PUBLIC SUPPORT AND PROSPECTS OF DRONES OR UNMANNED AERIAL VEHICLES (UAVs) TECHNOLOGIES FOR EFFECTIVE TRANSPORT AND LOGISTICS DELIVERY IN NIGERIA

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Abstract

The study focuses on the issue that prompt transportation and delivery of logistics from one location to the other in Nigeria is at present costly, difficult, unrealistic, and cumbersome as occasioned by; road congestion in urban cities, increased, insecurity pollution, unnecessary delays, and declined efficiency, among others. The menace often poses threats to city planners to maintain the pace of the ever increasing urbanization process and population growth in all ramifications. The current situation has, however, warranted possibility for drones or unmanned aerial vehicles (UAVs) technology for logistics delivery and transportation in Nigeria and other sub-Saharan African nations, to alleviate the stress posed by the conventional mode of transportation. This paper is poised to: investigate the public support and prospects of using of drones or UAVs for effective transport or logistics delivery, and also find out its applications in other sectors in Nigeria; examine the potential threats or barriers to the application; appraise the technology's cost-effectiveness, acceptability, local sustainability; and recommend the parameters around adoption, safety or security, reliability of drones technology, and effective monitoring for future implementation in Nigeria. The study generated its data from both primary and secondary sources while the research findings are comprehensively and descriptively analyzed. The study, however, recommends to transport sector, governments, end-users, and drone providers on logistics delivery to swiftly ensure that: safety of drone operations; insurance coverage availability be taken care of; ensure regulatory and procedural frameworks, better assessment and evaluation of drone pilot programmes; strengthening national and local capacity to test, learn, use and maintain drones; and ensure that evidences and prospects that could aid advancing the use of drones for logistics delivery or transport in the country be adequately shared.

Keywords: Drones or UAVs, Transportation, Prospects, Technologies, Payload, Nigeria

Introduction

Drones also known as unmanned aerial vehicles (UAVs) are pilotless aircrafts that were at historically and first used solely by the military though they are now being deployed for various scientific intentions, public security, and in commercial sectors (Abiodun and Raheem, 2020). Although drones as surveillance with sensor devices are already widespread in security or surveillance services, geo-spatial and planning sciences, and agriculture but their use as logistics delivery and transportation strategies still remains in its early years. And technically, delivery or transport drones are already manufactured in such a way that they are able to lift and fly logistics between 2 to 3 kg in weights and could perform flight operations in all locations (McKinsey Global Institute, 2016). The healthcare sector in addition profits from drones technical capabilities and simplicity of deployment. Currently, the deployment of remotely piloted aircraft systems (RPAS) and drones has gained a broader expansion to execute civilian tasks such as, sustaining search and rescue operations, monitoring weather conditions and tracing flows, delivering goods or logistics, and of course for aerial photography purposes. Drones or UAVs are, nowadays, being used to effect change in the environment; a verifiable instance is in agricultural practice, where positivity may be achieved by deploying drones to spray fields and track the growing patterns of cultivated crops on farms (McKinsey Global Institute, 2016).

Moreover, one of the most exciting feats of drone technology is found within the healthcare sectors most especially during the COVID-19 pandemic ravaging the global system. The applications of drones or UAVs are attainable in the industry for delivering vaccines, blood samples, medicines, and other medical supplies which may be urgently required in the various inaccessible locations (Abiodun, Fakoya and Alabadan, 2020). In addition to these, infectious diseases continue to spread most especially during the COVID-19 pandemic from the physical contacts while transporting healthcare logistics from one hospital location to the other. And the COVID-19 pandemic has also revealed the inherent cracks and lack of data visibility in healthcare supply chains in many countries, most especially in Nigeria. Though supply impediments are occasioned by natural disasters and emergencies, road congestion in urban areas, poor road or transport networks, and acute weather conditions – therefore, delivery via drone technologies remain a remedy to problems mentioned above (Bright, 2016). Up-to-date periods and information have indicated that unmanned aerial vehicles (UAVs) also known as drones, possess the prospects in attaining the position of ruling technology in the current 21st century. Drones or unmanned aerial vehicles (UAVs) are enabled with merger of three (3) major ethics of technological advancement which include: autonomous functioning, data processing, and endless mobility in all ramifications (Australian UAV, 2016).

As being observed in Nigeria, the logistics and supply chain business currently remains one of the top budding industries and in African continent at large, though the sector still remains in its emerging phase (Godwin, 2019). That is the major bane of the Logistics and Supply Chain Industry Report in year 2018, indicating that the value of Nigeria's logistics industry was projected to be above $700 million with slight increase from $141 million in year 2017. The logistics delivery and transportation sector is observed to have suffered a huge setback in infrastructure decline in Africa as a whole occasioned by; unfavourable government policies, poor road network, erratic power supply, multiple taxation, among others which have led to the sector not being able to achieve its full potential and also finding it very difficult to reach its last-

mile in logistics transportation and payload deliveries, most especially in Nigeria (Godwin, 2019).

