ISSN: 2756 – 4118 *African Journal of Science Policy and Innovation Management* Volume 1, Issue 2. December, 2020
ajspim.oauife.edu.ng

IMPACT OF INFORMATION AND COMMUNICATIONS TECHNOLOGY ON THE OPERATIONS OF THE NIGERIAN AIRSPACE MANAGEMENT AGENCY IN SOUTHWESTERN NIGERIA

Tosin, I. Olabisi, *Oluwatoyin, S. Ayanlade, and Timothy O. Oyebisi

African Institute for Science Policy and Innovation (AISPI), Obafemi Awolowo University, Ile-Ife, Nigeria
*Corresponding author email: oluwasinatoyin@gmail.com

ABSTRACT

This study seeks to assess the impact of Information and Communications Technology (ICT) on the operations of the Nigerian Airspace Management Agency (NAMA). The study was conducted in the Southwest geopolitical region of Nigeria, and focused on all the NAMA stations located in all the airports in the region. Primary data were collected through a structured questionnaire, which classified the impact of ICT into two namely; Safety and Communication and economic impact. Fifty (50) members of staff were randomly selected from four departments in the entire three airports, making a total of two hundred (200) participants for the study. Pearson Correlation Statistic results showed that ICT impacts safety and communication operations of NAMA the most, more than the economic operations. The pseudo R^2 values (Nagelkerke = 73%) indicate that the use of ICT explains a relatively high proportion of the variation in the operations of Nigerian airspace management. Moreover, the results of the Relative Importance Index (RII) (on a scale of 1 to 5) obtained from the analysis showed that direct and efficient air-ground linkage (4.84); safer environment (4.80); safe and secure data and information (4.76); easy access and transfer of data and information (4.75); more efficient use of the airspace (4.75); better resource utilization (4.75); reduction in the workload of the air traffic controllers (4.73); and reduction of communication errors (4.55) are highest-ranked impacts of ICT on Nigerian airspace operations, while ICT impact is not significantly felt on flight delay reduction (3.93); and reduction of fraud cases (3.76), which were the least-ranked. Thus, the study confirms and recommends the continued investment on ICT in the aviation sector because of its significant impact on the operations of the Nigerian airspace management.

Keywords: ICT, Airspace Management, Technology Impact, Southwestern Nigeria.

1.0. INTRODUCTION

The vital role of aviation in facilitating national economic growth and social benefits cannot be overemphasized. This role is evident in aviation which provides a rapid global transportation network, and enhances worldwide business and tourism. Therefore, aviation gives developing countries like Nigeria, the opportunity to develop global supply chains and enhance global trade (Adeniran & Gbadamosi, 2017). However, the air transportation industry is identified as a sector that needs to be protected and well guided due to the consequences and fatality of its incidents and accidents. Likewise, the increasing growth in demand for air transportation calls for the need to provide more effective, efficient and safe services, as evident in the visions and missions of the agencies guiding aviation in Nigeria such as the Nigerian Airspace Management Agency (NAMA) (Aderamo, 2010). Unfortunately, absolute Nigerian aviation safety is still unachievable as evident in several recorded cases of aviation accidents

and incidents in Nigeria (Daramola, 2014). For example, 59 runway accidents occurred in Nigerian aviation between 2000 and 2011, in which the unavailability of infrastructure and facilities was one of the contributory factors (Oriola & Adekunle, 2015). The high rate of the accidents made Oriola and Adekunle (2015) report that unless appropriate technology is in place, Nigerian aviation safety will continue to be a challenge for both aviation professionals and all that are directly or indirectly affected by air transportation.

Therefore, Pacheco, Fernandes, and Domingos (2014) argued for the importance of ICT in aviation safety management to curb the high rate of aviation mishaps and for the sustainability of air transportation services, in terms of safety enhancement. This is consistent with what Wong (2006) stated that owing to the issue of safety and insecurity globally, the aviation industry in recent years has seen the need to improve performance and safety through the incorporation of needed facilities and infrastructure. The author stated further that ICT has a significant role to play because its strategic, widespread, intensive and innovative use can bring about safety enhancements in the aviation sector. It is therefore imperative that these technologies be put in place to guarantee the safety of staff and passengers alike (Hassan, 2015). Hurter, Brenier, Ducas, and Le Guilcher (2016) also noted that there are many ways that ICT could enhance the safety of the airspace. For example, the authors suggested that knowledge and data be extracted from recorded or real-time significant traffic sequences in air traffic analysis, to understand better, the structure of the traffic and its evolution. Zhang and Chen (2018) stated that ICT could enhance airspace performance in a way that as the airspace capacity rises, there will be more flight safety and lesser flight separation, thus balancing efficiency, safety and equity in the aviation sector (Kopardekar *et al*., 2016).

Furthermore in 2015, as noted by Ovuworie (2018), that as against the mission and vision of the Nigerian airspace management agency, *Aviation Nigeria* reported that a reasonable amount of air safety reports made in the Nigerian airspace in the past two years were communication failure, 19 of which were received between January and November 2014, with each of these having the potential of resulting in mid-air collisions. Thus, the Nigerian airspace has gradually become a nightmare for pilots flying to and from the country, despite all the information and communication technologies put in place in Nigerian airports (Ovuworie, 2018).

