Harnessing Globalization, Information Science and Technological Innovations in Automobile Industry into the Transportation Systems in Nigeria

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Abstract
The Nigerian transportation sector is on the verge of a revolution, driven by innovations in the automobile industry. With the global automobile industry undergoing a significant transformation, Nigeria has an opportunity to leapfrog traditional development stages and embrace cutting-edge technologies that can transform its transportation system. The advent of electric vehicles, autonomous cars, advanced driver-assistance systems, connectivity and data analytics presents a unique chance to address the country's transportation challenges, such as congestion, safety, and environmental sustainability. As the transportation sector continues to evolve, it is essential to understand the role of information science and technological innovations in shaping its future. Harnessing these innovations can help to explore the transformative impact of these advances on transportation, examining the opportunities and challenges they present, and identifying strategies for harnessing their potential to create a more sustainable, efficient, and connected transportation system by enhancing the quality of life for its citizens. This study discussed the technology acceptance model, diffusion of innovation theory and systems theory model as its theoretical framework. This paper explores the opportunities and challenges of integrating automobile technology innovations into Nigeria's transportation system, and proposes strategies for harnessing their potentials to drive sustainable development and economic growth. The future study will address the potential impact of emerging technologies, changing consumer preferences, and global trends on the transportation sector in Nigeria.
Keywords: Automobile Industry, Transportation, Technological innovations, Globalization Economic growth and Sustainable development

Introduction

As the world grapples with the realities of globalization and technological innovations, the Nigerian automobile industry and transportation sector is poised for a transformative revolution, with far-reaching implications for economic growth, sustainability, and socio-economic development. Recently, there have been government efforts toward diversifying its economy and reducing its dependence on oil and the automobile industry and transportation sector has not been left behind in the transformation agenda of the government (Farinloye., Oluwatobi, Ugboma, Dickson, Uzondu, & Mogaji, 2024). The automobile industry and transportation offer a compelling opportunity for globalization and technological advancement to drive innovation, investment, and growth, in order to create new opportunities for economic empowerment and social mobility (Patil., Kazemzadeh, and Bansal, 2022, Secinaro et al., 2022 and Sun., Li, and Wang, 2019, Ejodame, 2015). Nigeria can transform its transportation sector and contribute to environmental sustainability by adopting Electric transportation or the use of Electric vehicles (EVs), the use of Autonomous vehicles and Compressed natural Gas (CNG) powered engines, by reducing

dependence on fossil fuels, and promoting a cleaner and more sustainable environment (Akujor, Uzowuru, Abubakar & Amakom, 2022).

Consequently, the National Automotive Policy according to Federal Government of Nigeria, (FGN, 2014) was drafted in 1993 by the National Automotive Council (NAC) to enhance the Nigerian automotive industry. The Nigerian Automotive Industry Development Plan (NAIDP) was also approved in 2013 to transform the Nigerian automotive industry and attract investment into the sector. The National Automotive Design and Development Council (NADDC) was established in 2014 as a merger of the National Automotive Council and the Centre for Automotive Design and Development with the aims of promoting and developing the Nigerian automotive industry, with a focus on creating an enabling environment for the manufacture of vehicles that meet international standards (NADDC, 2023). The NADDC is responsible for implementing policies and programs aimed at developing the industry, including incentives and protective measures, technical support services, and advocacy for raw materials development. The efforts of government and its citizens are gradually yielding fruits as Electric vehicles and Compressed Natural Gas (CNG) operated vehicles are being introduced into the transportation system in the country to compliment the petrol and diesel operated internal combustion engines that have been in use in the country (Akujor, Uzowuru, Abubakar and Amakom, 2022).

The general objective of this paper is to examine the impact of globalization on the automobile industry in Nigeria's transportation system by assessing the information science and technological innovations relevant to the transportation in Nigeria. This paper equally gives an insight into associated opportunities and challenges.

Literature Review

Understanding the Technology of Electric Vehicles (EV), its Opportunities and Challenges for Sustainable Transportation System in Nigeria

It is essential in this section, to operationalize the main components of electric vehicles that distinguish it from vehicles powered by internal combustion engines otherwise referred to as petrol and diesel engines. EVs employ the use of electric motors as source of power generation in place of internal combustion engines and the motors are operated by batteries. The battery pack stores the electrical energy that powers the motor and is charged by plugging the vehicle into a charging station or wall outlet, known as charge ports (Liu 2019). The charge port allows the vehicle to connect to an external power supply to charge the traction battery pack. The electric traction motor uses power from the traction battery pack to drive the vehicle's wheels. However, Liu in his study asserted that the on-board charger converts AC electricity from the charge port to DC power for charging the traction battery. And that the power electronics controller manages the flow of electrical energy delivered by the traction battery, controls the speed of the electric traction motor and the torque it produces. This device also converts higher-voltage DC power from the traction battery pack to the lower-voltage DC power needed to run the vehicle accessories and recharge the auxiliary battery (Liu 2019).