In addition, Nigerians have continued to witness all sorts of unavoidable difficulties in their daily logistics delivery and transportation engagements. This is due to the fact that logistics are not delivered in time; most especially in health sector where there is upsurge of complexity in timely transporting of blood samples and drugs for lives' rescue, ranging from one hospital to another; as a result of organizational economic imbalance, unnecessary traffic congestions on our roads, and high cost of transporting the goods and services from one location to the other (Camhi, 2016). In addition to these, conducts of elections in Nigeria have suffered a huge setback in the area of logistics (sensitive election materials and ballots papers) transportation and delivery. This is occasioned by the frequent hijacking of electoral materials or logistics by miscreants from the hands of Independent National Electoral Commission (INEC) officers while moving them on the poor and congested road networks (Okechukwu, 2019). In the process, serious challenges facing the delivery of medicines in hospitals in Nigeria have been traced to competency issues which include: lack of skilled personnel in logistics delivery, pilferages along the supply chain and absence of competent third party service providers (Abiodun, Fakoya and Alabadan, 2020).

Also, the 'last-mile' has been a critical logistical challenge for transportation and delivery of essential items to communities most in need in Nigeria and sub-Saharan Africa (Camhi, 2016). Pursuant to the submissions above, the study in its objectives is poised to: investigate the public support and prospects of using drones or UAVs usage for effective transport or logistics delivery, and as well find out drone applications in other sectors in Nigeria; examine the potential threats or barriers to applications; appraise the technology's cost-effectiveness, acceptability, local sustainability; and recommend the parameters around adoption, safety or security, reliability of drones technology, and effective monitoring for future implementation in Nigeria. Therefore, these are the major reasons crave for drone technologies should be on the increase in Nigeria and entire African continent.

Conceptual Analysis

Concepts of Logistics and Supply Chains
The concept of logistics entails an array of activities related to the production and distribution of produce for consumption, and this comprises two separate but integrated branches which include; materials management and physical distribution respectively (Martin, 1992). *Material management* on its own entails the various activities in relation to the production of parts and finished products, and as well their packaging and final recycling and reusing. On the other hand, *physical distribution* encompasses the various activities in relation to making fraction and finished products available for final consumption, most especially transportation and warehousing at a particular location. However, the more integrated the supply chain remains, the difficult it is to differentiate between physical distribution and materials management (Martin, 1992). This is due to the fact that distribution channels extend from logistics suppliers to final consumers, while responsibility for transport and warehousing is jointly shared among goods producers, wholesalers, and retailers. Therefore, logistics must remain very reliable with the

products it supports as end-users usually do not have any distinctive characteristic between a product and the distribution system supplying it.

Logistics in the same vein involves a basic correlation between the derived and induced demands of its activities; this is as materials management usually establishes a derived demand for physical distribution since the goods being produced must definitely be transported, stored, and sold to final end-users or consumers (Jean-Paul, 2020). Also, physical distribution has an induced demand influence on materials management; this is because distribution capabilities will definitely shape production in terms of its organization and location. Supply chain on the other hand, is conceptualized to mean an integrated relation between production and distribution of logistics (Martin, 1992). The concept of logistics is usually based on the system approach. This is pursuant to the fact that the flow of logistics or materials from a supplier to a manufacturing company and eventually to the end-user is seen as a single chain, ensuring efficiency and effectiveness in sequential activities to achieve the objective of customer satisfaction at a reduced cost (Jean-Paul, 2020).

In addition, logistics is conceptualized to relate to the various activities of material movement across the business processes which are clearly interdependent and closely coordinated in all sense – the activities are set to be well managed as a system. In his submission, Martin Christopher (1992) rolls out the functional areas of logistics and termed them "Logistics Mix" which consists: *Information flow*: order registration; order checking and editing; and order processing coordination. Second, *Warehousing:* involves the material storage; loads and material handling; network planning and size selection and network planning: order picking and filling; and dispatch documentation. Third, *Inventory control:* material requirement planning; and inventory level decision for customer service objectives. Fourth, *Packaging:* for handling and damage prevention; for communication; and for inter-modal transportation; and lastly, *Transportation:* Route planning; Mode selection; and Vehicle scheduling respectively (Martin, 1992). The key goal of logistics is to facilitate the flow of goods across the supply chain of a business venture in order to cost effectively make available the right goods at the right place and as well at the right time.

Concept of Drone or Unmanned Aerial Vehicle (UAV) Technology

A drone or unmanned aerial vehicles (UAV) simply refers to an aircraft without a human pilot on board to operate it. Drones or UAVs are devices that operate with all sorts of degrees of autonomy; they are flown under a remote-controlled device by a human operator using radio frequency or satellite remote network connections and fully controlled by on-board computers (Holton, et al., 2015). Drones or UAVs technologies are creation of military applications, though the exploit is currently on the increase in the areas of scientific, commercial, scientific, land planning, agriculture, recreational, among other applications. In the same vein, the estimated numbers of commercial and civilian UAVs have currently exceeded that of military globally, having sold over five million (5million) drones between years 2015 and 2016 respectively (Aerospace Forecast Report, 2016).