As against the mission and vision of the Nigerian Airspace Management Agency (NAMA), the airspace is unsafe for users. Several fatalities of aviation incidents and accidents have been documented, despite all the technologies on ground. What are then the impacts of the existing Information and Communication Technologies on the management of the Nigerian airspace? Therefore, this study seeks to assess the impact of Information and Communications Technology (ICT) on the operations of the Nigerian Airspace Management. The rest of the paper is structured as follows; related works; methodology; results and discussions; conclusions; and implications of the findings.

2.0. Related Works

Lekota and Coetzee (2019) noted that the aviation industry greatly relies on Information and Communications Technology (ICT) for its operations. However, the effectiveness of ICT is not limited to the aviation sector alone. In fact, the impact of Information and Communications Technology on every sector cannot be over emphasized. For instance, Idowu (2015) identified

the impact of the use of Information and Communications Technology on the performance of the Nigerian Stock Exchange (NSE). The authors reported a positive impact on performance because ICT brings about an increased level of confidence in the operations of the Stock Exchange. Similarly, Olumade (2017) examined the impact of ICT on lecturers' proficiency in Nigerian universities. The author found out that ICT has a powerful multiplier effect on university education, and enhances the university's vision and mission. Also, Gholami, Ravishankar, Shirazi, and Machet (2017) assessed the impact of ICT on the travel and tourism sector and found out a reduction in gas emission accumulated by transportation, due to the use of ICT.

Similarly, in the aviation sector, the impact of Information and Communications Technology had been documented. For example, Lekota and Coetzee (2019) and Fox (2016) stated that the use of ICT could be a way to respond to cyberattacks by having the needed cybersecurity standards. Also, Feher (2020) explained how an automated border control system, an ICT gadget, could be used to enhance aviation security. Moreover, Plachynda, Herasymenko, Pukhalska, and Kryzhevska (2019) applied ICT into the professional training of future civil aviation pilots. He then found out ICT having an enhanced self-study for students and also a positive impact on teachers. Other ICT impacts found out by researchers include economic growth (Adedoyin, Bekun, Driha, & Balsalobre-Lorente, 2020); and enhanced strategic plans and operations among others.

3.0. Methodology

The study was conducted in Nigeria, which consists of twenty (20) functional local and eight (8) major international airports. However, the scope was restricted to the Southwest geopolitical region of Nigeria, and focused on all the NAMA stations located in all the airports in the region. The airports were Murtala Mohammed Airport, Ikeja, Lagos State (functioning as both local and international airports); Ibadan Airport, Ibadan, Oyo State; and Akure Airport, Akure, Ondo State. Southwestern Nigeria is the major hub of economic activities in Nigeria, and thus experiences a considerable amount of transportation activities. The Murtala Mohammed Airport houses the headquarters of the NAMA, and it is the busiest airport in Nigeria, accounting for more than eighty percent (80%) of international airport operations in Nigeria (Adeniran & Gbadamosi, 2017).

Random sampling technique was used to select the participants of this research, based on their availability. Primary data were collected through a structured questionnaire administered to 200 Staff of NAMA at all the airports in the study area. Thus, using random sampling and based on respondents' availability, the questionnaire was used to elicit information on the impact of ICT on the operations of NAMA, with the impacts broadly classified into Safety and Communication impact and Economic impact. Copies of the questionnaire were administered to 200 members of staff from four different departments that handle the major management operations of the airspace namely Information and Communications Technology (ICT) department; Aeronautical Information Services (AIS) department; Air Traffic and Safety Electronics Services (ATSES) department; and Air Traffic Control (ATC) department. Fifty (50) members of staff were randomly selected, based on their availability, from each of these departments from all the three airports understudy making two hundred (200) participants for the study as in Table 1.0.

ISSN: 2756 – 4118 *African Journal of Science Policy and Innovation Management* Volume 1, Issue 2. December, 2020
ajspim.oauife.edu.ng

Table 1.0: Questionnaire Distribution to NAMA Staff

S/No	NAMA Dept/Unit	No of Questionnaire Distributed	No of Questionnaire Retrieved	% Retrieved
i.	Information and Communications Technology, ICT	50	48	96
ii.	Aeronautical Information Services, AIS	50	46	92
iii.	Air Traffic and Safety Electronics Services, ATSES	50	46	92
iv.	Air Traffic Control, ATC	50	47	94
	Total	**200**	**187**	**93.5**

To address the aim of the research, which is to assess the impact of the ICTs on the operations of the Nigerian Airspace Management Agency, the study variables for the impacts were categorized into Economic impact and Safety and communication impacts, based on the literature reviewed. The Economic impact explains the resultant effect that the use of ICT in the daily operations of the Nigerian Airspace Management Agency has on the organizational capital, while the safety and communication impact addresses the effect that the use of ICT has on the safety of the airspace and communication across the airports, especially between the engineers, air traffic controllers and the pilots (Sampigethaya, Poovendran, Shetty, Davis, & Royalty, 2011; Van Reenen et al., 2010). The study variables for each impact category were considered on a 5-point Likert scale, from 5 (Strongly Agreed) to 1 (Strongly Disagreed) as also indicated in Table 2.0.

