

Descriptive Assessment of Big Data Technologies Application in the Prevention of Infectious Diseases' Spread through Air Travels

Ajodo EU^{1*}, Kuti IA¹, Ajobo S¹ and Ndagi U²

¹Center for Disaster Risks Management and Development Studies, Federal University of Technology, Nigeria

²Global Health and Infectious Diseases Control Institute, Nasarawa State University, Nigeria

*Corresponding Author

Ajodo, EU, Center for Disaster Risks Management and Development Studies, Federal University of Technology, Nigeria.

Submitted: 2025, Nov 20; Accepted: 2025, Dec 10; Published: 2025, Dec 17

Citation: Ajodo, E. U., Kuti, I. A., Ajobo, S., Ndagi, U. (2025). Descriptive Assessment of Big Data Technologies Application in the Prevention of Infectious Diseases' Spread through Air Travels. *Int J Health Policy Plann*, 4(4), 01-12.

Abstract

Global spread of infectious diseases is on the rise due to inter-country air travels. The 2019 coronavirus outbreak Wuhan China that spread to other parts of the world is a typical example. Efforts toward preventing global spread of infectious diseases through the international airport had led to the use of big data and big data tools/technologies. The focus of this study is to use descriptive approach to investigate the role of big data tools/technologies in the prevention of infectious diseases' spread through air travels. The study adopted the quantitative research approach using online questionnaire formulated into Google Open Data Kit (ODK) form. The questionnaire was distributed using purposive sampling to 252 staff of three selected international airports in Nigeria with 101, 71 and 80 participants from airport A, B and C. The primary quantitative data obtained were analyzed using descriptive statistics. The result showed mean scores range from 3.24 to 3.99-points with computer-based PCR machines having the higher a mean of 3.99-points and hardware connectable sensors 3.79-points on a 5-points scale. Results equally revealed that 59.5 % of the participants agreed to have adopted big data tools/technologies for diseases detection and surveillance at the airports. In the area of application, travel surveillance (4.43) and incident mitigation (4.24) were among the top areas of application of big data within airports. The result showed that global pandemics (4.64) and workers' well-being (4.49) were top drivers of big data adoption and use in the airports. The study concluded that there is high-level of utilization and perceived effectiveness of big data tools among respondents, with consensus on the usefulness of these tools in diseases prevention at airports. It recommends developing robust data governance policies; prioritize protection of passengers and employees' data and compliance with regulatory standards in providing safety to travelers.

Keywords: Descriptive Assessment, Big Data, Big Data Tools, Prevention, Infectious Diseases, Disease Spread, Air Travels

1. Introduction

The spread of infectious diseases through air travels remains a significant global threat because of the profound impacts on health, economies, education and socio-politics [1,2]. Historically, infectious disease outbreaks have caused the highest mortality rates compared to other disaster types and often arise as secondary consequences of natural disasters such as earthquakes, floods, droughts, wars, tsunamis, and heat waves or human-made events conflicts, dam collapse and bio-terrorism acts [3-5]. The

widespread international movement of people facilitated by the aviation industry has increasingly contributed to the rapid global spread of infectious diseases [6,7]. The rapid air travel events have intensified the challenges of disease control and prevention [8]. Several notable infectious disease outbreaks have demonstrated the critical role of international air travel in their spread. For instance, the H1N1 influenza pandemic of 2009 began in Mexico and quickly escalated into a global health emergency within months [9]. Similarly, the Ebola virus epidemic in West Africa (2013–

2016) and the Zika virus outbreak in 2015–2016 exhibited rapid geographic expansion beyond their points of origin, amplified by international travel [10,11]. Each of these infectious disease crises was declared a public health emergency of international concern (PHEIC) to show the urgency of effective global surveillance and containment measures [12].

The health consequences of infectious disease outbreaks are matched often by enormous economic burdens [13]. The Middle East Respiratory Syndrome (MERS) outbreak in 2012, for example, affected 2,578 people with 888 recorded deaths and incurred hospital management costs averaging \$12,947 per patient [14,15]. The 2014 Ebola outbreak resulted in nearly 10,000 deaths and imposed multibillion-dollar economic losses with projections estimating costs reaching hundreds of billions if uncontrolled global spread occurred [16]. The COVID-19 pandemic that infected over 258 million people and causing more than 5 million deaths worldwide as of late 2021 further illustrated this dual burden of infectious diseases [17,18]. It inflicted trillions of dollars economic damage globally and cause unprecedented strain on health systems [19]. In light of these challenges, Precision Public Health (PPH) has emerged as a multidisciplinary approach that leverages big data and advanced analytics to enhance infectious disease surveillance, prediction and response at population level [20,21]. Roberts et al. argued that unlike precision medicine, which focuses on individual genomic information, PPH utilizes diverse data sources from environmental, social and health domains to deliver targeted public health interventions [22]. The application of big data, a technology characterized by its volume, velocity, variety, variability and veracity, enables real-time monitoring and evidence-based decision-making to improve outbreak management [21,23].

