5

Source: Worldometers Coronavirus, May 29, 2021.

156,546 recovered patients as of May 30, 2021. The cities of Lagos, Abuja, Kano, and Kaduna were the epicenters of the pandemic in the country. The highest confirmed daily cases of the pandemic were recorded on December 17, 2020, with 1,145 new infections (*29*). This record indicates then that the nation is prone to a second wave of the pandemic.

However, a comparative analysis of the COVID-19 pandemic for select countries (see Table 1 below) shows that Nigeria experienced a relatively low rate of infection. Despite the low rate of infection, the impact of the pandemic somehow devastated Nigeria's economy, resulting in the disruption of transportation, commercial, social, religious, and recreational activities.

Methodology

This study adopted a mixed method involving qualitative and quantitative research. The qualitative method sought to identify the new technologies/innovations, processes, and procedures employed by road transport in responding to the COVID-19 pandemic. Primary data from the qualitative method derive from semi-structured face-to-face oral interviews of a sample of 20 representatives of the sample frame of seven different categories of road transport operators in Nigeria. The respondents were chosen to cover the nation's seven heavily traveled road transport corridors in the South-eastern, South-western, and Northern parts of the country.

On the other hand, the quantitative method sought to obtain empirical data using a questionnaire to investigate the effectiveness of road transport responses to the COVID-19 pandemic (identified through face-to-face oral interviews). The respondents comprised 20 sampled stakeholders who are key informants for this study. The key informants are defined as a group of 15–35 people selected for their first-hand and special knowledge of the phenomenon under investigation (*30*). Consequently, the 20 key informants sampled in this study are within an acceptable range and permissible for an intensive sampling (*31*). They were sampled in this study because of their special knowledge of the road transport response to the COVID-19 pandemic in Nigeria. The key informants were randomly drawn from these seven categories of road public transport operators in Nigeria, namely public operators, quasi-public operators, organized group private operators, organized independent private operators, organized virtual operators, and informal private operators. The sample is for a finite quantity and without replacement. This is to ensure that element of bias is eliminated in the data. Moreover, the Kaiser–Mayer–Olkin measure of sample adequacy in the principal component analysis (PCA) results shows a value of .68. This indicates that the sample size is adequate for this study. The key informants assessed the effectiveness of 51 new technologies/innovations, processes, and procedures in keeping themselves and passengers safe from the COVID-19 pandemic using a 5-point Likert scale questionnaire.

Data analysis followed two approaches: the multiple criteria analysis (MCA) and PCA. The MCA of preferred percentages and calculated "mean" were applied to assess the levels of perception. The matrix of preferred percentages and calculated "mean" gave the frequency distribution of five levels of perception based on a 5-point Likert scale, namely very high (5), high (4), moderate (3), low (2), and very low (1). The scoring of the levels of perception proceeds with using the highest percentages to determine preferred perception and using a convenient scale to distribute the range of calculated mean.

The PCA is a statistical technique that converts a set of linearly uncorrelated variables into components or factors using orthogonal transformation. It applies to collapse the 51 identified new technologies/innovations, processes, and procedures employed by the road transport in responding to COVID-19 pandemic into fewer factors, and proceeded to measure their level of effectiveness to secure safety for road transport operators and users in the face of the pandemic.

Data Presentation and Analysis

Summary of the Face-to-Face Oral Interview on the New Technologies/Innovations Processes and Procedures Adopted by Road Transport in Responding to the COVID-19 Pandemic

New technologies/innovations. The study found many instances of innovative solutions used by road transport operators in Nigeria in keeping themselves and passengers safe from COVID-19. A courier and logistics company in Enugu, for instance, pooled its technicians into a WhatsApp© group that leveraged the National Cash Register (NCR©) technology for monitoring and repairs of automated teller machines and training on safety for drivers on essential duties in Enugu. This novel approach made financial services available for people who took advantage of periods of relaxed curfew to make purchases. Another company in Lagos used video calls to monitor driver–passenger compliance to government directives, and many transport operators in Abuja also introduced enlightenment lectures for commuters, leading to a high level of awareness of government directives and NCDC COVID-19 safety protocols.