The reliability of the data was guaranteed by making sure that the questionnaire was well designed and easily understood by the respondents. After the pilot study, ambiguous and wrongly worded questions were removed before proceeding to the field for data collection. Ethical considerations for the research were established by making sure that participation in the research was voluntary. Also, none of the respondents was forced to fill the questionnaire and were informed that they could leave out the questions they were not comfortable with.

Similarly, details of the research were known to the respondents at the onset by the introductory part of the questionnaire that was read to them before they started to fill the questionnaire. The respondents were also assured that their responses would be made as confidential.

4.0. Results and Discussion

Out of the two hundred (200) copies of the questionnaire distributed to the respondents, a total of one hundred and eighty-seven (187) were retrieved. This amounts to a 93.5% response rate. As stated earlier, two major categories of impact were presented to the respondents: Economic; and Safety and Communication Impacts, each measured on a Likert scale ranging from strongly agree to strongly disagree, and with eleven and five items respectively.

Table 2.0: The Study Variables used to measure the impact of Information and Communications Technology on the operations of the Nigerian Airspace Management

Impact	Study Variables
Economic impact	Increased number of flights
	Increased revenue
	Reduced flight operating costs
	Increased productivity
	More efficient use of the airspace
	Better resource utilization
	Interoperability across applications
	Reduction in cases of fraud
	Reduced air traffic controller workload
	Reduction in dependence on outsourcing
	Reduction in flight delay
Safety and Communication impact	Reduction of communication errors
	Safe and secure data and information
	Easy access and transfer of data and information
	More direct and efficient air-ground linkage
	Safer environment

(Hansman, 2005)

For the data analysis, Statistical Packages for Social Sciences (SPSS) version 20.0 was used to investigate the impacts of studied ICT variables on the operations of the Nigerian Airspace Management Agency, NAMA, with Relative Importance Index to determine rankings, obtained from the Mean analysis. Also, Pearson Correlation and ordinal logistic regression were used.

4.1. Economic impact of information and communications technology on the operations of the Nigerian airspace management

As depicted in Table 2.0, for the assessment of the economic impact of ICT on the operations of the Nigerian Airspace Management, eleven (11) variables were presented to the respondents namely: Increased number of flights; Increased revenue; Reduced flight operating costs; Increased productivity; More efficient use of the airspace; Better resource utilization; Interoperability across applications; Reduction in fraud cases; Reduced air traffic controller workload; Reduction in dependence on outsourcing; and Reduction in flight delays. Relative Importance Index, RII, was carried out using SPSS, to determine the importance of the presented impacts, according to rankings and positions, and based on the categories used in the study as in Table 3.0. Thus, the highest four economic impacts of Information and Communications Technology on the Operations of the Nigerian Airspace Management are discussed below:

i. More efficient use of airspace (Mean=4.75)

More efficient Use of Airspace' is ranked number one and the most important economic impact of ICT on the operations of the Nigerian airspace management. The first ranking might be because, with the use of ICT, there is better management of the airspace, thus an efficient air traffic management, as evident in what Hafidi, Benaddy, and Krit (2018) established that optimization and systems plays a significant role in air traffic management to ensure safety. Therefore, the study confirmed that the use of ICT enhances more efficient use of airspace.

ii. Better Resource Utilization (Mean=4.75)

'Better Resource Utilization' is also ranked first, together with 'More efficient use of the airspace' as the number one economic impact of ICT on the operations of the Nigerian airspace management. The ranking might be because with the use of ICT, resources can be well prepared and budgeted for, as scarce resources are being well managed and utilized with the use of ICT

iii. Reduction in the workload of the air traffic controller (Mean=4.73)

'Reduction in Workload of the Air Traffic Controller' is ranked third under the economic impact of ICT on the operations of Nigerian airspace management agency. The ranking might also be because with the use of ICT, Air traffic controllers can easily carry out their task of managing air traffic, which in turn reduces traffic, and thereby their workload, that is, the number of aircraft they have to attend to per time. The reduction in workload is obvious in that with the use of ICT in airspace management, the Air Traffic Controllers have reduced workload. Qureshi and Qazi Abro (2016) also confirmed this by stating that the use of ICT helps in reduction of workload.

This is confirmed by Qureshi and Qazi Abro (2016) that the use of ICT helps in efficiently achieving goals, and thus enabling better utilization of resources.

iv. Increased productivity (Mean=4.69)

'Increased productivity' is ranked third under the economic impact of ICT on the operations of the Nigerian airspace management. The ranking might also be because with the use of ICT, staff can carry out their duties without delay, thereby increasing their level of productivity, which will then result in a significant increase in the growth of the staff and the agency as a whole. Therefore, according to García-Muñiz and Vicente (2014), ICTs are essential drivers of growth and productivity.