The transmission system in EVs, according to Hossain, et al., (2022), involves the transfer of mechanical power from the electric traction motor to drive the wheels. Unlike what is obtainable in internal combustion engines where the power generated from the combustion of fuel and air is the cylinders are transmitted to the road wheels as engine torque.

The cooling system maintains proper operating temperature range of the engine, electric motor, power electronics, and other components. While the regenerative Braking System converts some of the vehicle's kinetic energy back into electrical energy, which is stored in the battery for future use. The Battery management System ensures

safe and efficient use of the battery pack by monitoring battery conditions like voltage, current, temperature, and state of charge (Patel, Bhoi, Padmanaban, and Holm-Nielsen, 2021).

The merits of electric transportation, according to Kim, include, Zero tailpipe emissions, lower operating costs, improved air quality and opportunities of job creation in EV manufacturing, increased energy efficiency and reduced dependence on fossil fuels Kim (2020). The challenges electric transportation face in Nigeria includes, limited charging infrastructure, limited public awareness and education, over-dependence on imported technology and limited access to reliable power supply.

Consequent upon these challenges, suggestions toward harnessing Electric transportation in Nigeria, accordingto Hossain, et al., (2022), include; developing charging infrastructure (e.g. public charging stations) encouraging private sector investment in electric vehicles, providing incentives for adoption (e.g. tax credits, subsidies), educating the public on benefits and cost savings including developing local manufacturing capacity.

Harnessing the use of Compressed Natural Gas (CNG) Engines in Nigeria Transportation System: The Technology, Merits and Demerits

Compressed Natural Gas (CNG) engines have distinct features and functions that differentiate them from petrol and diesel engines. One of the major differences in the features of the main systems of vehicles powered by CNG engines is the fuel supply system. CNG fuel tanks store compressed natural gas at high pressure (up to 200 bar) and the Fuel management system regulates gas flow, pressure, and temperature to the engine as Air-fuel mixer blends CNG with air for efficient combustion just as in the combustion process to produce the engine torque in Petrol engines. The major difference is that instead of petrol –air mixture charged into the cylinders, it's the mixture of air and CNG. Consequently, there are slight differences in the construction of some key components of the engine (Folkson, and Sapsford, 2022).

In the study of Lakshminarayanan and Agarwal (2019), the construction of the CNG engine that made it different from other internal combustion engines include the cylinder head and block that are designed for CNG combustion with modified spark plugs with longer gaps, and valves to complement its ignition system and combustion process (*See Figure 1*). The Crankshaft and camshaft are also optimized for CNG engine timing and performance while the Ignition coil in CNG engines produces higher voltage for efficient spark generation. The exhaust manifold and muffler are also designed for CNG exhaust gases, with reduced backpressure.

Generally, CNG engines have Engine Management System (EMS) that are fitted with Electronic Control Unit (ECU), that controls fuel injection, ignition timing, and engine performance while Sensors monitor engine parameters like temperature, pressure, and air-fuel ratio. CNG engines are fitted with safety features incorporating gas leaks by detection system that alerts the driver in case of gas leakages including automatic engine shut- off in case of system malfunction including gas leakage (Folkson, and Sapsford, 2022; Lakshminarayanan, and Agarwal, 2019).

Figure 1: CNG Vehicle

These features and functions enable CNG engines to have the benefits of running on cleaner-burning natural gas, reducing emissions and environmental impact. CNG engines also provide better fuel efficiency and lower operating costs compared to petrol and diesel engines and offer improved engine durability and reduced maintenance needs. Overall, CNG engines are designed to optimize the benefits of natural gas as a fuel, making them a popular choice for environmentally friendly and cost-effective transportation solutions which makes it readily adaptable in Nigeria.

The major challenges of using CNG include higher upfront costs, as the cost of purchasing CNG vehicles and equipment installation can be higher compared to traditional vehicles. Other challenges are limited CNG fuelling stations in the country, making it difficult for widespread adoption. According to Prakash (2020), CNG engine powered vehicles also have a shorter driving range and require more frequent refuelling, including Safety concerns as CNG vehicles require proper maintenance, inspection, and safety features to minimize risks. Therefore, the long-term sustainability of CNG vehicles is uncertain, particularly regarding the continued availability of natural gas resource in the country.

Overcoming the challenges of using CNG vehicles in Nigeria requires massive investment in infrastructural development by both government and private sector in building CNG fuelling stations and supporting infrastructure (Ugolo, Iwegbu, &Onwuchei, 2024). Private companies should be encouraged to invest in CNG vehicle manufacturing, fuelling stations, and maintenance services. There is also the need for increased public awareness; the public should be educated on the benefits of CNG vehicles, such as cost savings and environmental benefits. Government should also implement favourable policies and incentives to promote the adoption of CNG vehicles, such as tax breaks and subsidies in order to encourage local manufacturing of CNG vehicles and equipment to reduce reliance on imports (Ibeneme, and Ighalo, 2020). To ensure safety, there should be enforcement that will enhance safety standards for CNG vehicles and fuelling stations. Including training programmes for mechanics, technicians, and drivers on CNG vehicle maintenance and operation, especially in technical colleges and related institutions of higher learning in the area of curriculum development and innovations (Ibeneme, and Ighalo, 2020). By addressing these challenges, Nigeria can overcome the barriers to adopting CNG vehicles and reap the benefits of a cleaner, more efficient and cost-effective transportation system.