Technologies based on quick adoption and utilization of NCDC COVID-19 safety protocols. At the outset of the pandemic in Nigeria, particularly at the point of the index case on February 27, 2020, the NCDC released guidelines/protocols on health and safety measures to respond to the disease. These measures included the prohibition of all inter-state travel except for essential travels and services, such as transportation of agricultural products, petroleum products, relief items, goods, commodities related to the COVID-19 response, and persons on essential duty. The guidelines provide that road transport operators involved in providing the essential services must ensure the provision of hand-washing facilities, maintenance of social distancing, mandatory use of facemask/coverings, mandatory temperature checks, and use of alcohol-based hand sanitizers. This study found that transport operators were quick to adopt and utilize these guidelines. Some road transport operators interviewed, such as the Abuja Urban Mass Transit Company Limited, adapted and expanded the guidelines to cover all sectors of their operations targeting commuters, supervisors, drivers, and other field staff. All the interviewees reported the following operations at their stations: mandatory temperature checks, use of alcohol-based hand sanitizer, face masks/coverings, and disposable gloves for handling money. Others include hand-washing facilities and mandatory hand-washing for operators and users, sanitization of vehicles, as well as social distancing, both at terminals and on transit.

Information/communication technology (ICT)-based innovations. All transport operators sampled adopted and deployed ICT-based solutions in response to the pandemic. Online booking and ticketing, for instance, were generally used by the operators to avoid contact with commuters. Also, transport operators reported increased use of technologies to hold remote staff meetings. Rideon, which is a ride-hailing service provider in Enugu, reported that it has held all its meetings (100%) remotely since the start of the pandemic. However, according to respondents a major downside to this widespread adoption and use of information technologies is the increase in the cost of gadgets, voice, video and data services, as well as the unstable and poor quality of these services.

Technologies and processes that enabled change in the work procedure. Road transport operators in Nigeria changed their work procedures in response to the pandemic. All operators interviewed reported that they introduced duty shifts to create the required social distance in the work environment, especially the offices. Not all operators, however, were able to create a work-from-home environment as a result of lack of access to (and sometimes inability to use) certain information technology gadgets such as computers and smartphones, or because certain duties such as driving and cleaning cannot be performed remotely.

Information dissemination procedures and channels. The coronavirus being a novel virus brought fear and uncertainty, especially when it was confirmed to be of pandemic proportion. This triggered the release of huge amounts of information by official and unofficial sources through all

media channels. Some of the information was conspiracy theories that lacked any form of credibility. This study, however, found that road transport operators in Nigeria seemed to have relied solely on government-approved channels for information. All road transport locations visited had ample display of NCDC and Ministry of Health-approved infographics. The operators noted that this was important to ensure that they were consistent with guidelines for commuters and other road users. The Federal Ministry of Transport, for instance, collaborated with the Federal Roads Safety Corps, National Youth Service Corps, and other security agencies to organize public enlightenment programs for all categories of road transporters.

Medical response. Some of the transport operators indicate that they station some medical personals such as doctors and nurses at their terminal in case of emergency. Some of the transport companies offered free medical advice to commuters that fall within vulnerable groups.

Procedures for the National Response

i. Issuance and enforcement of directives: Regulatory authorities, especially the Ministries of Transport, were swift in issuing operational guidelines for essential service workers and transporters during the lockdown. Drivers and other operators reported that they were issued with appropriate permits for intra- and inter-city travel.
ii. Infrastructure changes: Although active transport has been encouraged to ease the worsening flow of traffic as a result of more private cars on the road, the study did not find any improvement in road infrastructure as a response to COVID-19 in Nigeria.
iii. Stimulus package: Twelve of the road transport operators interviewed were not aware of any national stimulus package meant for them. This unawareness calls to question the modalities for disbursing the Federal Government of Nigeria's Micro, Small and Medium Enterprise Survival Fund grants meant for the operators. In other words, road transport operators may have lost financial allocation from the government.

Analysis of Descriptive Statistics on the New Technologies/Innovations, Processes and Procedures Adopted by Road Transport in Responding to the COVID-19 Pandemic

The frequency distribution of preferred perceptions and calculated "mean," which derives from the descriptive statistics of perceptions of road transport operators on the effectiveness of the new technologies/innovations, processes, and procedures being used in keeping themselves and passengers safe from the COVID-19 pandemic in Nigeria, are shown in Table 2. The analysis indicates that operators viewed the measures as effective in keeping themselves and passengers safe from the pandemic in Nigeria. The matrix of derive data which shows the mean and standard deviation suggests that the measures were effective.