From the findings, there are also some other areas that the impacts of ICT on the economic operations of the Nigerian Airspace Management Agency are not significant. Some of these areas of lowest or insignificant economic impact of ICT, according to the research results of the study are presented below:

i. Reduction in fraud cases with the use of ICT (Mean=3.76)

The respondents were asked if the use of ICT does not reduce fraud cases in aviation, and most respondents slightly agreed that it does not. Therefore, 'Reduction in fraud cases' is ranked last under the economic impact of ICT on the operations of Nigerian airspace management. The respondents believed that the use of ICT in the organization had not caused any reduction in fraud cases. The ranking might be because most of the fraud being perpetrated in organizations nowadays are done with the use of the internet and different technological applications, which is known to be one of the disadvantages of ICT (Hathaway, 2017).

ii. Reduction in flight delay (Mean=3.93)

The respondents were asked if the use of ICT does not reduce flight delay, and most respondents slightly agreed that it does not. Thus, 'Reduction in flight delay' is next on the least-ranked economic impact of ICT on the operations of Nigerian airspace management. The respondents thought that even with the use of ICT, there are still flight delays, which might be because there may be other factors that contribute to the delay of flights, which may range from unfavourable weather conditions to delay caused by connecting flight cancellations, among others (Boye, 2015).

ISSN: 2756 – 4118 *African Journal of Science Policy and Innovation Management* Volume 1, Issue 2. December, 2020
ajspim.oauife.edu.ng

Table 3.0: The Relative Importance Index of the variables used to measure the impact of ICT on the Operations of the Nigerian Airspace Management

	Variables	SA		A		D		SD		U		TWF	RII	Rank
		F	*%*	*F*	*%*	*F*	*%*	*F*	*%*	*F*	*%*			Position
Economic Impact	Efficient use of the airspace	141	75.4	46	24.6	--	--	--	--	--	--	889	4.75	1
	Better resource utilization	141	75.4	46	24.6	--	--	--	--	--	--	889	4.75	1
	Reduction in the workload of the air traffic controller	144	77.0	35	18.7	--	--	--	--	8	4.3	884	4.73	3
	Increase in productivity	129	69.0	58	31.0	--	--	--	--	--	--	877	4.69	4
	Interoperability across applications	97	51.9	97	51.9	--	--	--	--	1	0.5	876	4.68	5
	Increase in revenue	116	62.0	41	21.9	30	16.0	--	--	--	--	804	4.30	6
	Reduction in flight operating costs	66	35.3	112	59.9	--	--	--	--	9	4.8	805	4.30	6
	Increase in no of flights	46	24.6	124	66.3	--	--	--	--	17	9.1	777	4.16	8
	Reduction in outsourcing	45	25.7	130	69.5	--	--	--	--	9	4.8	772	4.13	9
	Reduction in flight delay	63	33.7	86	46.0	38	20.3	--	--	--	--	735	3.93	10
	Reduction in fraud cases	101	54.0	1	0.5	60	32.1	--	--	25	13.4	704	3.76	11
Safety and Communication Impact	More direct and efficient air-ground linkage	158	84.5	29	15.5	--	--	--	--	--	--	906	4.84	1
	Safer environment	149	79.7	38	20.3	--	--	--	--	--	--	897	4.80	2
	Safe and secure data and information	143	76.5	44	23.5	--	--	--	--	--	--	891	4.76	3
	Easy access and transfer of data and information	141	75.4	46	24.6	--	--	--	--	--	--	889	4.75	4
	Reduction of communication errors	103	55.1	84	44.9	--	--	--	--	--	--	851	4.55	5

TWF=Total Weighted Frequency, RII=Relative Importance Index; *5.0-4.45: Strongly Agreed; 3.5-4.44: Slightly Agreed;, 2.5-3.44: Slightly Disagreed; 1.5-2.44: Strongly Disagreed and 0.0-1.44: Indifferent.*

iii. Reduction in outsourcing (Mean=4.13)

The respondents were asked if the use of ICT does not result in reduction in outsourcing and most respondents slightly agreed that it does not. Therefore, 'Reduction in outsourcing' is ranked ninth on the economic impact of ICT on the operations of the Nigerian airspace management. The respondents believed that ICT does not bring about any reduction in outsourcing, because some operations are still being outsourced. The reason for the outsourcing might be because the agency does not have expertise in ICT for every available task at the studied departments of the organization, and thus, the need to outsource some projects.

iv. Increase in the number of flights (Mean=4.16)

The respondents were asked if the use of ICT does not cause increase in the number of flights, and most respondents slightly agreed that it does not. Thus, 'Increase in the number of flights' is ranked eighth on the economic impact of ICT on the operations of the Nigerian airspace management. The ranking shows that respondents thought that there has not been an increase in the number of flights due to the usage of ICT in airspace management. The lack of increase in the number of flights might be because there may be other factors that influence the passengers to prefer other means of transportation which might not be dependent on the use of ICT or any technology. It might be dependent on the number of people that are willing to travel by air, the number of airlines that may want to fly per time, and users' preferred routes, among others (Green, Bilimoria, & Ballin, 2001).

