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BUS TERMINAL ARCHITECTURE FOR SUSTAINABLE TRANSPORTATION IN NIGERIA: AN OVERVIEW OF THE CHALLENGES

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ABSTRACT

An effective transportation system is primarily attributable to well-designed terminal architecture. It has been established that poor terminal structure hindered commuters' patronage, especially people with disabilities. The arrangement and quality of services provided at the terminal, which encompasses all terminal user categories, determine the degree of patronage from commuters. As considered one of the most important sustainable transportation, the development of adequate road terminals has been thriving over the last decade, especially in the densely populated cities of Nigeria. This paper explores the impact of Nigeria's road terminal on achieving a sustainable transport system. The methodology employed information gathering from literature and different bus terminals in Nigeria. The results of the empirical study confirmed that service quality can be conceptualized as functional service quality, technical service quality, comfort and cleanness, and service planning and reliability. It has positive effects on reuse intention by enhancing customer satisfaction, as customer satisfaction has an intermediary effect on passengers' repurchase intention. This study contributes to transport agencies analysing the relationship between service quality attributes and passengers' reuse intention for

improving the supplied service, increasing ridership, and implementing the sustainable transport policy.

Keywords: *Sustainable transportation, Terminal, Architecture*

INTRODUCTION

A terminal is a place where cargo and passengers are gathered or distributed while being transported. While travelling by road, passengers must go to bus terminals where people are "assembled" into busloads and then dispersed to their final destinations. Terminals could also be inter-changing locations for the same mode of transportation. The exact part that transit/terminal plays in economic development has been the subject of conflicting presentations over the years. Accessibility is important in our daily lives, especially when connecting with our internal and external environments (Saw et al., 2020). The advancement of Nigeria's economy has been significantly aided by its transportation infrastructure, particularly its terminal stations. However, a significant number of terminals for public transport suffer considerably from inadequate layout and infrastructure. Many commuters have been discouraged from using public stations as a source of transportation due to poor accessibility, especially for individuals with impairments (Soltani et al., 2012). Though there is ongoing discussion on the impact of transport on economic development, some academics stress that no amount of transport investment can result in economic development in a country that lacks growth-promoting elements. Nigeria is blessed with an abundance of resources and other growth-promoting elements. In Nigeria, there are already many different types of transportation available, ranging from antiquated footpaths and dirt roads used for human or animal transportation to contemporary superhighways as well as poorly erected terminals.

The establishment of a sustainable urban transport system necessitates a thorough and integrated approach to policy and decision-making, with the shared objective of bolstering an accessible, profitable, people-centered, and environmentally responsible transport system. Undoubtedly, the majority of cities worldwide lack the capacity to expand their road network in order to accommodate their expanding populations. Consequently, traffic is one of the biggest problems that most cities face. Congestion is a problem because

it has a domino effect that affects social, economic, and environmental factors at the same time. These include issues with public health, air quality, traffic accidents, and travel delays. To handle the expanding transport needs, it is imperative that a sufficient infrastructure and management plan be implemented. Hence, in order to improve the experience of their current consumers and draw in new ones, public agencies must look at what areas of their services can be improved. Customers' decision to select public transportation as their principal mode of transportation versus private modes is heavily influenced by their level of satisfaction (NAFIU, 2018).

According to Wojuaden and Badiora (2017), when evaluating the relationship between passengers' behavioral goals and their use of public transportation, the elements which include perceived value, service quality, and contentment are crucial. A statistically significant causal link between them was found. According to de Oña et al. (2013) there are seven factors that encompass twenty-seven aspects that passengers use to assess the quality of railway services in Milan, North Italy. The three most important characteristics were safe travel, station accessibility, and the level of service on board as presented in Figure 1. Ghosh et al. (2017) examined the impact of many aspects of Hellenic Railways' service quality. Six evaluation criteria (passenger information, system safety, itinerary accuracy, cleanliness, and servicing) were used for twenty-two attributes. System safety and itinerary correctness were the two best-performing features according to the passengers' ratings.