These civilian drones or UAVs are easily classified according Niezgoda Denis (2019) to their sizes – from mini-drones to people-carrying drones; the altitude reached, and autonomy.

Unmanned aerial vehicles (UAVs) or drones can be divided into three (3) main categories based on their flight mechanisms which include:

i. **Multi-rotor drones or UAVs –** These ones may possess four, six or eight rotors on them; and the drones are capable of hovering in a fixed position and can fly in any direction, manoeuvre very fast in the process. The UAVs are easily airborne in the absence of a runway, though with slower maximum speeds, and shorter flight times, than fixed-wing ones.

ii. **Fixed-wing drones or UAVs:** The drones are built in a simpler structure than other drones and look like to an aero plane. The fixed-wing drones are capable of flying for a longer period, and at very higher speeds than multi-rotor UAVs, and they are much more useful in surveying wide expanse of lands or areas. The fixed-wing UAV is capable of carrying heavier payloads over longer distances by using less fuel and energy. The drone or UAV carries bigger and better sensors and cameras and needs a runway or launcher for taking off and landing, and it is bound to remain in constant forward motion. This type of UAV is currently being deployed in some states, like Netherlands for logistics delivery and also in Africa, Ghana, South Africa, and Rwanda in delivering blood samples in hospitals, vaccines among others.

iii. **Hybrid model (tilt-wing):** This variety of UAV or drone has ability to fly higher or hover but it may as well switch to more efficient fixed-wing and faster flight in the process. It shares some of the major characteristics of the earlier mentioned drone types (multi-rotor and fixed-wings) (Niezgoda, 2019).

As clearly resonated by Abiodun (2020), drone technology has impacted the various sectors positively; security and intelligence services; agricultural and land surveying; media, photography, and entertainment; logistics transport and delivery; insurance and risk evaluation; disaster and emergencies management; wildlife animals and environmental monitoring; and mining activities and infrastructure surveillance respectively. Drone or UAV technology consistently continued to shape the current global space in terms of economic, political, and socio-cultural development and advancement (Abiodun, 2020).

Research Methodology
The study employed both quantitative and qualitative methods of research. Data were sourced from primary channel using a purposive sampling technique with a 10-item structured questionnaire that was administered both physical and online with private interview held via Zoom platform to elicit information from selected respondents that were identified to be knowledgeable in drones technology, logistics delivery and transport services: (DHL courier) in Frankfurt Germany; (Amazon) in Tilbury town, Essex, United Kingdom; security and robotics experts; and DHL and FedEx courier service operators in Nigeria respectively. The researcher's contact with the selected courier experts in both Germany and United Kingdom was only made possible during his postdoctoral research fellowship at the University of Oxford, United Kingdom in 2018/2019. During the period, the researcher was opportune to register his acquaintances with few managerial members of staff at Amazon and DHL Logistics Services during his academic excursions to German Airport in Frankfurt, Germany, and the DHL

members of staff and other knowledgeable respondents in Nigeria. Data were also collected using a secondary source which includes (books, newspapers and bulletins, publications, periodicals and handbooks on logistics and supply chains, and as well drone technology for surveillance and security. The instruments were significantly validated and results descriptively analyzed.

An Overview of the Logistics Delivery with Supply Chains Industry and Challenges in Nigeria

The logistics and chains supply industry has come of age as there exist some local and foreign private business entities that are operating in the logistics industry which include: DHL, Red Star Express (also known as FedEx), United Parcel Service (UPS), NiPOST (Nigerian Post Office) amongst others (Ogunbowale, 2018). Though the Nigerian Postal Service (NPS) is the agency that regulates the activities of stakeholders in country, and it operates a courier delivery service, the Nigerian Post Office (NiPOST) which competes with other courier operators in private industry.   In the first instance, there is the need for Nigeria to engage in and implement the various free-trade and bilateral with various states across the globe which include: the ECOWAS and African Growth and opportunity Act (AGOA) programmes that are much expected to improve trade significantly (Mazur, et al., 2016).

In relation to the submissions above, Logistics industry in any nation is recognized to be the main indicator of economic advancement articulated obviously in trade facilitation and business competitiveness (Markus and Denis, 2019). But regrettably, there exist regional and national discrepancies in Nigeria's logistics and transportation or supply chain infrastructure which impedes its trade competitiveness unenthusiastically. This is the reason the various logistics and transportation business experts submit that sophisticated infrastructure remains highly critical to all supply chain and logistics development goals. The state of the existing infrastructures coupled with level of integration between them impacts logistics reliability, access, cost, and cycle-time in all ramifications (Ogunbowale, 2018). However, maintaining a very competitive logistics and supply chain bionetwork requires a strategic and steady improvement in the area of regional infrastructure. This situation also requires very performing government institutions, industrial know-how, and financing skills (Ibid).