4.2. Safety and communication impact of information and communications technology on the operations of the Nigerian airspace management

As also evident in Table 2.0, for the assessment of the safety and communication impact of Information and Communications Technology on the operations of the Nigerian Airspace Management, five (5) variables were presented to the respondents namely; Reduction of communication errors; Safe and secure data and information; Easy access and transfer of data and information; More direct and efficient air-ground linkage; and Safer environment. The highest three safety and communication impact of Information and Communications Technology on the Operations of the Nigerian Airspace Management are discussed below:

i. More direct and efficient air-ground linkage (Mean= 4.84)

'More direct and efficient air-ground linkage' impact is ranked number one under the safety and communication impact. The respondents believe that ICT contributed tremendously by improving linkages and communications between air and ground. This ranking might be because there have been linkage systems and technologies put in place in the agency that have ensured effective air-ground communications presently and in the past. Therefore, these linkage gadgets, which are ICT-based, have contributed tremendously to efficient communication between the controllers and the pilots (Margolin, 2014). In line with this, it could be established that ICT has been a major medium for effective communication in the airspace sector.

ii. Safer environment with the deployment of ICT (Mean=4.80)

'Safer environment with the deployment of ICT' is the second most crucial impact of ICT under safety and communication. The respondents believe that the environment is safer with the deployment of ICT. The ranking might be because the management has provided different ICT-based security systems to make sure that the environment of the agency and the airport at large is safe for staff, travelers and other users of the airport (Yim, Castiglione, & You, 2014).

Thus, as also affirmed by Kamlakar and Purswani (2013), who reported that the environment has become safer with the use of ICT and that the use of ICT ensures a safer environment.

iii. Safe and secure data and information (Mean=4.76)

The third most important safety and communication impact is 'safe and secure data and information'. This might be because data and information in the agency have become safer and secure since their security has been improved on through ICT. This shows that the usage of ICT in Nigerian airspace management has made the agency's data confidential and with integrity. Boston and Akman (2015) also confirmed that with ICT security in place, data and information are safe and secure.

However, the lower ranks, according to the RII analysis, of safety and communication impacts of Information and Communications Technology on the operations of the Nigerian Airspace Management are discussed below:

iv. Reduction of communication errors (Mean=4.55)

The respondents were asked if the use of ICT does not reduce communication errors, and most respondents strongly agreed that it does not. Therefore, 'Reduction of communication errors' is the lowest impact of ICT as regards safety and communication on the operations of the Nigerian airspace management. This low ranking may be because communication errors are still being experienced in airspace organizations. This is obvious in that the communication in the agency is still majorly voice communication and has not entirely been changed to data communication (Ovuworie, 2018). Therefore, for this to be improved on using ICT, there is a need to improve on the communication methods to eliminate errors, to avoid a collision or other traffic incidents or accidents.

v. Easy access and transfer of data and information (Mean=4.75)

The respondents were asked if the use of ICT does not permit easy access and transfer of data and information, and most respondents strongly agreed that it does not. Thus, 'Easy Access and Transfer of Data and Information' is the second-lowest communication impact of ICT on the operations of the Nigerian Airspace Management Agency. This implies that the respondents believe that they have not had easy access to information, while also not being able to easily transfer data and information, even with the deployment of ICT. This might be because the network connection in the agency is not good or fast enough, and so not always be available for use by the staff, and also the needed specific sensitive data and information might not be easily accessed elsewhere or using another computer system, because of the security measures put in place to protect them (Boye, 2015).

Similarly, the mean analysis result to evaluate the overall impact of the Information and Communications Technology variables is shown in Table 4.0. From the table, it was evident that among all the impacts considered, ICT mostly causes more direct and efficient air-ground linkage with mean 4.84 and also, the results in the table indicate that there is safer environment with the deployment of ICT with mean 4.80, which were both categorized under safety and communication impact. However, among all the impacts considered, the respondents agreed that the use of ICT does not reduce the number of fraud cases with the lowest mean of 3.76, and also agreed that it does not reduce flight delay with a mean of 3.93, which were both interestingly economic impacts.

Also, Pearson correlation tests were carried out to know the category of impact, either economic; or safety and communication, that ICT impacts most. This is illustrated in Table 5.0. It was necessary to determine the relationship between the dependent (Operations of the Nigerian Airspace Management) and the independent variable (Use of the Information and Communications Technology), while also stating the strength and direction of the relationship.