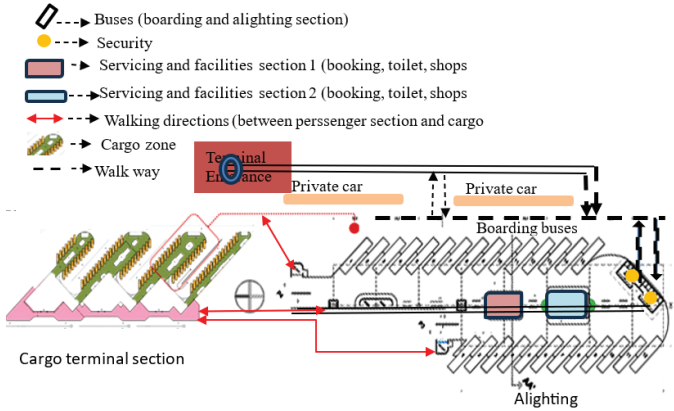

Figure 1. Bus Terminal Structure (design with facilities) for Sustainable Transportation

Source: Author, 2025

The terminal architecture of road transport, which have been crucial to Nigeria's political, social, and economic growth, will be the main topics of discussion in this article. This is addressed with a focus on their developmental impact on the Nigerian economy and the opportunities for their further growth, including the difficulties that face in assisting Nigeria to develop economically in the twenty-first century. There are instances of careless parking at bus terminals, particularly in the nation's megacities, which leads to traffic congestion. Such is done to alleviate certain concerns at the terminals. This is caused by inadequate terminal management in addition to a lack of sufficient, well-organized parking spaces within the transportation terminals. Like other well-known cities throughout the world, Lagos is also plagued by issues related to urban congestion, such as heavy traffic within the terminal, a lack of room for parking, and insufficient terminal amenities. However, unlike many queuing problems, the service time at the bus stop is also a function of frequency, because this affects passengers at the platform and thus the time spent by the bus at a bus stop. Besides, the service time also depends on the arrival of passengers at the bus stop. This generates a concurrent queuing problem in which the service time is a function of both the arrival pattern of buses and passengers. Therefore, the objective of this study is to develop a good bus terminal that is sustainable in Nigeria. The methodology employed in this research was via the information gathered from online and different bus terminals in Nigeria.

FEATURES OF TERMINALS FOR EFFECTIVE OPERATIONS

A transport terminal's significance is frequently correlated with its size. Large transport terminals, especially metropolitan mega bus stations, provide their site with the status of a gateway or hub in the field of road transport since they are now required hubs of transit between various parts of the global transportation network. Because of containerization, a hierarchy of terminals with varying roles and added values has emerged. These range from mega-gateways that manage the movements of a vast market region to little rail yards or truck depots that serve local markets. The orderliness and cleanliness of the environment, the attractive design of buses and bus stations, accessibility to public transportation, and passenger satisfaction which includes comfort and safety all have an impact on the sustainability

of the terminal as demonstrated in Figure 2. With these, one terminal could easily connect to another terminal for continuous transportation flow.