Information Science and Technological Innovations in Transportation

The transportation sector is on the cusp of a revolution, driven by the convergence of information science and technological innovations. The integration of advanced technologies, such as artificial intelligence, internet of things, and big data analytics, is transforming the way we travel, transport goods, and design infrastructure. This transformation is not only improving the efficiency and safety of transportation systems but also enabling new mobility services, reducing environmental impact, and enhancing the overall travel experience (Wu, Wang, Dang, and Lv, 2022).

In recent years, we have witnessed significant advancements in transportation technology, from the development of autonomous vehicles to the implementation of smart traffic management systems. These innovations are not only changing the way we travel but also creating new opportunities for economic growth, social connectivity, and environmental sustainability (Iyer, 2021). Information science and technological innovations are transforming the transportation sector in various ways, including:

1. Intelligent Transportation Systems (ITS): Utilizing real-time data and analytics to optimize traffic flow, reduce congestion, and improve safety.
2. Internet of Things (IoT)_: Connecting vehicles, infrastructure, and devices to

enhance efficiency, safety, and passenger experience.
3. Artificial Intelligence (AI) and Machine Learning (ML): Improving predictive maintenance, route optimization, and autonomous vehicles.
4. Big Data Analytics_: Providing insights on transportation patterns, demand, and preferences to inform infrastructure development and service optimization.
5. Cloud Computing: Enabling scalable, on-demand access to transportation data and applications.
6. Cybersecurity: Protecting transportation systems from cyber threats and data breaches.
7. Mobility-as-a-Service (MaaS): Integrating public, private, and shared transportation services for seamless travel.
8. Autonomous Vehicles (AVs): Enhancing safety, reducing emissions, and improving mobility for the elderly and disabled.
9. Smart Traffic Management: Optimizing traffic signals, routing, and parking for reduced congestion and emissions.
10. Electric and Hybrid Vehicles: Reducing emissions, operating costs, and environmental impact.
11. Transportation Data Analytics: Informing infrastructure development, service optimization, and policy decisions.
12. Digital Payments and Ticketing: Streamlining fare collection, reducing congestion, and enhancing passenger experience.
13. Real-time Information Systems: Providing passengers with accurate, timely information on schedules, delays, and service disruptions.
14. Transportation Asset Management: Optimizing infrastructure maintenance, reducing costs, and extending asset lifespan.
15. Supply Chain Optimization: Improving logistics, reducing costs, and enhancing delivery times.
16. These innovations are revolutionizing transportation, making it more efficient, sustainable, and responsive to user needs.

The Future of Mobility in Nigeria: Exploring the Potentials of Autonomous Vehicles (AV) in Nigeria

Autonomous vehicles (AVs) are vehicles that operate without human input, using a combination of sensors, software, and hardware to navigate and make decisions. Future mobility in Nigeria is poised for significant transformation, driven by technological advancements, changing consumer behavior, and government initiatives. According to Sadaf, (2023), the followings are some potential developments that could shape the future of mobility in Nigeria:

1. Electric Vehicles (EVs): EV adoption is expected to rise, driven by decreasing battery costs, government incentives, and growing environmental concerns.
2. Shared Mobility: Car-sharing, ride-hailing and bike-sharing services will continue to grow, reducing private car ownership and promoting more efficient use of vehicles.
3. Autonomous Vehicles (AVs): AVs will start to emerge, enhancing safety, reducing traffic congestion, and improving mobility for the elderly and disabled.
4. Non-Motorized Transport (NMT): NMT infrastructure, such as pedestrianized roads and bike lanes, will be developed to encourage walking and cycling.
5. Public Transportation: Efficient, reliable, and affordable public transportation systems will be developed, integrating buses, trains, and ferries.
6. Smart Traffic Management: Intelligent transportation systems (ITS) will optimize traffic flow, reducing congestion and travel times.
7. Mobility-as-a-Service (MaaS): MaaS platforms will integrate public, shared, and on-demand transportation services, making travel more convenient and efficient.

8. Rural Mobility: Innovative solutions, such as solar-powered tricycles and motorcycle ambulances, will improve access to transportation in rural areas.
9. Government Policies: Regulations and incentives will support the adoption of alternative modes of transportation, reducing reliance on private cars.
10. Private Sector Investment: Companies will invest in mobility infrastructure, services, and technologies, driving innovation and growth.

By embracing these changes, Nigeria can create a more sustainable, efficient, and equitable transportation system, improving the quality of life for its citizens. These technologies combined enable autonomous vehicles to perceive their surroundings, make decisions, and operate safely and efficiently.