Table 4.0: Mean analysis showing the overall impact of Information and Communications Technology on the performance of Nigerian Airspace Management

S/N		N	Min	Max	Mean
	Economic Impact				
1.	ICT ensures more efficient use of the airspace	187	4	5	4.75
2.	Use of ICT causes better resource utilization	187	4	5	4.75
3.	Using ICT reduces the workload of the air traffic controller	187	3	5	4.73
4.	ICT increases productivity	187	4	5	4.69
5.	Deployment of ICT ensures interoperability across applications	187	3	5	4.51
6.	Using ICT Increases revenue	187	2	5	4.30
7.	Using ICT reduces flight operating cost	187	3	5	4.30
8.	The use of ICT does not reduce dependence on outsourcing	187	3	5	4.21
9.	Deployment of ICT does not increase the number of flights.	187	3	5	4.16
10.	The use of ICT does not reduce flight delay.	187	2	5	3.93
11.	There is no reduction in fraud cases with the use of ICT	187	2	5	3.76
	Safety and Communication Impact				
12.	The use of ICT causes more direct and efficient air-ground linkage.	187	4	5	4.84
13.	There is a safer environment with the deployment of ICT	187	4	5	4.80
14.	Use of ICT ensures safe and secure data and information.	187	4	5	4.76
15.	Use of ICT does not permit easy access and transfer of data and information.	187	4	5	4.75
16.	Use of ICT does not reduce communication errors	187	4	5	4.55

5.0-4.45: Strongly Agreed; 3.5-4.44: Slightly Agreed;, 2.5-3.44: Slightly Disagreed; 1.5-2.44: Strongly Disagreed and 0.0-1.44: Indifferent.

It was therefore evident from the Pearson correlation table, Table 5.0, that ICT impacts the safety and communication operations of the Nigerian airspace management agency most, more than the economic operations as evident in the significant level of 0.032 ($p>0.05$). This is an indication that Information and Communications Technology has a positive direct relationship with all the operations regarding safety and communication of the agency. In other words, the more ICT devices and options in use, the more positive impact is felt on the safety and communication aspects of the operations of Nigerian Airspace management.

ISSN: 2756 – 4118 *African Journal of Science Policy and Innovation Management* Volume 1, Issue 2. December, 2020
ajspim.oauife.edu.ng

Table 5.0: Pearson Correlation showing the Impact of Information and Communications Technology on the operations of the Nigerian Airspace Agency

			Economic Impact	Safety and Communication Impact
Nigerian Airspace Operations		Pearson Correlation	.055	.032*
		Sig. (2-tailed)	.454	.660
		N	187	187

**. Correlation is significant at the 0.05 level (2-tailed).*

Also, ordinal logistic regression was used to evaluate the strength of the impact that ICT has on the operations of the Nigerian Airspace management. This was used to determine the impact of the independent variable (Use of ICT) on the dependent variable (Nigerian Airspace Management operations). This type of analysis was suitable because the dependent variable is categorical, while also the independent variables were in the Likert scale of 'Strongly Agree' to 'Strongly Disagree'. Before ordinal regression was run, several assumptions were tested. For example, making sure the dependent variable is ordinal, and one or more independent variables are continuous**,** ordinal or categorical**.** Lastly, it was confirmed that there is no multicollinearity among the variables**.** Multicollinearity occurs when there are two or more independent variables that are highly correlated with one another. The model fitting information, fitted with both functions, and the function with the better fit was chosen, as shown in Table 6.0.

Table 6.0: Model Fitting Information of the Ordinal Logistic Regression

Model Fitting Information				
Model	**-2 Log Likelihood**	**Chi-Square**	**df**	**Sig.**
Intercept Only	558.373			
Final	544.092	24.381	16	.000*

Link function: Logit.
** Significant at p<0.05 level*

However, before using the model fitting information in Table 6.0, how significant the impacts of the explanatory variables, the various uses of Information and Communications Technology, was determined. This is possible by first confirming whether the model improved the ability to predict. Therefore, a model without any explanatory variable (the baseline or Intercept Only model) was compared with the model with explanatory variables (the Final model). This was intended to see whether the explanatory variables have significantly improved the fit to the data. Therefore, the model fitting Information table (Table 6.0) gives the -2 log-likelihood values for the baseline and the final model, and chi-square was performed to test the difference between the -2LL for the two models. The significant chi-square statistic (p<.0005) indicates

that the final model gives a significant improvement over the baseline intercept-only model. This is an indication that the model gives better predictions than a guess based on the marginal probabilities for the outcome categories.

Likewise, Table 7.0 is the Goodness-of-Fit table. This table contains Pearson's chi-square statistic for the model (as well as another chi-square statistic based on the deviance). This is necessary to test whether the observed data are consistent with the fitted model. For the model to be a good fit, the values must be significant at $p<0.05$ level. The table thus showed that the data and the model predictions are similar and that the model is good.

Table 7.0: Goodness-of-Fit Test for the Ordinal Logistic Regression

Goodness-of-Fit			
	Chi-Square	**df**	**Sig.**
Pearson	13.107	0	.003
Deviance	13.208	0	.002
Link function: Logit.			

Furthermore, other methods of indexing the goodness of fit, such as measures of association, like the pseudo R^2, were also used. Since ordinal regression model is being used, unlike linear regression, it is not possible to compute the coefficient of determination (R^2), which summarizes the proportion of variance in the outcome that can be accounted for by the explanatory variables, so three approximations were computed instead.