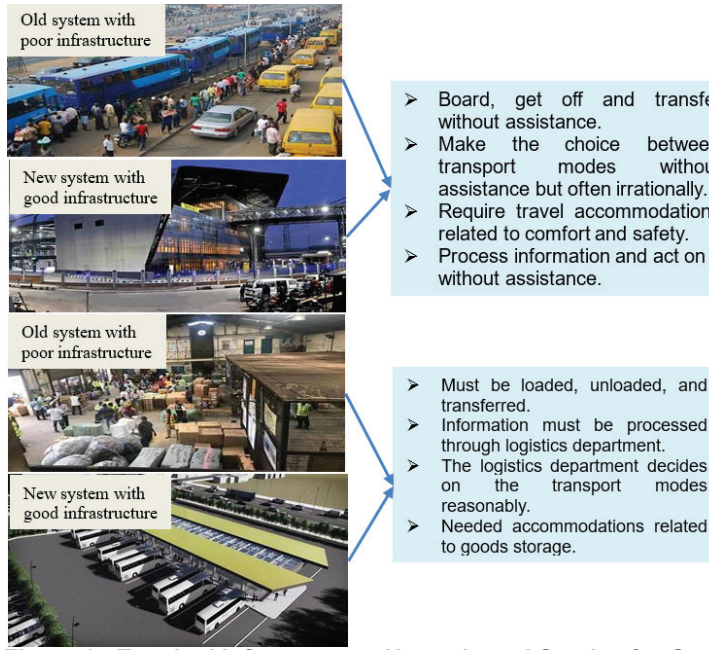

Figure 2. Terminal Infrastructure Upgrade and Service for Optimal Operations

Source: Author, 2025

This also holds true for passenger transit, where a clear hierarchy of terminals is apparent. Large hub airports that connect continents and are situated in global cities are at the top, while tiny local roads that only offer sporadic daily service to a few destinations are at the bottom. Since passengers and cargo systems typically travel via different conveyances and, occasionally, on different networks, thus they differ fundamentally from one another. However, because they include facilities that are frequently located in separate locations, the discrepancies are most noticeable at their respective terminals. Passenger and freight terminals are typically located at significantly different places when using road transit. There are separate facilities for passengers and goods at certain road ports. To encourage commuters to exercise caution, it is also necessary to install CCTV in bus terminals on the buses. The Nigerian State Government ought to work in tandem with the relevant organizations to enhance the regularity of bus

transportation services in urban terminals, hence decreasing passenger waiting times at bus stops and walking distance to these locations.

IMPACT OF ADEQUATE BUS TERMINAL ARCHITECTURE

Public transportation growth frequently occurs in a path-dependent manner, leading to varying degrees of mobility and ownership of passenger transport vehicles, including cars, buses, and rail transport until finally grown to sustainable grade as presented in Figure 3. The implication is that once a particular course has been chosen, it is difficult to veer off, therefore future advances are focusing on building reliable bus transport systems via adequate terminal architecture. The amount of inertia conveyed by the current technology and infrastructure is large. However, when there is a strong political, economic, and public desire to change the status quo and move towards a new paradigm that is thought to be more appropriate, there is still a chance for a path divergence. Three basic routes for the development of urban mobility can be distinguished from a pre-industrial metropolis that relied heavily on walking:

(a)Reliance on automotive services. Following this course of development, communities dependent on automobiles will be established, with ongoing investments made in motorization and the construction of a road and highway network. The diffusion of non-motorized modes of transportation, especially bicycles, is typically the initial stage. This was the case in Asian cities (especially China) in the 1970s as well as in cities with developed economies in the late 19th and early 20th centuries. A path divergence (1) in the direction of the establishment of public transport services is anticipated to occur at this point. However, a route taken by several developing economies is motorization, using the motorbike as a form of intermediary transportation, resulting in towns overrun with buses, motorcycles, and various types of autos (Ademola et al., 2020). Continued investment in road infrastructure combined with economic growth results in a car-oriented metropolis where most passenger mobility is provided by automobiles. Cities that first invested in transit projects but, due to a path divergence (3), abandoned multiple transportation services or did not pursue additional investments to meet the need for mobility, may likewise have such

an outcome.

(b)Transportation development. Moderate terminal building and motorization are part of this growth route. This approach results in the setup of transit cities, where most of the population uses public transportation to meet their mobility needs, through significant investments in public transportation and transit-oriented land use development policies. However, these kinds of cities are uncommon since, as more cities developed, a different route was taken that resulted in the creation of hybrid cities.

(C) Hybrid metropolises. This development trajectory results from increased motorization, although road building is happening at a higher rate than urban transit expansion. It ultimately results in an overabundance of cars and buses on the transit system. Many cities in industrialized economies during the second part of the 20th century were in this condition. A shift towards automotive dependence and quick motorization are examples of potential path divergence (3). Alternatively, a path divergence can be established (2), leading to more transit-oriented forms, by limitations on the usage and ownership of the automobile and the development of alternate modes of transportation.

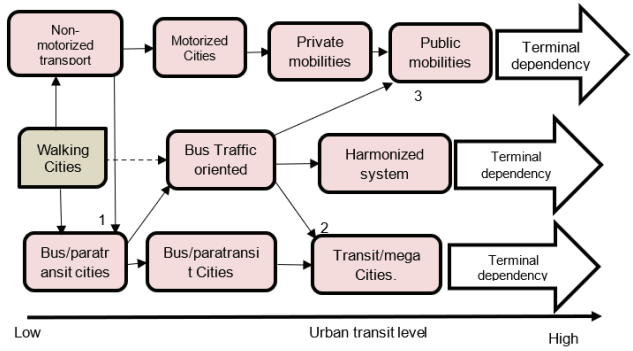

Figure 3. Sustainable Road Transport Transition due to Cities' Development and Good Terminal Infrastructure