According to the submission of Van-Vark, Chris (2015), it is also observed that the various technologies such as: real-time fuel management systems, warehousing management systems, GPS tracking system, control towers, cargo management systems, and communication and information systems such as Electronic Data Interchange (EDI) can be used to reduce paperwork and minimize the time taken for logistics compliance processes. Though it is unfortunate that these processes, are still not very trendy in Nigeria and this situation has posed a major opportunity for entry by advanced nations' firms to instill in Nigeria the competence and technical skill sets to close the gap in the logistics delivery business (Godwin, 2019). That is the reason one of the major stakeholders in the logistics and supply chain industry, Red Star Express, a courier and Logistics Company in Nigeria argues that there is absolute lack of infrastructure for fast-tracking the development of the economy (Ryan, 2016). And given the enormous nature of the industry in the country, pooled resources are mostly required in provisioning and improvement of the overall infrastructure networks in Nigeria, as this actually remains the

foundation upon which all businesses depend and thrive. This is due to the fact that a nation without first-class modern transportation systems and the infrastructure that usually supports it will forever remain underdeveloped in all ramifications (Markus, and Denis, 2019).

Also in the area of politics in Nigeria, logistics delivery has continued to remain an arduous task by the Independent National Electoral Commission (INEC) during elections in the country. However, logistics delivery and transportation during elections proves to be very difficult as the materials are usually exposed to hijacks by the various hoodlums while being conveyed to various locations. And to reduce or checkmate the growing malfeasance, the INEC National Commissioner, and Chairman, Election Operations and Logistics, Prof. Okechukwu Ibeanu, (2019) revealed that the electoral body before the 2015 general elections, went into partnership with the two major private transport unions in Nigeria: National Union of Road Transport Workers (NURTW) and Road Transport Employers Association (RTEAN) for easy transportation and distribution of election logistics. Situations in logistics delivery most especially in during elections in a nation like Nigeria endowed with a voting population of over 82 million voters, and 120,000 polling units, one would usually think or expect that materials or logistics delivery for such national assignment would be not be efficient in the absence of coordination and management (Okechukwu, 2019). To cap it all, one of the biggest challenges bedeviling successful activities of the Independent National Electoral Commission (INEC) in Nigeria is majorly in the area of logistics delivery or deployment for elections.

Moreover, Nigeria as a nation requires a logistics strategy directed on the areas such as: transport and distribution workforce; transportation and distribution industry; road infrastructure; interstate highway access; road congestion; road conditions; vehicle taxes and fees; railroad access; air cargo access; and water port access air among others, to ensure innovation within the infrastructure development system of logistics and supply chain in the country (World Bank, 2010). It was a very disheartening report that the Nigerian economy lost an estimated annual revenue of N3.46trillion due to poor infrastructure, poor implementation and corruption at the ports, of which N2.5trillion are corporate earnings losses across the various sectors of the economy (Lagos Chamber of Commerce and Industry, LCCI, 2018). But with the African Continental Free Trade Agreement (ACfTA) in existence, Nigeria is now hoped have free access to the entire African market thereby improving the trade between the neighbouring states and this would positively impact the logistics sector in the nearest future (ibid).

Research Findings and Discussion

Table 1: Socio-demographic Data of Respondents

Gender

Serial No.	Response	Frequency	Percentage %
1.	Male	203	51.26
2.	Female	193	48.73
	Total	**396**	**100 %**

Table 2

Age

Serial No.	Response	Frequency	Percentage %
1.	18-30	161	41.16
2.	31-45	125	31.06
3.	46-55	71	17.92
4.	56 and Above	38	9.84
	Total	**396**	**100 %**

Table 3: Marital Status

Serial No.	Response	Frequency	Percentage %
1.	Single	170	43.22
2.	Married	81	20.45
3.	Civil Partners	21	5.1
3.	Divorced	52	13.13
4.	Widow	46	11.86
5.	Widower	25	6.31
	Total	**396**	**100 %**

Table 4: Educational Qualifications

Serial No.	Response	Frequency	Percentage %
1.	High School	50	9.70
2.	Technical	28	10
2.	OND/Equivalent	98	24.75
3.	BSc/HND	199	50.25
4.	Masters/PhD	21	5.30
	Total	**396**	**100 %**

Table 5: Employment Status

Serial No.	Response	Frequency	Percentage %
1.	Employed	100	25.25
2.	Unemployed	220	55.55
3.	Self Employed	76	19.19
	Total	**396**	**100 %**

Table 6:	*Location*		
Serial No.	**Response**	**Frequency**	**Percentage %**
Outside Nigeria			
1.	Amazon - United Kingdom	16	4.1
2.	DHL- Frankfurt, Germany	26	6.5
Within Nigeria			
3.	Lagos, Nigeria	40	10.1
4	Rivers State, Nigeria	45	11.1
5.	Enugu State, Nigeria	64	15.2
6.	Ondo State, Nigeria	53	12
7.	Abuja (FCT), Nigeria	47	11
8.	Yobe State, Nigeria	30	7.5
9.	Sokoto State, Nigeria	26	6.5
10.	Oyo State, Nigeria	49	16
	Total	**396**	**100 %**

Source: Field Research Survey, 2019.