The presentation of derived data from quantitative analysis (PCA results) is shown in Table 3.

The results collapsed new technologies/innovations, processes, and procedures being used by road transport operators in keeping themselves and passengers safe from the pandemic in Nigeria into 11 categories, which account for 90.9% of the variability in the original 51 variables.

Component 1: Lockdown. The first index refers to lockdown as a distinct new technology, process, and procedure used by road transport operators in keeping themselves and passengers safe from the pandemic in Nigeria. Sixteen variables correlate highly in the composition of this component. These are, in descending order, restriction on inter-state and inter-city travel (.904), keeping the manifest of the passengers for contact tracing (.896), provision of waste-disposal facilities inside the vehicles and terminal (.895), the prohibition of touting in the terminal and transport vehicles (.862), dedication of special routes (.819), and obtaining and keeping contact address of all passengers (.761). Others are providing guidelines on do's and don'ts to every passenger (.719), valuable backup staff for other critical positions (.667), rear door boarding may temporarily replace the front door access (.639), modification of boarding and loading system (.629), modification of departure/arrival schedule for passengers (.582), routine maintenance (.563), disinfectant both inside the terminal and transport vehicles (.563), identification of essential functions within the organization (.528), the use of official channels for COVID-19 updates (.528), and customer service staff should only be available in information booths (.511). It has an eigenvalue of 9.815 and accounts for 20% of the total variation.

Component 2: COVID-19 safety protocol. The second composite indicator suggests that COVID-19 safety protocol contributes as a distinct new technology, process, and procedure used by road transport operators in keeping themselves and passengers safe from the pandemic in Nigeria. The component correlated positively on nine significant variables. These are, in descending order, ensure strict enforcement of NCDC COVID-19 safety protocol (.873), adopting cleaning routines (.821), ensuring that

Table 2. Frequency of Effectiveness of New Technologies, Processes and Procedures Used by Road Transport Operators