Technological advancements have supported the implementation of big data in infectious disease control [24]. Open-source frameworks such as Apache Hadoop and cloud computing environments provide scalable infrastructure to handle massive health datasets generated from international travel screening, remote monitoring systems, and healthcare facility records [21,25,26]. These big data tools facilitate and enhance surveillance, rapid case detection, outbreak prediction and risk communication that are critical for responding to dynamic and complex disease transmission patterns [25]. Given the intersection between air travel and infectious disease spread, and the fact that international airports serve as pivotal entry points, it is important to execute big data-driven surveillance and control strategies at the airports [27]. Ajodo et al., Vizitiu et al. and Batista had argued that implementing advanced analytics and real-time monitoring at airport checkpoints help in early identification of suspected cases, which enable prompt isolation and reducing disease transmission across borders [28-30]. This study examines the role and effectiveness of big data tools in managing infectious disease risks through three selected international airports in Nigerian. It aligned with global health protocols and the strategic public health priorities advocated by WHO and other international bodies. This research contributes to the growing field of PPH and offers evidence to guide policy and operational improvements by

exploring the adoption and integration of big data technologies in airports for health security systems. In doing so, it addresses the broader goal of minimizing both the human and economic costs associated with infectious diseases transmitted via air travel. It supports the broader efforts toward building resilient and adaptive global health defense mechanisms against infectious diseases outbreaks and their spread at a global scale.

2. Research Methodology

The study adopted descriptive quantitative research approach that used an online questionnaire to collect data from participants working within the Nigerian airports and aviation sectors. The quantitative online survey approach was chosen for its ability to efficiently gather data from a large and diverse sample within a short period. It is equally cost-effective and useful for simultaneous data collection from multiple participants from different airports [31]. The use of a structured questionnaire facilitated the collection of quantifiable data that was analyzed statistically to draw inferences on the adoption and application of big data tools in preventing infectious diseases' spread through international air travel. Participants were selected from staff employed at purposively chosen international airports in Nigeria. The inclusion criteria required participants to be actively working within these airports' operational sectors. This inclusion criterion ensured relevance and validity of responses to the research aim and objectives [32].

The online questionnaire was structured into three main sections: the first section prescreened participants for informed consent and involvement in airport operations to ensure only participants who gave their consent and works in one of the selected airports as at the time of the study were eligible to participate. Ineligible participants were screened out automatically at this stage of the survey. The second section gathered demographic information to profile the respondents, while the third section employed primarily a 5-point Likert scale to quantify perceptions and adoption levels of various infectious disease prevention big data tools and applications. Responses on the Likert scale ranged from 5 (highly applied) to 1 (not applied). The Likert Scale points was supplemented by 'yes,' 'not sure,' and 'no,' assigned numeric values for quantitative analysis. This design enabled collection of data on the practical deployment and effectiveness of big data tools in diseases prevention efforts.

The questionnaire was administered online through Google Open Data Kit (ODK) forms, which facilitated easy distribution, access and completion by participants actively involved in the airport operations. This online delivery method improved data collection efficiency [31]. It allowed respondents to participate remotely and at their convenience, while also supporting rapid data aggregation for analysis. The data from responses were downloaded into CSV Excel format for initial frequency distribution visualizations analysis. Subsequently, the data were imported into the Statistical Package for Social Sciences (SPSS) to conduct descriptive statistical analyses. The means were ranked to identify the relative adoption levels of various big data tools and their drivers in airport.

3. Results

3.1. Demographic Characteristics

The demographic distribution of participants in Table 1 showed that 40.1 % participants were from airport A. Airport C had 31.7 % participants, while Airport B had 28.2 %. The distribution showed a balanced representation across the three selected airports. This balance could enhance the generalizability of the research findings across different airport. The educational attainment showed that 85.7 % of participants were graduates, 10.7 % had postgraduates' degrees, while only 3.6 % senior school certificates holders. The higher educational attainment among participants suggests that the study involved a well-educated population, which could

positively influence responses and research outcome. It implied the participants had adequate education to answer questions on application of big data and big data tools in infectious diseases prevention. The result of the experience level revealed a concentration in the early to mid-experienced ranges with 25 % of participants having less than 3 years of experience, 27.4% in the 3-5 years' experience range and 21.4 % in the 6-8 years bracket. The smaller percentages in the older brackets (over 9 years). The result indicates a workforce with relatively young. This experience could affect the perception of the participants as it reflects the views of relatively early to mid-career individuals.

SN	Airport	Frequency	Percentage	Cum. Percent
1	A	101	40.1	40.1
2	B	71	28.2	68.3
3	C	80	31.7	100.0
	Total	252	100.0	
	Educational Attainment			
1	Senior school certificates	9	3.6	3.6
2	Graduates	216	85.7	88.3
3	Postgraduates	27	10.7	100.00
	Total	252	100.0	
	Age Groups (in years)			
1	Less than 3	63	25.0	25.0
2	3-5	69	27.4	52.4
3	6-8	54	21.4	73.8
4	9-11	33	13.1	86.9
5	12-14	9	3.6	90.5
6	Over 15	24	9.5	100.0
	Total	252	100.0	

Table 1: Demographic Characteristics of the Research Participants

3.2. Big Data Tools and Technologies, Adoption Area, Drivers, Effectiveness and Challenges

Table 2 revealed big data tools and technologies most used at selected airports with mean scores ranging from 3.24 to 3.99. This higher mean score indicated adequate and acceptance of big data tools in the listed areas. The computer-based PCR machine had the highest mean of 3.99, which suggested it is the most widely used data collection tool among the airports. This higher mean score, coupled with a relatively low standard deviation (0.972), pointed toward consistent and prevalent use across the airports. In similar vein, hardware connectable sensors and internet-enabled devices followed with mean scores of 3.79 and 3.76 respectively. These tools demonstrated broad acceptance and integration in airport operations for infectious diseases detection. The higher acceptance

and integration of these tools was likely due to their connectivity and real-time data acquisition capabilities. The moderate standard deviations (around 1.0 to 1.16) suggests a fair level of variation in use. It possibly reflects differences in infrastructure across the airports. Other sensor technologies such as chemical/gas sensors, sensor-based heat detectors and computer-aided big data tools maintain scores between 3.56 and 3.63. Although slightly lower than the top three, these means still indicated good application levels. The lowest mean scores appear for sensor-based smart glasses and headgear technologies (around 3.24–3.25), but these remain above the adequacy threshold of 3.0. This result showed the listed big data tools had acceptable integration across the studied airports.