Therefore, as in Table 8.0, what constitutes a "good" R^2 value depends upon the nature of the outcome and the explanatory variables. Here, the pseudo R^2 values (Nagelkerke = 73%) indicating that use of ICT explains a relatively high proportion of the variation in the operations of Nigerian airspace management.

Table 8.0: Test of the Ordinal Logistic Regression

Pseudo R-Square	
Cox and Snell	.060
Nagelkerke	.073
McFadden	.044
Link function: Logit.	

The parameter estimates table in Table 9.0 is the core of the output, indicating the relationship between the explanatory variables and the outcome. Thus, Table 9.0 shows the coefficients, standard errors, the Wald test and the associated p-values (Sig) at the 95% confidence interval of the coefficients. All the variables under safety and communication are statistically significant at $p<0.05$, while some economic variables are not significant. Therefore, for economic impact using 'estimate' column, for a one-unit increase, not less than 20.0 increase in the ordered log odds is expected, given that all of the other variables in the model are held constant. With safety and communication impact, for a one-unit increase, not less than 30.0 increase in the log odds is expected, given that all of the other variables in the model are held constant.

ISSN: 2756 – 4118 *African Journal of Science Policy and Innovation Management* Volume 1, Issue 2. December, 2020
ajspim.oauife.edu.ng

Table 9.0: Parameter estimates of the Ordinal Logistic Regression

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Airspace_Operations = 16.00]	-3.457	.143	9.150	1	.002	-5.698	-1.217
	[Airspace_Operations = 17.00]	9.299	.790	11.108	1	.001	3.831	14.768
	[Airspace_Operations = 18.00]	20.307	.120	24.292	1	.000	12.231	28.382
Location	[Economic=43]	26.227	.428	23.347	1	.088	15.589	36.866
	[Economic=45]	29.858	.672	11.854	1	.001	12.861	46.855
	[Economic=47]	25.906	.555	20.017	1	.000	8.938	22.873
	[Economic=48]	20.659	.325	8.201	1	.004	2.102	11.217
	[Economic=49]	22.240	.823	22.762	1	.000	10.747	25.733
	[Economic=51]	21.436	.851	.419	1	.517	-17.863	8.992
	[Safety_Communication=20]	35.085	.291	23.159	1	.003	-49.374	-20.796
	[Safety_Communication=21]	32.574	.795	.210	1	.000	-18.851	11.703
	[Safety_Communication=23]	30.574	.670	.586	1	.004	-12.728	5.580
	[Safety_Communication=24]	31.672	.604	12.507	1	.001	-8.815	-2.529

5.0. Conclusion

The results showed that there is a positive impact of ICT on the operations of Nigerian airspace management. This is obvious in the findings that showed that more efficient use of the airspace; better resource utilization; reduction in the workload of the air traffic controllers; increased productivity; efficient air-ground linkage; and safe and secure data are the highest ranked and most important impacts of ICT on the operations of the Nigerian Airspace Management Agency. While the reduction in fraud cases; reduction in flight delay; and reduction in outsourcing are the lowest-ranked economic impacts of ICT on the operations of the Nigerian airspace management. Thus, the research findings confirmed that investment and usage of ICT have significant impacts on the operations of the Nigerian Airspace Management Agency. However, it can be concluded that ICT has more impact on the safety and communication operations of the Nigerian Airspace Management Agency, more than the areas of economic operations.

6.0. Implications of Research Findings

The findings showed that ICT has a positive direct relationship with all the operations regarding safety and communication of the agency. In other words, the more ICT devices and options in use, the more the positive impact felt on the safety and communication aspects of the operations of Nigerian Airspace management. Therefore, to implement policies regarding the use of ICT in Nigerian Aviation, the government and policy analysts are advised to introduce more ICT devices into the Nigerian aviation, especially for safety and communication of the passengers and staff alike. Moreover, ICT devices must be incorporated for the efficiency of economic operations of the Nigerian Aviation.

REFERENCES

Adedoyin, F. F., Bekun, F. V., Driha, O. M., & Balsalobre-Lorente, D. (2020). The effects of air transportation, energy, ICT and FDI on economic growth in the industry 4.0 era: Evidence from the United States. *Technological Forecasting and Social Change, 160*, 120297.

Adeniran, A., & Gbadamosi, K. (2017). Concessioning a Strategy for Enhancing Nigeria's Airport Operational Efficiency-Lessons from Developed Countries. *International Journal of Research in Industrial Engineering, 6*(3), 228-245.

Aderamo, A. J. (2010). Demand for air transport in Nigeria. *Journal of Economics, 1*(1), 23-31.

Boston, A., & Akman, I. (2015). Impact of education on security practices in ICT. *Technical Gazette, 22*(1), 161-169.

Boye, A. B. (2015). Causative Factors of Air Traffic Delay in Muritala Muhammed International Airport Lagos, Nigeria. *Journal of Economics, Management and Trade*, 230-236.