Options	VH Freq (%)	H Freq (%)	M Freq (%)	L Freq (%)	VL Freq (%)	NA Freq (%)	Mean	SD	Decision
Public enlightenment	12 (60)*	6 (30)	2 (10)	NA	NA	NA	4.5	0.7	High
Social distance	15 (75)*	3 (15)	2 (10)	NA	NA	NA	4.7	0.7	High
Temperature check	10 (50)*	7 (35)	3 (15)	NA	NA	NA	4.4	0.7	High
Provision for facilities	10 (50)*	8 (40)	1 (5)	NA	NA	1 (5)	4.3	1.1	High
Provision of sanitizers	8 (40)	10 (50)*	2 (10)	NA	NA	NA	4.3	0.7	High
Promotion of avoiding touch	11 (55)*	4 (20)	5 (25)	NA	NA	NA	4.3	0.9	High
Promotion of covering the nose	7 (35)	7 (35)*	6 (30)	NA	NA	NA	4.1	0.8	High
Use of face mask	15 (75)*	5 (25)	NA	NA	NA	NA	4.8	0.4	High
Medical response	6 (30)	6 (30)*	5 (25)	2 (10)	NA	1 (5)	3.7	1.3	High
Use of official channels	5 (25)	9 (49)*	4 (20)	2 (10)	NA	NA	3.9	0.9	High
Cleaning of seats	8 (40)*	7 (35)	2 (10)	3 (15)	NA	NA	4.0	1.1	High
Cleaning of convenience	13 (65)*	6 (30)	1 (5)	NA	NA	NA	4.6	0.6	High
Cleaning of terminal	8 (40)	8 (40)*	3 (15)	1 (5)	NA	NA	4.2	0.9	High
Fumigation of terminal	9 (45)*	7 (35)	2 (10)	2 (10)	NA	NA	4.2	1.0	High
Use of e-ticket	4 (20)	6 (30)*	3 (15)	2 (10)	NA	5 (25)	2.9	1.9	Low
Electronic transfer payment	4 (20)	9 (45)*	4 (20)	NA	1 (5)	2 (10)	3.5	1.5	High
Respiratory hygiene	6 (30)	8 (40)*	6 (30)	NA	NA	NA	4.0	0.8	High
Shift work schedule	5 (25)	9 (45)*	3 (15)	1 (5)	NA	2 (10)	3.6	1.5	High
Modification of schedule	2 (10)	8 (40)*	5 (25)	5 (25)	NA	NA	3.4	1.0	High
Modification of boarding system	4 (20)	4 (20)	8 (40)*	4 (20)	NA	NA	3.4	1.0	High
Use of social media	5 (25)	11 (55)*	2 (10)	1 (5)	NA	1 (5)	3.9	1.2	High
Prohibition of touting	9 (45)*	7 (35)	1 (5)	2 (10)	1 (5)	NA	4.1	1.1	High
Provision of waste-disposal facilities	11 (55)*	5 (25)	2 (10)	1 (5)	1 (5)	NA	4.2	1.2	High
Proper disposal of wastes	11 (55)*	8 (40)	NA	NA	NA	1 (5)	4.4	1.1	High
Promotion of inclusiveness	7 (35)*	6 (30)	6 (30)	1 (5)	NA	NA	4.0	0.9	High
Health declaration	4 (20)	4 (20)	6 (30)*	4 (20)	1 (5)	1 (5)	3.2	1.3	High
Provision of guidelines	7 (35)	10 (50)*	2 (10)	NA	1 (5)	NA	4.1	1.0	High
Storage of manifest	8 (40)*	4 (20)	6 (30)	NA	2 (10)	NA	3.8	1.3	High
Avoiding routes	4 (20)	4 (20)	7 (35)*	NA	2 (10)	3 (15)	3.0	1.3	High
Restriction of travels	7 (35)	7 (35)*	4 (20)	NA	NA	2 (10)	3.8	1.5	High
Use of special routes	3 (15)	7 (35)*	5 (25)	3 (15)	NA	2 (10)	3.2	1.4	High
Identification of essential functions	5 (25)	9 (45)*	5 (25)	1 (5)	NA	NA	3.9	0.9	High
Development of inventory	3 (15)	12 (60)*	5 (25)	NA	NA	NA	3.9	0.9	High
Reviewing the stock	9 (45)*	5 (25)	5 (25)	1 (5)	NA	NA	4.1	1.0	High
Reviewing stock and supply chains	8 (40)*	6 (30)	4 (20)	2 (10)	NA	NA	4.0	1.0	High
Development of communication messages	2 (10)	8 (40)*	6 (30)	2 (10)	NA	2 (10)	3.2	1.4	High
Equipping staff washing rooms	7 (35)	7 (35)*	3 (15)	2 (10)	NA	1 (5)	3.8	1.3	High
Ensuring staff compliance with mask-wearing	13 (65)*	4 (20)	3 (15)	NA	NA	NA	4.5	0.8	High
Adopting a cleaning routine	14 (70)*	2 (10)	4 (20)	NA	NA	NA	4.5	0.8	High
Protection of staff	9 (45)*	6 (30)	3 (15)	1 (5)	NA	1 (5)	4.0	1.3	High
Ensuring strict enforcement of NCDC	12 (60)*	6 (30)	1 (5)	1 (5)	NA	NA	4.5	0.8	High
Availability of customer service staff	10 (50)*	6 (30)	3 (15)	1 (5)	NA	NA	4.3	0.9	High
Rear door boarding	6 (30)	6 (30)	6 (30)*	1 (5)	1 (5)	NA	3.8	1.1	High
Need for ticket inspection	11 (55)*	1 (5)	5 (25)	1 (5)	1 (5)	1 (5)	3.9	1.5	High
Valuable backup staff	7 (35)	7 (35)*	2 (10)	4 (20)	NA	NA	3.9	1.1	High
Promotion of working from home	6 (30)	8 (40)*	3 (15)	2 (10)	NA	1 (5)	3.8	1.3	High
Promotion of Zoom meetings	9 (45)*	5 (25)	3 (15)	2 (10)	NA	1 (5)	3.9	1.4	High
Service amendment	9 (45)*	2 (10)	5 (25)	3 (15)	1 (5)	NA	3.8	1.3	High
Routine maintenance	10 (50)*	5 (25)	4 (20)	1 (5)	NA	NA	4.2	1.0	High
Information sharing with local authorities	9 (45)*	6 (30)	4 (20)	1 (5)	NA	NA	4.2	0.9	High
Obtaining and keeping contact addresses of passengers	8 (40)*	6 (30)	2 (10)	3 (15)	1 (5)	NA	3.9	1.3	High

Note: *Preferred perception; VL = Very low; L = Low; M = Moderate; H = High; VH = Very high; NA = Not available; SD = standard deviation; NCDC = Nigerian Centre for Disease Control.