Table 7: Responses on Public Awareness and Support for Aerial Drone Usage in Different Sectors

Various sectors UAVs or drones could be deployed or used	**Percentage %**
Military, search and rescue operations (detection/tracking of military targets)	72%
Delivery services for small items (mail, books) to private residences	53%
Climatic/geological mapping (testing snow/water/vegetation levels)	59%
Traffic monitoring on major highway routes (reporting back-ups and delays during rush hour)	40%
Detecting criminal activities in open public places (drug dealing, miscreants' activities)?	42%
Journalists' reporting/coverage of news events (sporting arena, crime scenes, natural disasters)	50%
Crowd monitoring at large public events (concerts, sporting events)	39%
International border patrol, for example, monitoring immigration activities	38%
(n=396)	

Source: Field Research Survey, 2019

Discussion

The percentage of survey respondents that aware of and support UAV or drone usage varies across different areas of application. As shown in Table 7 above, a majority of the respondents submit they are aware of the use of aerial drones in military and search and rescue operations (72%), delivery services (mail, textbooks and other parcels) to private residences (53%), geographical and climatic mapping (59%), journalism - coverage of events (50%)and international border patrol activities (56%). In the same vein, about half of the respondents reported being aware of drone usage in the areas of traffic monitoring (40%), detecting criminal

activity in open public places (42%), crowd monitoring at large public events (39%), and international border patrol (38%) respectively. The level of public awareness and support of aerial drone or UAV usage Nigeria and other sub-Saharan African states varies; though the outcome indicates that like enlightenment and sensitization need be done for firm actualization of the technology's adoption in Nigeria and the continent of Africa.

Table 8: Respondents' Responses on Potential Barriers to Effective Drone or UAV Technology Applications in Different Sectors in Nigeria

Anticipated threats or barriers of drone or UAV technology application in transport and logistics delivery in Nigeria	Percentage %
Challenges in legal framework	68%
Ethical and regulatory issues	51%
Privacy intrusion and safety issues	52%
Threats to physical safety, stealing of payload	73%
Possible hacking, threats or hijacks of drones use by criminals and terrorists	82%
Weather condition, social, economic, and environmental problems	41%
Problems in adapting existing physical and digital infrastructure for drones or UAVs integration into urban space.	29%
(n=396)	

Source: Field Research Survey, 2019

Discussions
Majority of the 396 respondents in this category focus possible threats or hijacks of drones use by criminals and terrorists in the country (68%) while on legal frameworks is (68%); this comprises the issues on adapting the existing legal framework. Also on ethical issues, the respondents' submissions indicate (51%); the ones on privacy intrusion and disturbance show (52%) while the one on potential threats to physical safety in the community, which may involve accidents, crashes, collisions, and injuries indicates (73%). In the same vein, responses on anticipated threats on weather condition, social, economic and environmental issues indicate (41%) while the responses on potential barriers of adapting existing physical and digital infrastructure for drones or UAV integration into urban space come out to be (29%) respectively. The out above depicts that the people in the country are knowledgeable of various potential threats and barriers that could hinder the successful and effective workability of drone technology applications.

Table 9: Respondents' Responses on Prospects of Drones or UAVs Technologies Applications for Transport and Logistics Delivery in Nigeria

Prospects of Drones or UAVs Technologies Applications for Transport and Logistics Delivery in Nigeria	Percentage %
Faster delivery of logistics	89%
Cost-effective and cheaper delivery	63%
Efficient delivery to rural locations	58%
Prompt delivery to real-time locations	56%
Enhancing environmental friendliness	63%
Adequate security for goods or logistics	67%
(n=396)	

Source: Field Research Survey, 2019

Discussion
Respondents in this category attest to the facts that drones application in logistics delivery helps in faster delivery of logistics (89%) pursuant to the fact that drones can fly over congested traffics, streets, areas, and take the fastest routes over buildings and other various road obstacles. In the same, the respondents gave their response that drones or UAV usage aids cost-effective and cheaper delivery activities (63%), while others agree that the technology gives room for efficient delivery to rural locations or areas in the country when used (58%); this is because it can deliver to remote areas where cars and trucks cannot reach efficiently. Also clearly stated is the (56%) of respondents who submit that UAVs or drones if used allows for prompt delivery to real-time locations in the country. Response from the respondents (63%) also signifies that drones or UAVs usage in logistics delivery enhances environmental friendliness in the country if deployed while (67%) of the respondents ensures adequate security for goods or logistics respectively. The submissions above clearly indicate that there are excellent prospects in drones technologies application in transport or logistics delivery in Nigeria in all ramifications.