As the industry continues to evolve, wider adoption across the globe is expected and Nigeria should not be an exception. It is possible for Autonomous Vehicles to flourish in Nigeria, but there are several challenges that need to be addressed. Nigeria's roads and transportation infrastructure are still developing and may not be ready for AVs in some areas as there is need for clear regulations and standards for AVs in the country. AVs require high-quality mapping data, reliable internet connectivity, and advanced sensor technology (*See Figure 2*). AVs need to be designed with security in mind to mitigate potential cyber threats and there is also the need for Consistent and reliable electricity needed for charging infrastructure.

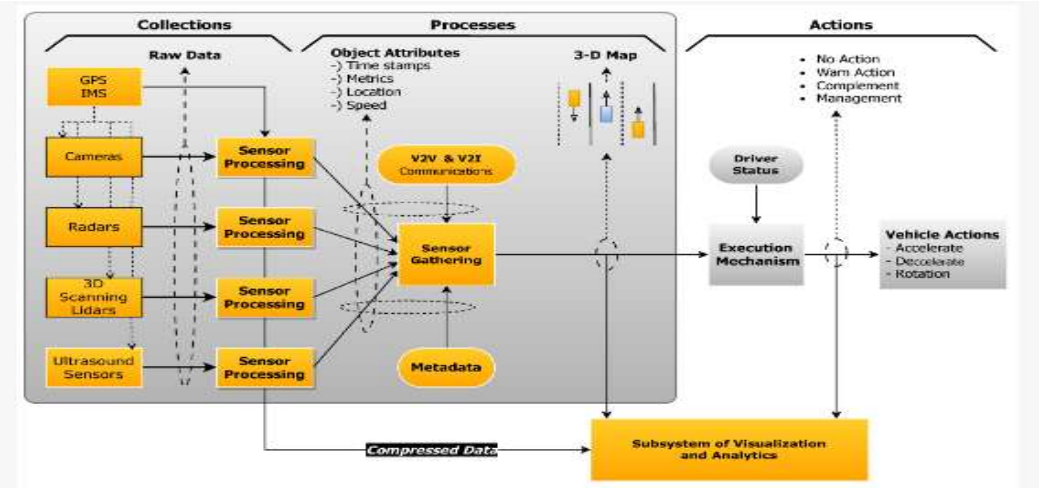

Figure 2: Autonomous Vehicle Overview (Giannaros, et al., 2023)

However, there may be concerns about job displacement and safety. Developing local expertise in AV technology and maintenance is essential and encouraging local production and assembly of AVs could help drive adoption. To overcome these challenges, Nigeria could Invest massively in infrastructural development, establish clear regulations and standards, partner with international companies to leverage their expertise, develop local talent and expertise, conduct public awareness campaigns to educate citizens about AV benefits and encourage private sector investment in AV technology and infrastructure (Giannaros, et al., 2023). With careful planning, investment, and collaboration, AVs can flourish in Nigeria, improving transportation efficiency, safety, and economic growth.

By adopting a phased and adaptive approach, autonomous vehicles can be successfully introduced in Nigeria, addressing the country's unique challenges and opportunities and the focus could first be on autonomous shuttle services for public transportation, reducing the need for personal vehicle ownership. Considering the issue of poor electricity supply, solar-powered autonomous vehicles can be deployed to

reduce reliance on fossil fuels and mitigate the impact of power outages. Besides, AVS can be adapted to local infrastructure to navigate Nigeria's unique road conditions and infrastructure and implement robust security measures to protect passengers and vehicles from potential threats. The country can also invest in training and upskilling local engineers, technicians, and drivers to support autonomous vehicle technology (NDP, 2021-2025 report).

Table 1: Global Automotive Industry Review

Indicator	2019	2020	2021	2022	2023	2024	2025f
Passenger car registration (Millions)	60.7	50.7	57.2	61.4	63.5	64.6	65.3
% Change	-6.1	.16.5	12.9	7.4	3.3	1.8	1.1
Stock of passenger cars per 1,000 population	169.1	169.5	170.8	172.3	174.0	175.6	177.3
Commercial vehicle registrations	27.3	25.5	28.3	30.6	32.0	33.2	34.3
% Change	0.2	-6.7	11.0	8.2	4.7	3.6	3.3