Source: Researcher's Survey, 2020.

Table 3. Summary of Principal Component Analysis Results on the Road Transport Operators Perception of the Effectiveness of New Technologies, Processes, and Procedures Used by Them to Respond to the Pandemic in Nigeria

S/N	Component	Percentage of variance (the strength of road transport operators perception on each component)	Cumulative percentage of variance
1	Lockdown	20	20
2	COVID-19 safety protocols	12.6	32.6
3	Environmental sanitation	9.8	42.4
4	Promotion of hygiene	8	50.4
5	Information technology	7.8	58.2
6	Face mask	7.3	65.5
7	Social distancing	6.6	72.1
8	Public enlightenment	6.2	78.3
9	Palliative	5.1	83.4
10	Inclusion	4.1	87.5
11	Mass media	3.4	90.9

every staff attending to sick people (.808), customer service staff should only be available in information booths (.723), promotion of telephone/Zoom meetings (.673), and routine maintenance (.635). Others are a protection to staff attending to sick people (.604), obtaining and keeping contact addresses of all passengers (.537), and information sharing with local authorities to align crisis plans (.535). It has an eigenvalue of 6.149 and accounts for 12.6% of the total variation.

Component 3: Environmental sanitation. The third composite index that measures new technology, process and procedure used by road transport operators to keep themselves and passengers safe in the face of the COVID-19 pandemic in Nigeria is environmental sanitation. This component loaded significantly on seven variables which are, in descending order, regular cleaning of the terminal and transport vehicles with disinfectant (.844), review of stock and supply chains for operational material (.798), and public enlightenment on the prevention and control of COVID-19 both inside the terminal terminals and transport (.667). Others are the promotion of the use of elbow to cover your face or tissue when coughing and sneezing (.633), fumigation of the terminal and transport vehicles regularly (.625), review the stock and availability of essential protection (.607), and cleaning of the place of convenience regularly with disinfectant (.583). It has an eigenvalue of 4.818 and explains 9.8% of the total variation.

Component 4: Promotion of hygiene. The fourth component indicates that promotion of hygiene is a new technology, process, and procedure used by road transport operators in keeping themselves and passengers safe from the pandemic in the country. This component consists of five significant and positively correlated variables. These are the provision of facilities for washing of hands with soap under running water (.832), avoiding touching your eyes nose and mouth with unclean hands (.823), good ventilation and respiratory hygiene both inside the terminal and transport vehicles (.678), modification of boarding and loading system (.533), and modification of departure/arrival schedule for passengers (.507). It has an eigenvalue of 3.913 and accounts for 8% of the total variation.

Component 5: Information technology. The fifth composite index indicates information technology as a distinctly new technology, process, and procedure used by road transport operators in keeping themselves and passengers safe from the pandemic in Nigeria. This component correlated highly on four variables, namely online payment/electronic transfer payment (.861), shift work schedule for staff (.846), online booking/use of e-ticket (.705), health declaration (.698), and avoiding routes with traffic congestion (.690). It has an eigenvalue of 3.818 and explains 7.8% of the total variation.

Component 6: The use of face mask. The sixth component suggests that the use of face mask is a distinctly new technology, process, and procedure used by road transport operators in keeping themselves and passengers safe in face of the COVID-19 pandemic. It significantly correlates on four variables which include the use of face mask both inside the terminal and transport vehicles (.870), temperature checks both in the terminal and transport vehicles (.851), disinfectant both inside the terminal and transport vehicles (.610), and protection to staff attending to sick people (.561). It has an eigenvalue of 3.580 and accounts for 7.3% of the total variation.

Component 7: Social distancing. The seventh component is an index that indicates social distancing as a distinctly

new technology, process and procedure used by road transport operators in keeping themselves and passengers safe from the pandemic. This component also correlated positively on four variables, namely proper and frequent disposal of wastes (.884), the social distance both inside the terminal and transport vehicles (.754), the use of official channels for COVID-19 updates (.560), and modification of departure/arrival schedule for passengers (.512). It has an eigenvalue of 3.220 and accounts for 6.6% of the total variation.