Overview of Drones or UAVs Technologies in Other Sectors in Nigeria
The study reveals the various prospects in applying drone or UAV technology in logistics delivery/transportation and other essential sectors or industries for potential advancements in Nigeria as follows:

1. **Urban first and last mile delivery**
The various instances of rapid development and urbanization witnessed today signify the future emerging markets in a nation. Therefore, the attendant population explosion would get over 5 billion before the year 2030 if care is not taken (Swiss Re, 2019). However, the situation would pose dangerous implications in the trend of: pollution, roads congestion, and inefficiency occasioned by delays in the easy transportation of passengers and goods from one location to another. As a result of this, it would very difficult for logistics delivery using the poor and congested road networks as it is being experienced in some Nigerian urban cities of Lagos, Ibadan, Port-Harcourt, among others. And pursuant to these problems, drones or UAVs would definitely provide significant relief for inner cities by taking traffic off the roads and into the

skies (Abiodun, Fakoya, and Alabadan, 2020). Some UAVs are designed to lift and fly some varieties of payloads as these however usually support urban first and last-mile logistics delivery and transportation networks – parcels are easily delivered directly to users located in any part of the country. It is just a matter of a customer to receive a notification via his/her smart-phone that will enable the logistics to be easily tracked through or with the assistance of GPS at his/her out-door location (Stewart, 2016). As soon as the delivery drone or UAV gets to the out-door delivery location or programmed destination, it would easily hover and carefully lower the parcel through its delivery device that is fixed to a retractable cord.

A parcel delivery service via drone; *Source:* Web2Carz

2.   Rural transportation or delivery services

In the same vein, there is possibility of drone or UAV technology to deliver logistics or commodities in rural areas with poor infrastructural facilities or geographic challenges. The study outcome indicates that drones or UAVs make swift transport of logistics such as letters or parcels, drugs or vaccines, textbooks among others easily possible to rural areas; and most especially for the logistics industry, rural delivery by drones is helpful not only in emergency applications but also to assuage the existing first and last-mile delivery or transport problems and at the same time improve coverage of supplies, cost, and quality of the needed commodities (Bright, 2016). At times, the rural locations may be characterized with mountains, islands, valley and the areas could be highly remote (where boats, cars may be required for distribution), thereby impeding the transport or delivery very difficult – in this case, drones or UAVs remain the best means of transporting or delivering the goods or logistics (ibid).

A DHL Paketcopter delivering a parcel in a remote area; *Source:* Wall Street Journal

This type of drone or UAV is usually called "Paket-kopter or parcel-copter" and it is always placed under the manual control of an operator during a flight with the aid of GPS (Sandvik and Lohne, 2014). This UAV has a release device which enables it to lower down the parcel for easy delivery to the recipient with the use of a remote control or pre-programmed instruction.

3.   Infrastructure monitoring, surveillance and security

For unabated efficiency, effectiveness and survival, it has now become imperative for various firms, organizations, and companies in the logistics business in Nigeria to protect and closely monitor their infrastructure (Ogunbowale, 2018). Drones or UAVs would assist with safety and security surveillance in all-inclusive facilities; various docks and yards, pipelines, warehouse locations, among others. This would ensure the facilities or infrastructure fully protected from theft and destruction (Jean-Paul, 2020). Drones or unmanned aerial vehicles are deployed to secure several logistics industry operations which include: the movement of trucks and forklifts on site, and also to monitor energy infrastructure and as well patrol oil fields as being done in advanced states like: Turkey, United States of America, United Kingdom, Russia, among others (Irwin, 2016). These technologies can also be deployed to monitor various maintenance activities on oil pipelines for example in Niger Delta region, roads, and other infrastructure in the Nigeria. This can ensure they are used to full capacity and are protected, that is, theft reduction in warehouses containing items of particular value (Abiodun and Dahiru, 2020).

Pipelines and Energy facilities being monitored on high sea using a drone;
Source: Model airplane news

The present condition of the facility is being assessed from the air, while any damage to it can be easily evaluated. And as time goes on, it may be possible for drones or UAVs to be used to execute minor repairs on hard-to-reach locations of buildings and infrastructure (Abiodun and Raheem, 2020).