Source: Economic Intelligence Unit Estimates and Forecast

The global automotive industry review *(Table 1)* shows that in 2019, there were 60.7 million passenger car registrations, with a decrease of -6.1% compared to the previous year. The stock of passenger cars per 1,000 populations was 169.1. In 2020, the number of passenger car registrations decreased further to 50.7 million but saw a significant increase of 16.5% from the previous year. The stock of passenger cars per 1,000 populations remained relatively stable at 169.5. In 2021, passenger car registrations increased to 57.2 million, with a 12.9% growth from the previous year. The stock of passenger cars per 1,000 populations also increased to 170.8. In 2022 and 2023, passenger car registrations continued to rise, reaching 61.4 million and 63.5 million, with % changes of 7.4% and 3.3%, respectively. The stock of passenger cars per 1,000 populations also increased. The trend continued in 2024 and 2025, with further increases in passenger car registrations and stock per 1,000 populations. Commercial vehicle registrations also showed growth over the years, with consistent percentage changes indicating a steady increase in registrations. Overall, the data provides insights into the trends in passenger car and commercial vehicle registrations, as well as the stock of passenger cars per 1,000 populations over the years. The fluctuations in the numbers and percentage changes highlight the dynamic nature of the automotive industry and vehicle ownership trends. So, considering the Nigerian factor, autonomous vehicles can be successfully deployed in the country by starting with controlled environments like airports, universities, or enclosed communities such as local governments, businesses, and estates to address specific transportation needs and concerns and roll out the vehicles in phases, starting with small-scale pilots and gradually expanding to larger areas (NDP, 2021-2025 report).

Harnessing Smart Transportation Systems in Nigeria: Leveraging Internet of Things (IoTs) and Data Analytics for Efficient Traffic Management

Smart transportation refers to the integration of information and communication technologies (ICTs) into transportation systems to improve their efficiency, safety, and sustainability. It involves the use of advanced technologies such as: Internet of Things (IoTs) sensors, Data Science, Artificial intelligence, big data analytics, Cloud computing, 5G networks, Autonomous vehicles, Smart traffic management, Intelligent public transit systems, Real-time information systems and electronic payment systems (Oladimeji et al., 2023).

Smart transportation aims to, optimize traffic flow and reduce congestion, improve public transit services, enhance safety and security, reduce emissions and environmental impact, increase accessibility and mobility for all, provide real-time information to passengers, streamline logistics and goods transportation, support

economic growth and development (Oladimeji et al., 2023; Ikpe, and Ohwoekevwo, 2024).

According to IBM (2020) typical examples of smart transportation includes; smart traffic lights that adjust their timing in real-time to optimize traffic flow, Autonomous buses and trains, ride-sharing and bike-sharing services, and intelligent parking systems. Electronic toll collection systems, smart pedestrian and cyclist management systems, logistics optimization platforms, real-time public transit information systems. Smart transportation has the potential to transform the way we travel, making our transportation systems more efficient, sustainable, and equitable inNigeria's rapid urbanization and growing population leading to increased vehicular traffic, resulting in congested roads and lengthy commute times. To address this challenge, Nigeria can leverage IoT solutions like intelligent traffic management systems, smart parking systems, and smart traffic sensors to transform its transportation sector.

Figure 3: Smart IoT Traffic Management

In the study of Rahim (2020), IoT refers to the network of physical devices, vehicles, home appliances, and other items embedded with sensors, software, and connectivity, allowing them to collect and exchange data with other devices and systems over the internet. These devices, also known as “smart devices”, can collect and share data, enabling them to interact with the physical world and with each other (*See Figure 3 and Figure 4*). Li (2019) reveals that IoT sensors and devices can be integrated into transportation infrastructure to collect real-time data on traffic flow, volume, and speed. This data is analysed to optimize traffic signal control, reducing congestion and decreasing travel times.

The benefits of IoT in traffic management as further stated by IBM (2020) which include; improved traffic flow and reduced congestion, enhanced safety and reduced accidents, increased efficiency and reduced travel times, better decision-making with data-driven insights and enhanced passenger experience. By harnessing the power of IoT, Nigeria can create a more efficient, safe, and sustainable transportation system, improving the quality of life for its citizens and driving economic growth.

Figure 4: Information Science and Intelligent Transport Systems

Accomplishing effective traffic management in a developing nation like Nigeria requires a strategic approach, considering the unique challenges and

limitations such as limited infrastructure and resources, inadequate power supply and internet connectivity, high cost of implementation and maintenance, lack of technical expertise and training, inadequate data management and analysis capabilities, limited public awareness and education, including corruption and bureaucratic hurdles (Okolie and Edo, 2023). Overcoming these shortcomings, connotes that the country should start small with Pilot projects in specific areas, like major intersections or highways and collaborate with international organizations and private sector companies for funding and expertise, implement affordable and scalable technologies, like wireless sensors and mobile apps and establish a centralized data management system for efficient analysis and decision. It is necessary to develop public-private partnerships to share resources and risks and to invest in renewable energy sources for power stability and engage in public awareness campaigns to educate citizens on the benefits and usage (Farinloye et. al., 2024). There is also the necessity to provide training and capacity building for local technicians and officials including curriculum development accordingly in technical colleges and related institutions for up - to - date capacity building of the growing population of the country and foster collaboration between government agencies, academia, and private sector stakeholders, including prioritizing transparency and accountability in project implementation and management (NDP, 2021-2025 Report). By acknowledging the challenges and leveraging the merits, Nigeria can overcome the hurdles and achieve effective traffic management, improving the lives of its citizens and driving economic growth.