SN	Data Collection Tools Use	EA	HA	MA	HD	ED	N	FX	Mean	SD	D
		5	4	3	2	1					
1	Computer-based PCR machine	93	84	57	15	3	252	1005	3.99	0.972	A
2	Hardware connectable sensor	72	84	66	30		252	954	3.79	0.991	A
3	Internet-enabled devices	90	60	63	30	9	252	948	3.76	1.163	A
4	Chemical/gas sensor	66	81	57	42	6	252	915	3.63	1.113	A
5	Sensor-based heat detector	63	81	66	30	12	252	909	3.61	1.126	A
6	computer-aided big data tools	60	69	78	42	3	252	897	3.56	1.064	A
7	Sensor-based pressure detector	63	78	54	42	15	252	888	3.52	1.202	A
8	Sensor-based noise detector	57	90	42	54	9	252	888	3.52	1.162	A
9	Voice activation sensor	48	78	81	42	3	252	882	3.5	1.02	A
10	Sensor embedded reflective clothing and jackets	63	69	63	45	12	252	882	3.5	1.183	A
11	Radiation detection sensor	54	75	78	30	15	252	879	3.49	1.131	A
12	WIFI connected big data tools	54	66	84	45	3	252	879	3.49	1.054	A
13	Sensor-based dust detector	63	72	48	60	9	252	876	3.48	1.202	A
14	Sensor-based vibration detector	48	93	48	57	6	252	876	3.48	1.109	A
15	Other not mentioned, please specify	45	60	93	39	15	252	837	3.32	1.117	A
16	Sensor-based smart watches	45	57	84	48	18	252	819	3.25	1.166	A
17	Sensor-based head and hard gears	45	54	84	57	12	252	819	3.25	1.135	A
18	Sensor-based smart glasses	36	75	72	51	18	252	816	3.24	1.143	A

Note: Means score below 3-points were considers poor level of big data and big data tools application at the airports, while mean above 3-points were consider adequate and acceptable.

Table 2: Types of Sensor-based Big Data Tools/Technologies Used at the Airports in Nigeria

Table 3 showed the adoption and use of big data in diseases prevention at airports. The result revealed that 59.5 % of the participants reported that the airport has adopted big data, while 27.4 % have not adopted it and 13.1 % are unsure. Regarding the extent of adoption, 7.1 % of the respondents rated very low, 20.2 % as low, 35.7 % moderate, 26.2 % high and 10.7 % very high. This indicated that high-level of adoption rate, with over half

of the respondents reporting that airports actively used big data tools for diseases detection. Additionally, the majority perceive adoption to be at a moderate to high level, which suggested that airport authority recognize the importance of leveraging big data in disease control at airports. It highlighted a trend towards using data-driven strategies to mitigate the health risks of infectious diseases.

Adoption of Big Data		Frequency	Percent	Cum. Percent
Have you adopted/use any of the types of big data mentioned in above	No, not adopted	69	27.40	27.40
	Cannot say	33	13.10	40.50
	Yes, adopted	150	59.50	100.00
	Total	252	100.00	
Rate the degree of adoption/use of bid data	Very low extent	18	7.10	7.10
	Low extent	51	20.20	27.40
	Moderate extent	90	35.70	63.10
	High extent	66	26.20	89.30
	Very high extent	27	10.70	100.00
	Total	252	100.00	

Table 3: Adoption and Use of Big Data in the Prevention of Diseases' Spread at the Airport

Table 4 presented the result of adoption and use of big data technologies in different areas related to risk of diseases outbreak mitigation within airport operations in Nigeria. The mean adoption report ranges from 3.64 to 4.43 with most adoption areas falling between 4.0 and 4.5-points. This suggests a generally positive attitude and acceptance of these technologies in enhancing airport operations to mitigation infectious diseases and safety measures. The result revealed that travel surveillance leads with the highest mean of 4.43, which indicates this area of application benefits most from big data tools. This high mean and relatively low standard deviation (0.713) suggested consistent use and its role in monitoring passenger flow to ensure security and health safety. Hazard-related applications, including hazard reduction, incident prevention, and employee/traveler's protection, each have a mean of 4.24. These

areas are evidently priorities for airport management, using big data to proactively mitigate risks and enhance safety. The consistency in means and standard deviations near 0.8 to 0.9 reflects strong but somewhat variable engagement across airports, likely influenced by operational complexity and resource availability. Other crucial uses such as hazard communication, awareness/detection, incident monitoring, investigation and hazard mapping also received acceptance rates between 4.02 and 4.18. Even the lowest mean score, 3.64 for "Other concerns," remains well above the adequacy cutoff. This confirms a broad and positively perceived integration of big data technologies across multiple safety, surveillance and operational domains at airports. It showed the importance in enhancing infectious diseases risk management for passenger protection at the airports.