4.   Intra-logistics transportation or delivery

Drones also play a very fundamental role in intra-logistics delivery in a nation. This is sometimes applicable in the automotive industry with its gigantic production locations, drones or UAVs are used to maintain intra-plant delivery or transport as well as the supplier-to-plant emergency deliveries which are usually carried out with the use of helicopter (Marcus and Denis, 2019). In the same vein, massive mining locations can also benefit from the on-site express delivery of items that are central to maintaining operations in the areas of: delivery of tools, machine parts, and lubricants. Drones are very easy to deploy and they are made to follow pre-defined flight paths, so there is no requirement for specially trained personnel to fly them. But as far as the

system operations are restricted to private sites only, the company only has to deal with minimal regulatory boundaries and privacy issues (Marcus and Denis, 2019). However, the notable limitation for intra-logistics may only be in the area of payload. In addition, usage of drones or UAVs for intra-logistics delivery is at the same observed inside the warehouse sites. Here, the UAV sensors, with the aid of internet service, usually enable the drone to, without any help from man, observe and analyze the surrounding sites to the extent that the drone or UAV would be able to navigate through the warehouse, find logistical objects and carry out an inventory check in all ramifications (Ibid). The data collected are thereafter transmitted to third-party systems via intelligent interfaces.

5.   Agriculture and forestry industry

In modern agriculture, drones or unmanned aerial vehicles (UAVs) are already playing a crucial role today. The drones enable farmers to assemble or collect current and early warning data on their crops, identify or sense abnormalities as early as possible in order to swiftly take better decisions about using herbicides, fertilizers, and pesticides (Mathers, 2014). In the same vein, drones or UAVs are deployed for animal tracking to prevent loss of movement while they are also helpful in spotting and mapping to prevent escalation of forest inferno respectively.

Drone technology or application in forestry; *Source:* Sensefly.com

6.   Construction Industry: locations and layout Planning

Construction sectors and in other industries can also benefit in numerous ways from the use of drone systems in the country. This is evident in the sense that the drones or UAVs can easily analyze a location from the sky, using live footage from its flight (Mathers, 2014). This would easily provide an overview and indication of the location details. However, footage and data collected by a drone are easily used in land mapping – this can be adopted by the Nigerian Army to easily locate the Boko Haram terrorists hiding in Sambisa forest in North Eastern region of Nigeria (Abiodun, 2020).

7.   Environmental protection services

Drones or unmanned aerial vehicles (UAVs) play a significant role in environmental protection matters in a country. This is evident, for instance, in the safeguarding of animal species in conservation parks and private game reserves from poachers (Raxter and Young, 2015). This is practiced in South African zoos. In some advanced countries like the United States of America, drones are flown on high seas and oceans to monitor and protect some species of animals like whales, giant sharks among others (Mathers, 2014). In this technology application, a battery-

powered UAV is deployed; it remains at ease in the wind, it is waterproofed, equipped with GPS systems and a camera that releases both videos and still pictures with multiple security backups so that, in case it has any hitch or a low battery in the sea, the UAV automatically returns to base (Abiodun, 2020).

Drone being deployed for environmental services; *Source:* Avinc

8.   Emergency and risk response and aerial policing

UAVs are very useful in the area of emergency and risks responses in all ramifications. This is evident in period of the vicious earthquake in Japanese history, Fukushima 2011, coupled with a disastrous Tsunami that claimed over 16,000 lives and the whole region rendered devastated (Mathers, 2014). The serious issue after such disasters is that decision makers are usually bereft of information on which to base their submissions. This situation got more worsened in Fukushima by radioactivity leaking from damaged reactors, thereby subjecting every person who penetrates the power plant area at high risk of radioactive contamination. In this circumstance, drones or UAVs technologies remain the only great data-gathering devices suitable for deployment (Schroeder and Meier, 2016). The drones or unmanned aerial vehicles (UAVs) are fully equipped with cameras and sensors, remotely controlled, and are fully independent of the potentially destroyed infrastructure. At the same time, the significant contribution includes keeping humans out of danger arena and preventive risk exposure. According to Abiodun (2020), the drone or UAV known as *"Honeywell T-Hawk"* helps in policing and could be actively deployed to gather intelligence from the heart of the devastated location. The drone is powered by a two-stroke gasoline engine and could be airborne for up to 40 minutes before requiring for more fueling. Drones are very cost-effective when deployed for law enforcement, policing operations, situational awareness during sieges, and other high-risk operations over the conventional aircrafts that are is too costly in all ramifications. Drones carry a variety of cameras, they could be deployed within few minutes, and fly at heights that effectively make them inaudible from the ground (Abiodun and Raheem, 2020).

Police applications of UAVs; *Sources:* Telegraph, Falcon-UAV

9.   Film, journalism and photography industry

Globally and at present, aerial journalism, film and photography service providers appear majorly to be the largest commercial users of drones. The deployment is very easy in many cases - off-the-shelf cameras are easily coupled to the drone with its ready-made mountings; and the usage saves cost tremendously (Field Research Survey, 2019).

An aerial drone flying with an off-the-shelf camera coupled to it; *Source:* Fast Company

10.   Aiding and facilitating developments to the world of transportation

Drone technology is meant to establish a network that is basically designed around human need, rather than the hitches of the straight-jacketed technology that formed the current transportation system, most especially in Nigeria and Africa at large (Field Research Survey, 2019). The basic idea is to use drones to draw or expand the level of infrastructure developments in different locations. Drone technology is capable of transporting relief shipments or logistics to hard-to-reach locations and to give room for economical growth, expansion, and connection from urban cities to rural populations.