Component 8: Public enlightenment. The eighth composite index indicates that public enlightenment is a distinctly new technology, process and procedure used by road transport operators in keeping themselves and passengers safe from the pandemic. The component loaded significantly on three variables, namely development of communication messages (.836), equipping staff washing and dressing rooms (.716), and developing an inventory of staff qualifications, licenses, and so forth. It has an eigenvalue of 3.004 and accounts for 6.2% of the total variation.

Component 9: Provision of palliatives. The ninth component suggests that provision of palliatives is a distinctly new technology, process and procedure used by road transport operators in keeping themselves and passengers safe from the pandemic. Two variables, namely the provision of alcohol-based hand sanitizers for cleaning of hands (.780) and cleaning of the place of convenience regularly with disinfectant (.568) correlated positively to form the component. It has an eigenvalue of 2.476 and accounts for 5.1% of the total variation.

Component 10: Inclusion. The tenth component indicates that promotion of inclusion in road transport services is a distinctly new technology, process and procedure used by road transport operators in keeping themselves and passengers safe in the face of the COVID-19 pandemic. This component consists of only one variable, namely the promotion of inclusiveness in transport services with regards to the elderly, persons with disabilities, women, and children (.747). It has an eigenvalue of 1.988 and accounts for 4.1% of the total variation.

Component 11: Mass media. The eleventh component indicate that mass media is a distinctly new technology, process and procedure used by road transport operators in keeping themselves and passengers safe from the pandemic. It also loaded significantly on one variable, namely the use of social media, television, radio, local town-criers, and podcast for the dissemination of information and other issues (.634). It has an eigenvalue of 1.648 and explains 3.4% of the total variation.

Overall, the 11 categories of new technologies, processes and procedures used by road transport operators in keeping themselves and passengers safe from the COVID-19 pandemic in Nigeria (see Table 3) based on their perceived level of effectiveness are as follows in descending order: lockdown, COVID-19 safety protocols, environmental sanitation, promotion of hygiene, information technology, face mask and social distancing. Others are public enlightenment, provision of palliatives, inclusion, and mass media.

Discussion

The face-to-face oral interviews show that road public transport providers follow government directions when reacting to COVID-19. It also highlights three important examples of road public transport using new technologies/innovations to respond to the COVID-19 epidemic. First, a courier and logistics firm in Enugu used the WhatsApp© group technology to coordinate the operations of its staff who were saddled with the responsibility of monitoring and servicing the automated teller machines during the lockdown. This innovative approach availed financial services to the residents who made purchases during the relaxed period of the lockdown. Second, a road transport company based in the city of Lagos monitored the level of compliance of its drivers with COVID-19 safety protocols by video call technology. Third, ICT-based solutions such as online booking and electronic ticketing systems were employed by the road public transport operators in the provision of essential services to commuters in the face of the pandemic. This minimized the level of contact between the road public transport service providers and commuters, which may have contributed to curtailing the risk of the spread of the pandemic. Besides, there was an increase in the use of ICT technologies like Zoom in holding remote meetings among the staff of road transport companies.

The oral interviews show that road transport operators adopt innovative processes and procedures in responding to the pandemic. Their efforts draw mainly from NCDC COVID-19 pandemic safety protocols. Directives from regulating agencies drive changes in work procedures, information technology, information dissemination, and national response to the pandemic. The road transport operators employed these innovative changes to keep themselves and passengers safe from the COVID-19 pandemic. Thus, they exhibited high awareness of the COVID-19 pandemic and demonstrated compliance with directives to contain the pandemic.

Furthermore, the MCA in Table 2 indicates that the level of perception of the effectiveness of 51 new

technologies, processes, and procedures used by road transport operators in keeping themselves and passengers safe from the COVID-19 pandemic is very high. The use of face masks, social distancing, cleaning of convenience, and public enlightenment among others showed a high effective rate with a mean of 4.5 and above on a 5-point Likert scale. The implication is that the unique experiences of the road transport sector response were perceived effective in containing the COVID-19 pandemic in the road transport sector. This may be one of the major reasons Nigeria is experiencing a low level of COVID-19 infections and related deaths (see Table 1). The results of the PCA (see Table 3) corroborates the perceived effectiveness of the 51 new technologies, processes, and procedures used by road transport operators to respond to the COVID-19 pandemic. The new approaches generate 11 non-pharmaceutical components that account for 90.9% of the variance. This result implies that road transport operators strongly perceived that the non-pharmaceutical response was effective in keeping themselves and passengers safe from the COVID-19 pandemic in Nigeria.