SN	Area of big data technologies adoption and use	EA	HA	MA	HD	ED	N	FX	Mean	SD	Decision
		5	4	3	2	1					
1	Travel surveillance	141	78	33	-	-	252	1116	4.43	0.713	Accepted
2	Hazards identification	117	84	45	6		252	1068	4.24	0.827	Accepted
3	Incident prevention	120	87	33	9	3	252	1068	4.24	0.896	Accepted
4	Employee/travelers protection	123	78	42	6	3	252	1068	4.24	0.896	Accepted
5	Hazard communication	99	111	30	12	-	252	1053	4.18	0.82	Accepted
6	Hazard awareness/detection	108	84	51	6	3	252	1044	4.14	0.903	Accepted
7	Incident monitoring	108	75	45	21	3	252	1020	4.05	1.024	Accepted
8	Incident investigation/analysis	102	84	48	12	6	252	1020	4.05	1.001	Accepted
9	Hazard mapping	96	90	45	18	3	252	1014	4.02	0.978	Accepted
10	Hazards reporting	99	72	63	15	3	252	1005	3.99	0.996	Accepted
11	Incident communication	87	87	51	18	9	252	981	3.89	1.071	Accepted
12	Other concerns, please specify	69	81	66	15	21	252	918	3.64	1.184	Accepted

Note: Means score below 3-points were considers poor level of big data and big data tools application at the airports, while mean above 3-points were consider adequate and acceptable.

Table 4: Area of Adoption and Use of Big Data Technologies Airports

Table 5 showed the drivers influencing the adoption and utilization of big data tools and related technologies within airport operations. The result revealed that global pandemics and worker health and well-being emerge as the top drivers of big data adoption and use in the airport with mean score 4.64-points and 4.49-points. This result indicates that respondents strongly supporting initiatives that leverage Big Data to enhance infectious diseases prevention and employee welfare. The results highlighted industry's commitment to ensuring travelers' health and well-being of its workforce as top drivers of big data and big data tools adoption at the airports.

Additionally, enhanced safety and risk mitigation stand out prominently as another key driver with an overwhelmingly high

level of agreement among respondents as indicated by mean score of 4.46-points. In a sector where safety is paramount, the ability to harness big data for risk assessment and mitigation is important for maintaining operational integrity. Similarly, regulatory compliance to safety standards scored 4.04-points. This score showed that it is a significant driver of big data adoption and utilization. The aviation industry operates within a highly regulated framework, which necessitates the need for adherence to stringent safety protocols and standards. The data-driven insights also emerge as a primary driver with a significant majority of respondents expressing agreement towards leveraging big data for informed decision-making as indicated by the mean score of 3.83. The emphasis on data-driven insights aligns with the broader trend across industries

where data analytics play a pivotal role in strategy formulation.

Efficiency/productivity, need for swift emergency response and technological advancements are additional drivers that enjoy substantial agreement among respondents. These drivers collectively reflect the industry's recognition of the transformative potential of big data in optimizing operations, enhancing responsiveness and staying abreast of technological innovations.

Moreover, risk reduction for employees, competitive advantage, changing work environments and public perception further showed the multifaceted impact of big data adoption within airport operations. The results suggest a widespread acknowledgment within the aviation industry of the value big data tools offers and its potential to drive operational safety, diseases prevention and enhance stakeholder satisfaction.

SN	Drivers of Adoption of Big Data in Airports	EA	HA	MA	HD	ED	N	FX	Mean	SD	D
		5	4	3	2	1					
1	Global pandemics	186	42	24	-	-	252	1170	4.64	0.649	A
2	Worker health and well-being	156	69	21	6	-	252	1131	4.49	0.749	A
3	Enhanced safety and risk mitigation	147	78	24	3	-	252	1125	4.46	0.716	A
4	Productivity and efficiency	135	90	24	3	-	252	1113	4.42	0.712	A
5	Reduction of risk to employers	141	81	27		3	252	1113	4.42	0.776	A
6	Need for quick response to emergency	141	75	33	3	-	252	1110	4.4	0.759	A
7	Advancements in technological	123	84	42	3	-	252	1083	4.3	0.785	A
8	Competitive advantage	96	105	39	9	3	252	1038	4.12	0.88	A
9	Regulatory compliance to safety standards	75	114	60	3	-	252	1017	4.04	0.764	A
10	Changing work environments	72	102	66	9	3	252	987	3.92	0.891	A
11	Perception of the public	89	91	34	27	11	252	976	3.87	0.899	A
12	Data-driven insights	79	93	46	31	3	252	970	3.83	0.951	A

Note: Means score below 3-points were considers poor level of big data and big data tools application at the airports, while mean above 3-points were consider adequate and acceptable.

Table 5: Drivers of Adoption and Use of Big Data/Big Data Tools and Technologies

Table 6 illustrates the level of protection offered by big data and big data tools. The majority (71.4 %) either agreed or highly agreed that big data provides superior protection compared to traditional methods. This result showed a positive outlook on big data efficacy in infectious diseases prevention at the airports. However, a significant proportion (26.2 %) remained neutral implying some uncertainty or lack of clarity in understanding the extent of big data's benefits. When asked to estimated percentage protection provided by big data over traditional methods, more than half (56.0 %) estimated an improvement of 50 % or more, which indicated

substantial confidence in the capabilities of big data. These results reflect optimistic stance toward big data's protective capabilities, with a notable subset expressing uncertainty. Further results highlighted diversity in perspectives among the sampled group, with some respondents attributing significant advancements to big data while others remain more cautious in their estimations. The results suggest a growing recognition of big data's potential to enhance preventive measures. Further research may be necessary to address concerns and uncertainties around the effectiveness of big data tools in infectious diseases prevention and control.