Limitations of the Research

Some limitations of the current study are notable because they place key restrictions on the researcher's substantive inferences about the nature of public awareness and support for aerial drone or UAV applications. The key limitations of the study are; the study research instruments were majorly administered to Nigerian respondents that were knowledgeable in internet and advanced technology's applications whereas these set of respondents not be the general or overall representatives of all Nigerians. In addition, the researcher, in his utmost desire to gather adequate data or information via the physical masteries of drone or UAV technology applications in at the DHL base in Frankfurt, Germany during the period of study, was only able to witness applications of UAVs or drones in transport and delivery in both heavy and light payloads or logistics. But pursuant to the researcher's very limited time approved to report back to Oxford, United Kingdom, where he had a chunk of busy academic schedules, was unable to have the full glimpses of drone applications in other sectors as earlier designed.

Conclusions and Perspectives for Further Studies

It is currently evident that substantial challenges slouch ahead for drones or UAVs applications, most especially in the areas of; privacy intrusion, physical safety, potential hijacks by terrorists and criminals, among others in Nigeria and other sub-Saharan African nations. Though, it is absolutely apparent that these challenges would be overcome within a short period of time in case there is total commitment with determination for technological advancement in Africa as a

whole. The submission is supported with the fact that specific evident indications have emerged that drones or UAVs technological applications are already becoming fruitful and succeeding globally – it (aerial drone technology) enhances delivery speed and customer service levels, remains very cost-effective (lower cost) and, at the same time, save lives. Therefore, the two most potential uses in the logistics industry as being practiced in some African states of Rwanda, South Africa and all over the world pave way for urgent express shipments in crowded megacities - improving the network flexibility, logistics delivery speed, and even the environmental proof; and as well rural deliveries in areas that lack adequate infrastructure. It also enables residents in remote areas, most especially in sub-Saharan African countries to be well connected to the global trade networks. It is much more believed that this study will persist to be of impressive interest for further studies over the next few years, in case technological advancements and transformation in legislation process hasten the dissemination of drones or UAVs technologies.

Recommendations
In order to adequately ensure a consistent pace around adoption, safety, reliability of drones technology for transport or logistics delivery, and effective monitoring for future implementation in Nigeria, the study recommended the following:

Strengthening of regulatory frameworks, code of conducts and insurance
As we all aware that regulatory frameworks remain a key factor influencing the pace of drones or UAVs technology's adoption for logistics and other businesses in Nigeria, there is a need for national aviation authority to begin expanding frameworks that would guarantee safe UAV or drone operations, and the same time give room for more innovations. And as soon as these regulatory frameworks are put in place, more businesses would begin to adopt drone-based technologies. In addition, the laws governing drone operators are still developing, and insurance should be made to become part of the regulatory framework, to provide coverage in case of physical losses or liabilities during and after drone operations.

Increasing level of demand for high-quality drone data
It has been observed for over decades now that numerous global industries have been deploying helicopters, planes, and satellites for geo-spatial and other photo-inclined data collection but the images still appear very costly and as well fail to provide the best intensity of quality so desired. Therefore, drones or UAVs technology is hereby recommended as it guarantees cost effective and higher quality of data; and the increasing demand for data will definitely increase the deployment of drones for logistics and business activities in all ramifications.

Ensuring steady existence of attractive data processing and accessibility
Existence of attractive data processing and accessibility is highly recommended. Enhanced data processing and accessibility remains one of the significant propellers that promote drone technologies adoption in business engagements as we all know that that data obtained during drone or UAV operations would have to be processed before delivering substantial benefits for commerce. In addition to this, the autonomous flight control systems should be adequately developed to enable businesses to automatically operate via drones for all logistics missions.

Quest for modern or advanced technological breakthroughs

Drones or unmanned aerial vehicles (UAVs) are made up of several technologically-advanced components that determine their reliability, safety, and efficiency – therefore, constant improvements in hardware solutions and declining cost will definitely aid the growing number of drone applications in the country. This is hereby recommended.

Adequate provisioning for safety and security of drones operations

The study also recommends there should be adequate provision that would guarantee the security and safety of drones operations. It is of importance that effective mechanism be put in place to guarantee air traffic management systems for drones or UAVs to avoid collisions with other flying objects during operations.

Adequate attention has to be paid to systematic learning of drone use

The study recommends there should be adequate and more attention paid to systematic learning of drone use. It is therefore imperative to have a better sense of the costs and benefits of drone technology in different settings and in relation to diverse challenges.

The need to intensify national and local capacity to test, learn, use and maintain drone technology

It is recommended that capacities on the above should be further intensified through adequate or more training, knowledge exchange, and mentoring of both national and local actors. In addition to capacity development, a concerted effort is required to enlighten or educate the general public about the blessings and curses of drone technology use in all ramifications.

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