Daramola, A. Y. (2014). An investigation of air accidents in Nigeria using the Human Factors Analysis and Classification System (HFACS) framework. *Journal of Air Transport Management, 35*, 39-50.

Feher, A. (2020). Automated Border Control Systems Vs.(Aviation) Terrorism. *Colocviu strategic, 168*(1), 1-9.

Fox, S. J. (2016). Flying challenges for the future: Aviation preparedness–in the face of cyber-terrorism. *Journal of transportation security, 9*(3-4), 191-218.

García-Muñiz, A. S., & Vicente, M. R. (2014). ICT technologies in Europe: A study of technological diffusion and economic growth under network theory. *Telecommunications Policy, 38*(4), 360-370.

Gholami, R., Ravishankar, M., Shirazi, F., & Machet, C. (2017). An exploratory study on sustainable ICT capability in the travel and tourism industry: the case of a global distribution system provider. *Communications of the Association for Information Systems, 40*(1), 22.

Green, S., Bilimoria, K., & Ballin, M. (2001). *Distributed air-ground traffic management for en route flight operations.* Paper presented at the AIAA Guidance, Navigation, and Control Conference and Exhibit.

Hafidi, M., Benaddy, M., & Krit, S. (2018). Optimization and automation of air traffic control systems: An overview. *International Journal of Engineering, Science and Mathematics, 7*(3), 104-116.

Hansman, R. (2005). *The impact of information technologies on air transportation.* Paper presented at the 43rd AIAA Aerospace Sciences Meeting and Exhibit.

Hassan, A. (2015). Analysis of emergency response procedures and air traffic accidents in Nigeria. *Ethiopian Journal of Environmental Studies and Management, 8*(6), 662-668.

Hathaway, M. (2017). When Violating the Agreement Becomes Customary Practice. *Getting beyond Norms*, 5.

Hurter, C., Brenier, Y., Ducas, J., & Le Guilcher, E. (2016). *Cap: Collaborative advanced planning, trade-off between airspace management and optimized flight performance: Demonstration of en-route reduced airspace congestion through collaborative flight planning.* Paper presented at the 2016 IEEE/AIAA 35th Digital Avionics Systems Conference (DASC).

Idowu, A. A. (2015). *Impact of Information and Communications Technology on the Operations of the Nigerian Capital Market.*

Kamlakar, A., & Purswani, P. S. (2013). Subject: Airport Management Topic:-The Role of Ict in Aviation Commercial Activities.

Kopardekar, P., Rios, J., Prevot, T., Johnson, M., Jung, J., & Robinson, J. E. (2016). Unmanned aircraft system traffic management (utm) concept of operations.

Lekota, F., & Coetzee, M. (2019). *Cybersecurity Incident Response for the Sub-Saharan African Aviation Industry.* Paper presented at the International Conference on Cyber Warfare and Security.

Margolin, J. (2014). System and method for safely flying unmanned aerial vehicles in civilian airspace: Google Patents.

Olumade, S. A. (2017). Information And Communications Technology (Ict) And Lecturers'proficiency In Nigerian Universities. *MOJEM: Malaysian Online Journal of Educational Management, 3*(3), 45-60.

Oriola, A. O., & Adekunle, A. K. (2015). Assessment of runway accident hazards in Nigeria aviation sector. *International Journal for Traffic and Transport Engineering, 5*(2), 82-92.

Ovuworie, G. (2018). Air Transportation in Nigeria: A Safety Management Perspective.

Pacheco, R. R., Fernandes, E., & Domingos, E. M. (2014). Airport airside safety index. *Journal of Air Transport Management, 34*, 86-92.

Plachynda, T., Herasymenko, L., Pukhalska, G., & Kryzhevska, K. (2019). Using Information Communication Technologies in Professional Training of Future Civil Aviation Pilots. *Romanian Journal for Multidimensional Education/Revista Romaneasca pentru Educatie Multidimensionala, 11*(2).

Qureshi, Z. H., & Qazi Abro, M. (2016). Efficient Use of ICT in Administration. *International Journal of Economics, Commerce and Management, IV (10)*, 540-550.

Sampigethaya, K., Poovendran, R., Shetty, S., Davis, T., & Royalty, C. (2011). Future e-enabled aircraft communications and security: The next 20 years and beyond. *Proceedings of the IEEE, 99*(11), 2040-2055.

Van Reenen, J., Bloom, N., Draca, M., Kretschmer, T., Sadun, R., Overman, H., & Schankerman, M. (2010). The economic impact of ICT. *Final report*.

Wong, T. (2006). ICT Applications in Aviation *Encyclopedia of E-Commerce, E-Government, and Mobile Commerce* (pp. 573-579): IGI Global.

Yim, K., Castiglione, A., & You, I. (2014). Prosperity of IT security technologies in homeland defense: Springer.

Zhang, D., & Chen, Y. (2018). *Airspace Sectorization Method for Flexible Airspace Management.* Paper presented at the 2018 37th Chinese Control Conference (CCC).