Protection provided by Big Data		Frequency	Percent	Cum. Percent
Big data provides better protection compared to traditional method	Disagree	6	2.4	2.4
	Neutral	66	26.2	28.6
	Agree	99	39.3	67.9
	Highly agree	81	32.1	100.0
	Total	252	100.0	
If you answered 2 to question 20 above, by how many percentages in your estimation?	50 % and above	141	56.0	56.0

	Between 0-9.9 %	6	2.4	58.3
	Between 10-19.9 %	24	9.5	67.9
	Between 20-29.9 %	24	9.5	77.4
	Between 30-39.9 %	39	15.5	92.9
	Between 40-49.9 %	18	7.1	100.0
	Total	252	100.0	

Table 6: Comparison of the Level of Protection Provided by Big Data

The results in Table 7 shows concerns on adoption and use of big data and big data tools in the airport. Result revealed 73.8 % of participants expressed concern, 19.0 % reported no concern, while 7.1 % were either concerned or unconcerned. This indicates a significant level of apprehension among respondents about the implications of big data usage in the airport. Regarding safety concerns in airport operations, 73.8 % reported very high-level of concern, 19.0 % reported a high level and 7.1 % reported moderate extent of concern. This suggests that safety is a paramount issue for the majority of respondents, with a substantial portion expressing a very high level of concern. When asked to rate the

level of safety and mitigation derived from the use of big data, 34.5 % rated very high, 52.4 % rated high, 11.9 % rated moderate and only 1.2 % rated it as very low. This result suggests maximal confidence in the level mitigation and safety big data provided. It showed that a significant portion of respondents believe in the potential of big data to enhance risk mitigation and safety. Despite some skepticism, a considerable portion of respondents opined that big data could provide high levels of safety and believed in the potential benefits of big data in enhancing diseases prevention at the airports.

Concern on use of big data and extent of protection		Frequency	Percent	Cumulative Percent
Are you concern about the adoption/use of big data (in your organization)?	No, not concerned	48	19.00	19.00
	Not sure, I am concerned	18	7.10	26.20
	Yes, I am concerned	186	73.80	100.00
	Total	252	100.00	
To what extent is safety a concern in airport operations?	Moderate extent	18	7.10	7.10
	High extent	48	19.00	26.20
	Very high extent	186	73.80	100.00
	Total	252	100.00	
How would you rate the level of safety and mitigation derived from use of big data?	Very low	3	1.20	1.20
	Moderate	30	11.90	13.10
	High	132	52.40	65.50
	Very high	87	34.50	100.00
	Total	252	100.00	

Table 7: Concern on Use of Big Data and Extent of Protection

Table 8 shows concerns big data adoption in airports. The result revealed that limited awareness level receiving the highest mean of 3.74, closely followed by security and privacy (3.73) and data ethics (3.71). These were the most significant concerns among the participants. Other concerns were data protection (3.68) and

exposure to productivity pressure (3.67). Participants were equally concern on potentially employee surveillance (3.52), limited evidence of safety (3.43) and other concerns (3.33). The mean scores indicate that respondents were concerned on the current state of big data adoption and its application in airport.

SN	Concerns on Big Data Adoption/ Application in the Airport	EA	HA	MA	HD	ED	N	FX	Mean	SD	Decision
		5	4	3	2	1					
1	Limited awareness level	72	81	75	9	15	252	942	3.74	1.095	Accepted
2	Security and privacy	75	75	69	24	9	252	939	3.73	1.097	Accepted
3	Data ethics	66	87	69	21	9	252	936	3.71	1.055	Accepted

4	Data protection	60	96	63	21	12	252	927	3.68	1.073	Accepted
5	Exposure to productivity pressure	63	84	72	24	9	252	924	3.67	1.064	Accepted
6	Potentially hidden employee surveillance	45	96	65	30	12	248	876	3.52	1.065	Accepted
7	Limited evidence of safety	57	51	105	21	18	252	864	3.43	1.139	Accepted
8	Other concerns	54	48	99	30	21	252	840	3.33	1.181	Accepted

Note: Means score below 3-points were considers poor level of big data and big data tools application at the airports, while mean above 3-points were consider adequate and acceptable.

Table 8: Concerns on Big Data Adoption/Application in Airports

The result in Table 9 shows the challenges relate to big data adoption and use in disease prevention in the airports. Cost of obtaining big data tools ranked top with mean of 4.30, which revealed strong agreement on its impact on adoption and use. Other significant challenges such as the limited supply of big data tools (mean 4.01), lack of technical know-how (3.92) and maintenance and repairs (3.90) showed high recognition with emphasis on resource availability and technical capacity as major barriers to effective big data use. Other challenges include lack of regulatory standards (3.76), integration with existing systems (3.7) and resistance to

change (3.69). This indicates there are organizational and systemic factors that influence the adoption and use of big data at the airport. Challenges with lower but still significant level of impact were privacy concerns (3.48) and cyber security threats (3.31). This highlights security and data protection as ongoing challenges in the adoption and use of big data and big data tools in the airport. The mean scores suggest that while various technical, financial and organizational hurdles exist, stakeholders generally acknowledge these challenges as valid and important for improving big data implementation in airport disease prevention efforts.

SN	Challenges of Big Data Adoption/Use in Airports	EA	HA	MA	HS	ED	N	FX	Mean	SD	Decision
		5	4	3	2	1					
1	High cost of big data tools	120	87	45	-	-	252	1083	4.3	0.754	Accept
2	Limited supply of big data tools	87	93	66	-	6	252	1011	4.01	0.908	Accept
3	Lack of technical know on how to use	66	117	54	12	3	252	987	3.92	0.877	Accept
4	Maintenance and repairs	75	99	57	21	-	252	984	3.9	0.923	Accept
5	Lack of regulatory standards	57	120	39	30	6	252	948	3.76	1.009	Accept
6	Integration with existing systems	51	114	60	15	12	252	933	3.7	1.011	Accept
7	Resistance to change	48	114	63	18	9	252	930	3.69	0.976	Accept
8	Limited customization	39	111	72	30	-	252	915	3.63	0.885	Accept
9	Environmental factors	60	90	57	39	6	252	915	3.63	1.08	Accept
10	Interoperability	39	102	81	24	6	252	900	3.57	0.944	Accept
11	Reliability	45	84	90	24	9	252	888	3.52	1.008	Accept
12	Data management	45	105	54	33	15	252	888	3.52	1.109	Accept
13	Privacy concerns	51	81	69	39	12	252	876	3.48	1.12	Accept
14	Cyber security threats	45	81	60	39	27	252	834	3.31	1.237	Accept

Note: Means score below 3-points were considers poor level of big data and big data tools application at the airports, while mean above 3-points were consider adequate and acceptable.