Source: Author, 2025

Transportation obstacles require careful consideration and management to ensure continuity and smooth operation, as well as to maximize the limited resources of transportation systems in regional developments and increase

the efficacy and efficiency of infrastructure. The terminal's growing traffic volume, delays, accidents, and environmental issues—all of which are frequent occurrences in large cities, and both developed and developing nations [4]. A study carried out in Istanbul, Turkey [5] revealed that the city's inadequate public transport infrastructure was one of the causes of traffic congestion. Older buses and minibuses require more time to operate and cannot run faster, which results in a growing line of cars. The government should upgrade and renovate spaces, particularly in areas with rapid transportation, by adding Wi-Fi and offering comfy seats. Ali et al. (2009), conducted a thorough investigation, thus found that bus riders were content with the level of protection and cost of the tickets. However, this work gave five sensitive categories that could be used to measure the influence of good terminal architecture: Facilities, certainty, responsiveness, consistency, and empathy. The quality of public transport services was assessed using these five criteria. In analyzing these, importance-performance analysis (IPA) is beneficial in assessing consumer acceptability of the terminal. Based on the literature, Figure 4 simplifies the terminal satisfaction using the five key categories taken form 2012-2023. According to the findings, workers' empathy demonstrated the highest result, showing that staff are willing to assist provided that required materials are provided. Other parameters yielded similar, however, the responsiveness of terminal authority revealed good effort in making the road/terminal utility continuous. The facility's nature revealed poor response in the first two years, thus improved from 2013 continuously till 2023. This demonstrated a positive trend in the Nigeria terminal facilities and operations towards effective and efficient utilization.

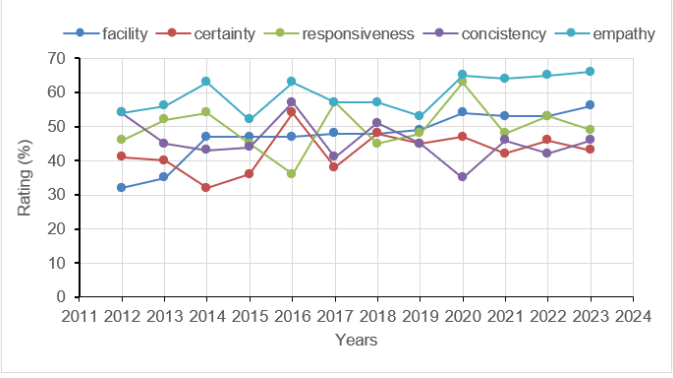

Figure 4. Survey Recorded Impact on Terminal Architecture towards Transport Sustainability

Source: Author, 2025

CHARACTERISTICS OF GOOD BUS TERMINAL STRUCTURES

Adequate level of services. Customer satisfaction is determined by the quality-of-service delivery, which is seen to be the most significant factor of both consumer behaviours and customer loyalty (Ghosh et al., 2017). Assessing service quality is the first step in any effort to improve customer satisfaction (Aydin et al., 2015). Therefore, in order to meet customers' expectations and deliver high-quality services, service organizations must clearly define their individual service quality standards. In the service industries, however, innovation is seen as a powerful driver of both firm performance and customer satisfaction, making even providing the basic expected level of service quality insufficient. Therefore, in order to satisfy customers and win their loyalty, service organizations constantly strive to innovate and improve the way they deliver their services.

Infrastructure. The primary function of a terminal is to handle and transmit loads or passengers since modes are physically separated. Modern terminal infrastructures require massive investments and are among the largest structures ever built (Yao et al., 2012). For example, in developed countries, mega bus terminals and distribution centers are visible on remote sensing images. Terminals have a nominal capacity, related to the amount of land they occupy and their technological, labor, and managerial intensity. Infrastructure considerations are essential as they must accommodate current traffic and anticipate future trends along with technological and logistical changes (Zainol et al., 2018). A utilization rate of 75 to 80% of design capacity is considered to be optimal since, above this level, congestion starts to rise, undermining the reliability of terminal operations (Benson & Whitehead, 2017). A terminal rarely has consistent utilization, often characterized by periods of high and low activity (daily, weekly, monthly).