Methodology

Theoretical background

A great number of theories support the adoption of technological innovations. Some of the theories that go in-line with the adoption of technological innovations in automobile industry in Nigeria include TAM, Diffusion of Innovation Theory and System Theory, etc. However, this study will review Theory of Acceptance Model and Diffusion of Innovation Theory and System Theory and how they affect the adoption of technological innovations in automobile industry in Nigeria.

Technology Acceptance Model

The Technology Acceptance Model (TAM) is a prominent theory that seeks to understand and predict how users adopt and use technology. It was developed by Fred Davis and Richard Bagozzi in the 1980s and has since become a foundational model in the field of information systems research. The model posits that perceived usefulness (PU) and perceived ease of use (PEOU) are critical factors influencing an individual's acceptance of a technology.

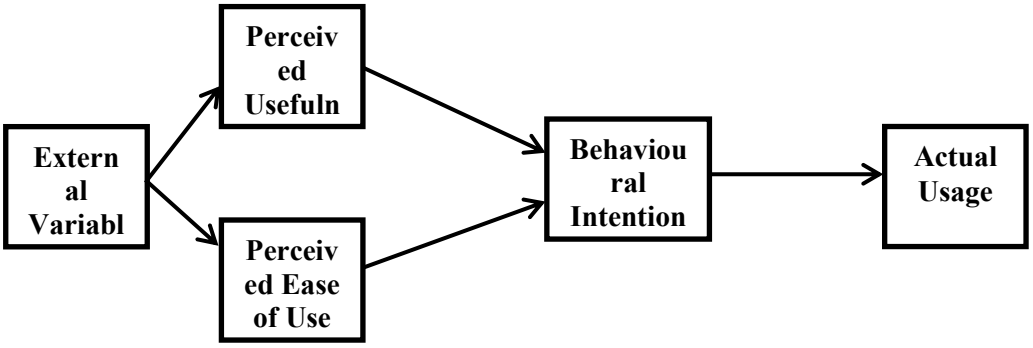

Figure 5: Technology Acceptance Model, Adapted from Davis & Venkatesh, 1996, p.20.

When applying the TAM to the context of harnessing globalization and technological innovations in the automobile industry in Nigeria, the following key insights can be drawn.

Perceived Usefulness

In the automobile industry in Nigeria, the adoption of technological innovations can greatly enhance operational efficiency and competitiveness. For example, implementing global positioning systems (GPS) in vehicles can improve route planning and tracking, leading to better fleet management and reduced fuel costs. Moreover, the integration of advanced manufacturing technologies such as robotics and automation can enhance production processes and product quality. To encourage the acceptance of such technologies, stakeholders must perceive them as useful in achieving their goals – be it cost reduction, increased productivity, or improved service delivery (Park, Kim, Shon, and Shim, 2013; Horton et al., 2001; Davis & Venkatesh, 1996).

Perceived Ease of Use

Technological innovations are often met with resistance due to concerns over complexity and difficulty of use. In the context of the automobile industry in Nigeria, stakeholders – including manufacturers, suppliers, and consumers – may be hesitant to embrace new technologies if they require significant training or substantial changes to existing processes. Thus, it is crucial for organizations to ensure that technological solutions are designed with user-friendliness in mind. For instance, the development of intuitive user interfaces for in-vehicle systems can make it easier for drivers to interact with advanced features such as navigation, entertainment, and driver assistance systems (Park, Kim, Shon, and Shim, 2013; Horton et al., Lane and Coleman, 2012; 2001; Davis & Venkatesh, 1996).

External Variables

In addition to PU and PEOU, the TAM acknowledges the influence of external variables on technology acceptance. These can include factors such as social norms, organizational support, and perceived risk. In the context of the automobile industry in Nigeria, government policies and regulations play a significant role in shaping the adoption of technological innovations (Lane and Coleman, 2012). For instance, incentives for electric vehicles and investments in infrastructure for alternative fuels can encourage the industry to embrace sustainable solutions. Likewise, partnerships with global technology providers can facilitate the transfer of knowledge and expertise, enabling local players to leverage cutting-edge technologies in their operations (Park, Kim, Shon, and Shim, 2013).

Continued Research

As the automobile industry in Nigeria continues to evolve in response to globalization and technological advancements, ongoing research is needed to assess the factors influencing technology acceptance and adoption. By exploring the dynamics of user behavior, organizational practices, and market trends, researchers can provide valuable insights for policymakers, industry players, and technology providers seeking to harness the benefits of globalization and innovation (Park, Kim, Shon, and Shim, 2013). Moreover, longitudinal studies can track the evolution of attitudes towards technology over time, shedding light on emerging patterns and best practices for leveraging technology in the context of the Nigerian automotive sector (Lane and Coleman, 2012).

The application of the Technology Acceptance Model to the automobile industry in Nigeria offers a valuable framework for understanding the complexities of technology adoption in a rapidly changing environment. By focusing on perceived usefulness, perceived ease of use, and external variables, stakeholders can enhance their strategies for harnessing globalization and technological innovations, driving sustainable growth and competitiveness in the sector (Lane and Coleman, 2012).