Using PCA to secure a breakdown, lockdown appears to be the most perceived effective (20%) response among the 11 non-pharmaceutical measures used by road transport operators in keeping themselves and passengers safe from the COVID-19 pandemic in Nigeria. The other measures follow in descending order thus: COVID-19 safety protocols (12.6%), environmental sanitation (9.8%), promotion of hygiene (8%), information technology (7.8%), face mask (7.3%), and social distancing (6.6%). Others are public enlightenment (6.2%), palliative (5.1%), inclusion (4.1%), and mass media (3.4%). These non-pharmaceutical measures are very efficient in containing the pandemic. They are therefore critical and strategic in the fight against the pandemic in the future. The policy implication of this finding cannot be overemphasized. Therefore, government policy guidelines on containing the COVID-19 pandemic should be oriented toward non-pharmaceutical safety protocols. However, this policy guideline is without prejudice for pharmaceutical safety measures (e.g., vaccines).

Policy Implications and Recommendations

Although the road transport sector experienced some measure of success in keeping operators and passengers safe from the COVID-19 pandemic, there is a need to enhance policy guidelines and strategies to contain the pandemic. Such strategies should ensure continuing vigilance and the application of measures that helped in keeping road transport operators and passengers safe from the pandemic. These policy guidelines must not relax as the COVID-19 pandemic recedes. Therefore, monitoring activities are critical to ensure continued compliance with policy guidelines. Already there are indications of contempt in compliance with guidelines as the threat of COVID-19 fades.

Therefore, policy measures should ensure that road transport operators will not lower their guard in response to the pandemic. Rather, they should continue the strict application of the new technologies, processes, and procedures until the threat of the pandemic subsides. For the lockdown directive, although it has proved to be the most perceived effective response, its application should be discretionary because it has severe negative economic consequences. The other safety protocols including environmental sanitation, promotion of hygiene, wearing of face mask, and physical distancing should still be paramount and should apply as fortuitous circumstance permits in the road transport sector. Besides, the need for public health campaigns is imperative for sustainable safety.

The policy objectives for redressing pandemics must seek synergy between policymakers and road transport stakeholders and secure interdepartmental cooperation among public and private sector units networked in safety protocols. The purpose of this policy objective is to secure compliance, which feeds on government monitoring.

The response of road transport operators to the COVID-19 pandemic has serious policy implications for the road safety, emergency, and essential services sectors. There is therefore the need to review the nation's road safety and emergency response policies in line with the lessons from the road transport response to the COVID-19 pandemic. In addition, the nation's transport policy did not adequately address the public health implications in the provision of transport services. Therefore, there is a need to review Nigeria's transport policy to make it responsive to the challenges posed by the pandemic.

Conclusion

This study analyzed road transport operators' response to the COVID-19 pandemic in Nigeria. The results seem to indicate that road transport operators strongly (90.7%) believe that 51 adopted new technologies/innovations, processes, and procedures will keep them and passengers safe from the COVID-19 pandemic in Nigeria. A breakdown shows that observing the lockdown directive was perceived as the most effective response used by road transport operators' to keep themselves and passengers safe from the pandemic. This is followed in descending order by COVID-19 safety protocols, environmental sanitation, promotion of hygiene, information technology, face mask, and social distancing. Others are public enlightenment, palliative, inclusion, and mass media. These non-pharmaceutical measures are very efficient in containing the pandemic,

although the vulnerability of these measures to relegation in the absence of monitoring is thought provoking. Nevertheless, non-pharmaceutical measures should inform national policy objectives for safety in the era of pandemics.

Author Contributions

The authors confirm contribution to the paper as follows: study conception and design: Maxwell Umunna Nwachukwu, Obiora Obasi; data collection: Obiora Obasi; analysis and interpretation of results: Maxwell Umuna Nwachukwu, Donald Chiuba Okeke. Obiora Obasi; draft manuscript preparation: Maxwell Umunna Nwachukwu. Donald Chiuba Okeke. All authors reviewed the results and approved the final version of the manuscript.

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