Dwell time generally refers to the amount of time a conveyance (bus, truck, rail, or ship) is permitted to load or unload cargo at a terminal (Shen et al., 2023). Travelers anticipate spending as little time as possible at passenger terminals. Residency time, or the amount of time cargo remains in a terminal yard or storage area while awaiting loading, makes the situation more complicated for freight terminals (Shen et al., 2023). Transport service availability and scheduling, as well as the overall performance of

terminal infrastructure, are all reflected in dwell time. Additionally, it may be transactional, typically associated with the completion of clearing processes (such as customs and check-in). Lastly, dwell time may be associated with storage, meaning that the carrier or the cargo owner purposefully leaves the cargo at the terminal as a component of a supply chain management or transportation plan.

Accessibility. Aspects of accessibility include dependability, travel duration, and frequency of service. It also covers providing sufficient accommodation for travellers with unique requirements resulting from various forms of disability (Singh, 2016; Chang & Chen, 2011). The ability to switch between modes of transportation, the quality of the roads leading to and from the bus stop, and comfort both within the vehicle and at the bus stop are all considered characteristics of convenience. Safety is not just about avoiding traffic, but also about being safe from abuse and violence when riding the bus or waiting at the stop. Travel time, accessibility, dependability, comfort, security, cost, and information are the most crucial aspects of public transportation (Ademola et al., 2020). Accessibility to other terminals (at the local, regional, and global scale) and how well the terminal is linked to the regional transport system are important.

With reference to the concept of a transport terminal as presented in Figure 5, most transport terminals and their infrastructure have a nominal capacity that represents the amount of traffic they can reliably manage in a given amount of time. It is jointly determined by a combination of static and dynamic factors: Increasing the dynamic capacity of transport assets/ terminal is a simple way to increase their productivity and efficiency, thus making them sustainable. Eventually, there is a point at which dynamic capacity reaches its peak, and the only way to increase nominal capacity is to add more static capacity (or reduce demand or shift modes).

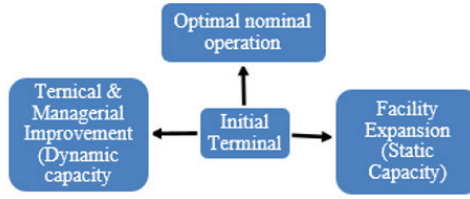

Figure 5. Concept of Transport Infrastructure Capacity
Source: Author, 2025

Static capacity is applicable to the land and infrastructure available. Without extending the building or the infrastructure, which typically requires more land and capital expenditures, static capacity cannot be readily altered. In places where there is a scarcity of land or a high cost of land, this might be a challenging proposition.

Dynamic capacity can be enhanced in relation to superstructure, labor, and technology. For example, without requiring extra space a more effective terminal operation approach can boost its physical throughput and capacity. Improved traffic light synchronization can also increase a road system's dynamic capacity. The infrastructure and management that are more efficient lead to improved utilization densities and intensities.

Dynamic capacity problems are typically encountered by transport infrastructure running at more than 80% of nominal capacity (Zainol et al., 2018). Because a single transport facility or infrastructure is connected to others, it is impossible to achieve optimal nominal capacity; therefore, capacity upgrades need to be coordinated. For example, queues at the terminal's entry points, where ships wait to enter the port while trucks wait at the gate to pick up or deliver containers, indicate that a port terminal that is operating close to its maximum nominal capacity is experiencing severe congestion (Yao et al., 2012; Ali et al., 2015). An analogous circumstance pertains to airports, wherein their ability to manage security protocols and luggage processing is influenced by the capacity of other airports that are connected to them.

TERMINALS CHALLENGE

Size Capacity to Accommodate Activities

The transportation terminal problem in Nigeria cities manifests in the form of poorly constructed network and road complementary facilities as well as ineffective transport management. The terminal size as well as the interconnection among all the facilities stands as the greatest confrontations in reaching commuters with needed services. Again, Onokala et al., (Chinyelu, 2018) discussed urbanization and urban transportation problems in Nigerian

cities. Nigerian cities are dominated by paratransit or intermediate modes of transport. The most common types are small 14–18-seater buses, shared-fare taxis, motorcycles and tricycles which provide main, collector and feeder services between different parts of the city. Onokala et al., (Chinyelu, 2018) discussed the implications of the adoption of small buses for "mass Transit" on the Transport Policy of Nigeria.