Table 9: Challenges of Big Data Adoption and Use in Airports for Diseases Preventions

4. Discussion of the Findings

The study's participant demographic revealed a well-distributed representation from three Nigerian airports, with a majority being graduates and early to mid-career professionals. This implies a relatively informed and adaptive workforce, which is critical

for the acceptance and effective implementation of big data technologies in infectious disease prevention. A study by Achieng and Ogundaini supports the notion that educated health workers enhance digital health adoption and implementation in sub-Saharan Africa [33]. While Achieng and Ogundaini collaborate the findings

of this study on the role of educated workforce in digital adoption, Herron and Wolfe maintained that the younger or less experienced workforce observed in this study might lack the practical skills to leverage fully new technologies [34]. This lack of practical skills the duo believed could hinder the effectiveness of adopted technologies. The position of Herron and Wolfe agreed with the broader finding of this study on the challenges of big data adoption and utilization in infectious diseases prevention at the airport level in Nigeria. Additionally, the dominant use of computer-based PCR machines and sensor technologies shows robust integration of real-time, sensor-based data collection vital for early infectious disease detection at airports [34]. This aligns with global findings of Owuor, Sahraoui et al. and Xie et al. where sensor and PCR tech form the backbone of airport disease surveillance [35-37]. Xie et al. had maintained that emerging molecular diagnostic strategies are transitioning from traditional amplification methods like PCR to amplification-free biosensing approaches, which hold promise for rapid, safe and economically accessible respiratory disease diagnosis [37]. Xie et al. posited that the approach is suited for decentralized and home-based testing, believing that the technologies could be optimized through integration with AI for enhanced infectious disease prevention and control [37]. Contrary to this position, Azzolini et al. argued that over-reliance on technology can result in blind spots if human factors and data interpretation skills are weak [38]. The finding was supported by recent reviews on amplification-free biosensors and AI integration in molecular diagnostics for respiratory diseases, which emphasize the potential for faster, safer and more accessible testing during outbreaks.

Moving further, over half of respondents confirmed adoption of big data tools for the prevention of infectious diseases at airports at moderate to high-level. The finding indicates a rising reliance on data-driven approaches for infectious disease control. This is consistent with global trends of increasing big data integration in public health surveillance [39,40]. However, research from some African contexts, for instance, Aborode et al. highlighted persistent gaps and uneven adoption rates due to infrastructure and policy constraints [41]. The strong adoption of big data in travel surveillance and hazard functions underscores its critical role in operational safety and infectious disease risk mitigation. Gilbert et al. reported that predictive and real-time monitoring of infectious diseases was well-documented in outbreaks prevention linked to travel hubs [42]. Yet, others like Matini et al., and Owolabi and Owolabi cautioned that without integrated data systems, these benefits of predictive and real-time monitoring of infectious diseases might not translate into effective on-the-ground interventions [43,44]. While this position may be true, predictive and real-time monitoring of infectious diseases with big data tools and technologies holds enormous benefits in future infectious diseases control and epidemiological responses. The study identified pandemics, worker well-being and safety as primary drivers of big data uptake. The finding reinforced the need for health and operational safety as well as how infectious diseases prevention and control are becoming public health priorities. This driver profile matches findings from Jee on International Health

Regulations and Fonka et al., on drivers of pandemic response frameworks [45,46]. Contrarily, some critiques like Beacher et al. and Kalaiarasan suggested that economic and political factors often overshadow health-centric motivations in technology adoption decisions [47,48]. While the argument of the critiques is true, considering the case of Anthony Fauci and Donald Trump during the COVID-19 outbreaks, fact remained that pandemics, worker well-being and safety will continue to be the primary drivers of big data technology adoptions [49,50]. Additionally, the fact that most participants believed big data offers superior protection over traditional methods do not only reflect optimism in its enhanced surveillance capacity, but also its potential position in future health emergencies. Idahor et al. echoed similar optimism in the use of big data and AI in the COVID-19 pandemic for outbreak prediction and resource allocation [51]. Nonetheless, Summers et al. pointed out skepticism in the use of big data over data accuracy and privacy issues limiting full confidence (ECDC report on digital surveillance) [52]. While concerns about safety and big data use are high, the majority of the respondents acknowledge its contribution to risk mitigation. This dual perspective aligns with findings from Ghana and Tanzania where Mendonça and Mafra reported improved safety outcomes in infectious diseases control with big data, and the fueled ethical debates around surveillance and consent [53]. Aborode et al. shared opposing views stressing that unregulated big data use risks exacerbating inequalities and infringing rights, which may compromise overall benefit [41].