Technology adoption plays a crucial role in harnessing globalization and technological innovations in the automobile industry in Nigeria. Embracing technological advancements can lead to improved efficiency, sustainability, and competitiveness in the transportation sector.

According to Nees, (2016), here are some key areas of technology adoption that can drive innovation in the automobile industry in Nigeria.

Electric Vehicles (EVs):

The adoption of electric vehicles can significantly reduce carbon emissions, improve air quality, and reduce dependence on fossil fuels in Nigeria. EV technology is rapidly advancing, with longer battery life, faster charging, and more affordable models becoming available. Encouraging the adoption of EVs through incentives, tax breaks, and infrastructure development (such as charging stations) can drive the transition to cleaner transportation in Nigeria.

Autonomous Vehicles:

Autonomous vehicles, also known as self-driving cars, have the potential to revolutionize the transportation sector by improving road safety, reducing accidents, and enhancing mobility for individuals, especially those with disabilities or limited mobility. Nigeria can explore the adoption of autonomous vehicle technology in urban transportation systems, freight transport, and public transport services to increase efficiency and safety.

Connected Vehicles:

Connected vehicle technology enables vehicles to communicate with each other and with infrastructure systems, leading to improved traffic management, enhanced safety features, and real-time data sharing. Integrating connected vehicle technology in Nigeria can help reduce traffic congestion, enhance road safety, and enable smarter transportation systems.

Mobility Services:

Technology has spurred the rise of mobility services such as ride-sharing, bike-sharing, and on-demand transportation platforms. Embracing these services in Nigeria can provide affordable and convenient transportation options for citizens, reduce traffic congestion, and improve overall mobility in urban areas.

Digital Platforms and Information Systems:

Leveraging digital platforms and information systems can enhance communication, data sharing, and efficiency in the transportation sector. Technologies such as Geographic Information Systems (GIS), traffic management systems, and real-time tracking apps can provide valuable insights for planning, monitoring, and optimizing transportation operations in Nigeria.

Sustainable Practices:

Adopting sustainable practices in the automobile industry, such as using eco-friendly materials, implementing energy-efficient technologies, and promoting renewable energy sources, can help reduce environmental impact and promote sustainable development in Nigeria.

Training and Skill Development: As new technologies are adopted in the automobile industry, there is a need for continuous training and skill development for industry professionals, technicians, and policymakers. Training programs on emerging technologies, best practices, and safety standards can help ensure a smooth transition to innovative solutions in the transportation sector.

In conclusion, technology adoption is essential for harnessing globalization and driving technological innovations in the automobile industry in Nigeria. By embracing advanced technologies, promoting sustainable practices, and investing in digital solutions, Nigeria can position itself as a leader in the evolving transportation landscape, improve efficiency, promote environmental sustainability, and enhance the overall quality of transportation services for its citizens.

Diffusion of Innovation Theory and Systems Theory Model

The automobile industry in Nigeria has been experiencing significant growth and advancements in recent years, largely driven by globalization and technological innovations. In order to effectively harness these changes, it is important for stakeholders in the industry to have a deep understanding of theories that can guide the adoption and implementation of innovative technologies.

Diffusion of Innovation Theory

The Diffusion of Innovation Theory, proposed by Everett Rogers in 1962, highlights the process by which an innovation is communicated through certain channels over time among the members of a social system. The theory categorizes individuals into different groups based on their willingness to adopt new technologies. These categories include innovators, early adopters, early majority, late majority, and laggards.

Table 2: Diffusion of Innovation Theory

The Innovators	Communication Channels	Time	Social System
Relative Advantage		Innovation –Decision Process (Knowledge, persuasion, decision, implementation and confirmation)	Social Structure
Compatibility	Change Agents	Individual Innovativeness (Innovators, early adopters, early majority, late majority and Laggards)	Norms
Complexity		Rate of Adoption	Norms
Trialability (Reversibility, Risks, Uncertainty & Commitment)			Opinion Leaders
Observability			

In the context of the automobile industry in Nigeria, the Diffusion of Innovation Theory can be applied to understand the different stages of adoption of new technologies in the production, design, marketing, and distribution processes of vehicles. For example, innovative technologies such as electric vehicles or autonomous driving systems may initially be adopted by a small group of innovators or early adopters within the industry before gaining wider acceptance among the majority of stakeholders. Rogers (1995) suggests that the problem of pro-innovation bias can be overcome by investigating an innovation while the diffusion process is still underway. He observes that such an in-process diffusion research design allows a scholar to investigate less successful as well as more successful cases of innovation diffusion.

Systems Theory Model

Systems Theory emphasizes the interconnectedness of parts within a system and how they interact with each other to achieve a common goal. In the context of the automobile industry in Nigeria, Systems Theory can be used to analyze the various components of the industry, including manufacturers, suppliers, distributors, consumers, and government regulations, and how they function as an interconnected system.