Public Acceptability

A key challenge in bus terminals in Nigeria is about public perceived acceptability. Using public transit to live a satisfactory life is measured by perceived accessibility. Perceived quality is defined as the ability to comprehend subjective metrics that are derived from user perception and combine them with quantitative evaluations of predefined parameters (Atiullah Saif et al., 2018). In contrast to conventional accessibility, which is based on the same objective attributes for large areas or groups of people Lättman et al. (2016), proposed to take into account the perceived accessibility in public transport as a supplementary measure to conventional objective measures of accessibility by capturing the subjective element of accessibility.

Policy Vs Vision-Led Planning

Several presentations about the Nigerian bus terminal arrangement explained a complicated and occasionally extremely annoying situation in which the public's resistance to sustainable transportation planning and policy has impeded the shift. The absence of governmental support for the goals of vision-led planning as well as several important initiatives and tools used to carry out the visions is correlated with the public's lack of acceptance. The conflict between vision-led and forecast-led planning was one of the main issues identified. A lack of readiness to undertake policy measures influencing demand and modal choice, which were deemed necessary in order to realize the visions was criticized in several Nigerian cities about the disparities between agencies within the agency hierarchy. Presentations claimed that in Lagos, the regional and municipal administrations maintained that their organizations led the way in vision-based transportation planning, while the national administration was entirely dependent on projections. Forecasts, however, were only one aspect of the

larger picture, according to the national transport administration official.

Terminal Management Costs

From an economic standpoint, consolidation functions and terminals are necessary due to the expenses involved in performing these tasks. An essential part of the overall cost of transportation is the terminal charge. These are fixed expenses that differ greatly between modes and are incurred regardless of the final length of the trip. They can be seen as such:

- Infrastructure costs. This includes the construction and maintenance costs of structures such as facilities and staff salaries, thus becoming more challenging in terminal management.
- Management costs. There are management costs associated with managing a large number of terminals, which are handled by public organizations like terminal authorities or commercial businesses like terminal operators. Operating and maintaining complex terminals requires knowledge of complex information systems.

Nevertheless, the policy administrators also cited difficulties and disputes as obstacles to their goal of creating a more sustainable transportation system. The inability to make decisions about how to carry out plans for fewer private car uses was one of the major obstacles. The infrastructure of city and suburban terminals is crucial in mitigating commuter unhappiness. If the aforementioned challenges can be resolved, the efficient architecture and current bus terminal infrastructure will lead to an emphasis on addressing future reliance on road transport.

CONCLUSION

The study concluded that, in terms of sustainable mobility, the majority of Nigerian commuters are dissatisfied with bus transport terminals. The outcomes of the study showed that the following variables affect passengers' happiness with bus terminals: ease of access to public transportation, cleanliness and orderliness within buses, attractive bus design, and appropriate capacity of public transportation services. Thus, the study offers guidance to terminal administration on where to make improvements to boost customer satisfaction with public bus transit services in Nigeria.

The transportation administration is advised to implement the following changes to enhance public bus transportation services in Nigeria, in light of the conclusions of the study. To prevent pickpocketing and on-board theft, operators should start a campaign that teaches the public about safe property handling practices at bus stops and seeks to dissuade and discourage thieves who prey on gullible travellers and commuters.

To encourage passengers to exercise caution, therefore, it is necessary to install CCTV in buses and at bus stations, besides posting anti-larceny posters. Transit hubs should be built with sophisticated, green infrastructure for sustainable operations. Enough benches and shelters should be available at bus stops to give commuters comfortable areas to rest. Nigerian bus terminals are unclean; the results of this study show that many commuters place a high priority on both the outside and interior cleanliness of buses. As a result, the bus operator needs to take the necessary steps to improve the buses' cleanliness and accessibility. By creating distinct sections for passengers and goods, public bus travel times will be shortened, and service frequency will rise, encouraging more people including owners of private vehicles to take public transportation.

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AUTHOR CONTRIBUTIONS

All authors contributed to the work. The first author did the information generation and writing of the manuscript, while the second and third authors edited and finalized the structure of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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