Ethical and privacy concerns, including limited awareness and employee surveillance, were prominent among the challenges of big data adoption and use. It highlights the need for careful handling and managing sensitive data responsibly. Studies by Achieng et al. confirm these are major barriers in SSA health systems, which necessitate transparent data policies, stakeholder education and cautious adherence to Helsinki declaration [33]. Contrastingly, Sun et al. and Egwuonwu et al. argued that these concerns are overstated citing technological safeguards as sufficient measures to address privacy if properly implemented. Consequently, challenges around cost, supply limitations, technical skills gaps and regulatory obstacles alongside cybersecurity threats can be bridged using appropriate measures [54,55]. These issues are consistent with findings across African airports and health systems, where resource constraints and weak governance impede full potential big data [41]. However, researches by Kazançoğlu et al. and Jha and Singh indicates that targeted investments and capacity-building programmes can rapidly overcome most of the barriers identified in this study and enable successful big data applications for infectious diseases prevention at airports level [56,57]. While these findings illustrate a complex but changing landscape in big data adoption in Nigerian airports for infectious disease prevention, it is characterizing by strong drivers and benefits tempered by significant technical, ethical and organizational challenges. The balance of studies affirms the transformative potential of big data while cautioning against unethical adoption without addressing contextual constraints and concerns.

5. Conclusion

Big data adoption for infectious disease prevention in Nigerian airports is decisively advancing with robust sensor-based PCR and emerging bio-sensing technologies. These tools enable rapid, real-time disease detection essential for effective outbreak control. While adoption is notably strong in travel surveillance and infectious hazard management, there is persistent significant challenges in data integration, practical skills gaps and ethical concerns such as privacy and employee surveillance. The primary motivations sustaining this progressive adoption are pandemics, worker well-being, and operational safety, which indicate the public health imperative driving these technological implementations. Despite optimism about big data's capabilities to provide superior protections, skepticism around data privacy, accuracy and regulatory frameworks remains strong with potential to hinder adoption and use. Overcoming cost, technical capacity and governance related barriers through targeted investments and capacity-building initiatives could increase adoption and use. While this study confirms that big data technologies hold transformative potential for infectious disease control in airports, the full benefits can only be realized through ethically grounded strategies that address technical, organizational and social challenges.

Declarations

Ethical Approval

Ethical approval was received from Review Committee on Research Ethics of the Center for Disaster Risks Management and Development Studies of the Federal University of Technology, Minna, Niger State, Nigeria.

Inform Consent

Informed consent complied with Helsinki Declaration of June 1964 as reviewed in 2024. All participants voluntarily chose participates having understood fully the language, objectives, methods, potential benefits and risks of the study.

Data Availability Statement

The datasets generated and analyzed during the current study are not publicly available in compliance to Part VII of Data Security (Sections 39 to 40) of the Nigeria Data Protection Act (NDPA) 2023, which require data handlers to secure personal data, maintaining confidentiality and integrity, but are available from the corresponding author on reasonable request.

References

1. Findlater, A., & Bogoch, I. I. (2018). Human mobility and the global spread of infectious diseases: a focus on air travel. *Trends in parasitology*, 34(9), 772-783.
2. World Health Organization. (2015). *Investing to overcome the global impact of neglected tropical diseases: third WHO report on neglected tropical diseases 2015* (Vol. 3). World Health Organization.
3. Spiridonov, V., Ćurić, M., & Novkovski, N. (2025). Exploring Natural Hazards: From Earthquakes, Floods, and Beyond. In *Atmospheric Perspectives: Unveiling Earth's Environmental Challenges* (pp. 271-306). Cham: Springer

- Nature Switzerland.
4. Diaconu, D. C., & Grecu, A. (2023). Conflicts and natural disasters, sources of migration in the twenty-first century. In *Environmental Consequences of International Conflicts: The MENA Region* (pp. 83-108). Cham: Springer Nature Switzerland.
5. Alexander, D. (2018). *Natural disasters*. Routledge.
6. Kulczyński, M., Tomaszewski, M., Łuniewski, M., & Olender, A. (2017). Air transport and the spread of infectious diseases. *World Scientific News*, (76), 123-135.
7. Crouse, J., & Klyonov, M. (2021). The Global Spread of Mass Infectious Diseases and its Major Consequences. In *Транспортная безопасность и противодействие терроризму на транспорте: правовые и организационные аспекты* (pp. 38-46).
8. Tuite, A. R., Bhatia, D., Moineddin, R., Bogoch, I. I., Watts, A. G., & Khan, K. (2020). Global trends in air travel: implications for connectivity and resilience to infectious disease threats. *Journal of travel medicine*, 27(4), taaa070.
9. Hoffman, S. J., & Silverberg, S. L. (2018). Delays in global disease outbreak responses: lessons from H1N1, Ebola, and Zika. *American journal of public health*, 108(3), 329-333.
10. Grubaugh, N. D., Saraf, S., Gangavarapu, K., Watts, A., Tan, A. L., Oidtman, R. J., ... & Andersen, K. G. (2019). Travel surveillance and genomics uncover a hidden Zika outbreak during the waning epidemic. *Cell*, 178(5), 1057-1071.
11. Coltart, C. E., Lindsey, B., Ghinai, I., Johnson, A. M., & Heymann, D. L. (2017). The Ebola outbreak, 2013–2016: old lessons for new epidemics. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 372(1721), 20160297.
12. Pervou, I. (2024). Public Health Emergencies of International Concern (PHEICs) as Humanitarian Crises: Global Health Law and Public International Law (PIL) at the Crossroads. *The Humanitarian Crisis in the 21 st Century*, 1.
13. Smith, K. M., Machalaba, C. C., Seifman, R., Feferholtz, Y., & Karesh, W. B. (2019). Infectious disease and economics: The case for considering multi-sectoral impacts. *One health*, 7, 100080.
14. AlRuthia, Y., Somily, A. M., Alkhamali, A. S., Bahari, O. H., AlJuhani, R. J., Alsenaidy, M., & Balkhi, B. (2019). Estimation of direct medical costs of Middle East respiratory syndrome coronavirus infection: a single-center retrospective chart review study. *Infection and drug resistance*, 3463-3473.
15. World Health Organization, 2. (2019). *Infection prevention and control during health care for probable or confirmed cases of Middle East respiratory syndrome coronavirus (MERS-CoV) infection: interim guidance: updated October 2019* (No. WHO/MERS/IPC/15.1 Rev. 1). World Health Organization.
16. Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Beagley, J., Belesova, K., ... & Costello, A. (2021). The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises. *The lancet*, 397(10269), 129-170.
17. Kaye, A. D., Okeagu, C. N., Pham, A. D., Silva, R. A., Hurley, J. J., Arron, B. L., ... & Cornett, E. M. (2021). Economic impact of COVID-19 pandemic on healthcare facilities and