By applying Systems Theory to the automobile industry in Nigeria, stakeholders can identify potential bottlenecks, inefficiencies, and areas for improvement within the system. For example, the adoption of new technologies such as electric vehicles may require collaboration between different sectors of the industry, as well as changes in government policies and regulations to support the transition to more sustainable transportation solutions.

Harnessing Globalization and Technological Innovations

The combination of the Technology Acceptance Model, Diffusion of Innovation Theory and Systems Theory Model can help stakeholders in the automobile industry in Nigeria effectively harness globalization and technological innovations. By understanding the different stages of technology adoption and the interconnectedness of components within the industry, stakeholders can develop strategies to navigate challenges and leverage opportunities presented by

globalization and technological advancements Rogers (1995).

For example, automotive manufacturers in Nigeria can use the Diffusion of Innovation Theory to identify early adopters of new technologies within the industry and collaborate with them to drive innovation. At the same time, applying Systems Theory can help stakeholders analyze the supply chain, distribution networks, and regulatory environment to ensure a smooth transition to new technologies and capitalize on the benefits of globalization.

In conclusion, by embracing advanced technologies, promoting sustainable practices, and investing in digital solutions, Nigeria can position itself as a leader in the evolving transportation landscape, improve efficiency, promote environmental sustainability, and enhance the overall quality of transportation services for its citizens. The Diffusion of Innovation Theory and Systems Theory Model are valuable frameworks that can also guide stakeholders in the automobile industry in Nigeria in harnessing globalization and technological innovations. By understanding the dynamics of technology adoption and the interconnectedness of the industry, stakeholders can develop informed strategies to drive growth, competitiveness, and sustainability in the rapidly evolving automotive sector

Discussion of Findings.

The study began with a comprehensive review of relevant literature on globalization, information science, and technological innovations in the automobile industry, with a focus on their impact on transportation systems. The review includes academic articles, reports, case studies, and publications from reputable sources to gain a thorough understanding of the subject. On opportunities for technological innovations, the study identified potential benefits of harnessing globalization, information science, and technological innovations in the Nigerian transportation system. Opportunities which include improved efficiency, reduced environmental impact, enhanced safety, and increased accessibility for citizens.

The study equally discussed the challenges and barriers that may hinder the successful integration of global innovations into the Nigerian transportation system. These challenges may include infrastructure limitations, regulatory hurdles, financial constraints, technological readiness, and cultural factors that impact adoption.

In providing technological solutions, the study focuses on specific technological solutions that have the potential to transform the Nigerian transportation system. This solution includes the adoption of electric vehicles to reduce emissions, the deployment of smart transportation systems to optimize traffic flow, and the implementation of digital platforms for improved connectivity and information dissemination. More so, while discussing policy recommendations, the study provides policy recommendations to policymakers, industry stakeholders, and government agencies on how to harness globalization, information science, and technological innovations in the Nigerian transportation sector. These recommendations include incentivizing innovation, creating supportive regulatory frameworks, investing in infrastructure, and promoting public-private partnerships as well as theories that support technological innovations in the Nigerian transportation system.

Conclusions and Recommendations

In conclusion, Globalization and technological innovations in the automobile industry offer immense opportunities for Nigeria's transportation system. Autonomous Vehicles (AVs) and Electric Vehicles (EVs) can improve safety, efficiency, and reduce congestion and emissions in Nigeria's transportation system. The Internet of Things (IoT) can enhance traffic management in Nigeria by providing real-time data and insights. However, challenges such as poor infrastructure, security concerns, and limited technical expertise need to be addressed. Strategic partnerships between local and

international companies can facilitate the adoption of AVs, EVs, and IoT in Nigeria.

By implementing the following recommendations, Nigeria can harness the benefits of globalization and technological innovations in the automobile industry, towards improving the transportation system, reducing emissions, and driving economic growth. The Nigerian government should therefore:

1. Invest in infrastructural development, smart traffic management systems, and security measures to support AV, EV, and IoT adoption.
2. Encourage public-private partnerships to facilitate the deployment of AVs, EVs, and IoT in Nigeria.
3. Develop policies and regulations that support the adoption of AVs, EVs, and IoT, such as tax incentives and subsidies for local production.
4. Invest in education and training programs to develop local expertise in AI, robotics, programming, and data analytics.
5. Conduct public awareness campaigns to educate citizens about the benefits of AVs, EVs, and IoT and address cultural concerns.
6. Collaborate with international companies to leverage their expertise and technology.
7. Develop alternative power sources, such as solar and wind power, to support EV charging infrastructure.
8. Establish a national framework for the development and deployment of AVs, EVs, and IoT in Nigeria.
9. Utilize IoT sensors and data analytics to optimize traffic management and reduce congestion.
10. Encourage the adoption of EVs and AVs in public transportation systems, such as buses and taxis

The future study will address the potential impact of emerging technologies, changing consumer preferences, and global trends on the transportation sector in Nigeria.

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