- systems: International perspectives. *Best Practice & Research Clinical Anaesthesiology*, 35(3), 293-306.
18. World Bank Group. (2022). *Global economic prospects, January 2022*. World Bank Publications.
 19. Mohiuddin, A. K. (2023). Escalation of war and conflicts among the COVID-19 pandemic, natural disasters, and economic crises: A global health concern. *American Journal of Biopharmacy and Pharmaceutical Sciences*, 3.
 20. Folasole, A. (2023). Data analytics and predictive modelling approaches for identifying emerging zoonotic infectious diseases: surveillance techniques, prediction accuracy, and public health implications. *Int J Eng Technol Res Manag*, 7(12), 292.
 21. Khoury, M. J., Armstrong, G. L., Bunnell, R. E., Cyril, J., & Iademarco, M. F. (2020). The intersection of genomics and big data with public health: opportunities for precision public health. *PLoS medicine*, 17(10), e1003373.
 22. Roberts, M. C., Holt, K. E., Del Fiol, G., Baccarelli, A. A., & Allen, C. G. (2024). Precision public health in the era of genomics and big data. *Nature medicine*, 30(7), 1865-1873.
 23. Kasson, P. M. (2020). Infectious disease research in the era of big data. *Annual Review of Biomedical Data Science*, 3(1), 43-59.
 24. Wu, J., Wang, J., Nicholas, S., Maitland, E., & Fan, Q. (2020). Application of big data technology for COVID-19 prevention and control in China: lessons and recommendations. *Journal of medical Internet research*, 22(10), e21980.
 25. Badawy, M., Ramadan, N., & Hefny, H. A. (2024). Big data analytics in healthcare: data sources, tools, challenges, and opportunities. *Journal of Electrical Systems and Information Technology*, 11(1), 63.
 26. Iacobucci, G. (2020). Covid-19: UK lockdown is “crucial” to saving lives, say doctors and scientists.
 27. Brogeland, E., & Währén, M. (2024). Building a Data-Driven Culture A Case Study in the Airport Industry.
 28. AJODO, E., Kuti, I. A., Ajobo, S., & Ndagi, U. (2025). Qualitative Assessment of the Use of Big Data and Big Data Tools in the Prevention of Epidemiological Diseases’ Spread Through Airports.
 29. Vizitiu, V., Henning, R., & Dragomir, M. (2024, March). Managing pandemics in airport security environments: A comparative analysis of classic airport security and smart security approaches. In *International Scientific-Technical Conference MANUFACTURING* (pp. 312-324). Cham: Springer Nature Switzerland.
 30. Batista, S. B. (2024). *Digital Transformation Within Airports Security Processes: New Security Technology Implementation Impact* (Master's thesis, Universidade NOVA de Lisboa (Portugal)).
 31. Regmi, P. R., Waithaka, E., Paudyal, A., Simkhada, P., & Van Teijlingen, E. (2016). Guide to the design and application of online questionnaire surveys. *Nepal journal of epidemiology*, 6(4), 640.
 32. Van Iddekinge, C. H., Roth, P. L., Raymark, P. H., & Odle-Dusseau, H. N. (2012). The critical role of the research question, inclusion criteria, and transparency in meta-analyses of integrity test research: A reply to Harris et al.(2012) and Ones, Viswesvaran, and Schmidt (2012).
 33. Achieng, M. S., & Ogundaini, O. O. (2024). Big data analytics for integrated infectious disease surveillance in Sub-Saharan Africa. *South African Journal of Information Management*, 26(1), 1668.
 34. Herron, J., & Wolfe, K. A. (2021). University innovation hubs & technology-enhanced learning in K12 environments. *TechTrends*, 65(3), 320-330.
 35. Owuor, D. O. (2015). *A smart phone based expert system for airport screening of infectious diseases: test case with the Ebola virus symptoms* (Doctoral dissertation, Strathmore University).
 36. Sahraoui, Y., Korichi, A., Kerrache, C. A., Bilal, M., & Amadeo, M. (2022). Remote sensing to control respiratory viral diseases outbreaks using Internet of Vehicles. *Transactions on Emerging Telecommunications Technologies*, 33(10), e4118.
 37. Xie, Y., Zong, Z., Jiang, Q., Ke, X., & Wu, Z. (2025). Seeking Solutions for Inclusively Economic, Rapid, and Safe Molecular Detection of Respiratory Infectious Diseases: Comprehensive Review from Polymerase Chain Reaction Techniques to Amplification-Free Biosensing. *Micromachines*, 16(4), 472.
 38. Azzolini, C., Boscher, C., Capone Jr, A., Donati, S., Falco, A., Oggionni, F., ... & Paolucci, U. (2025). Inclusive and accessible implementation of telemedicine: Insights from the United Nations international expert roundtable. *Health Informatics Journal*, 31(3), 14604582251381675.
 39. Rehman, A., Naz, S., & Razzak, I. (2022). Leveraging big data analytics in healthcare enhancement: trends, challenges and opportunities. *Multimedia Systems*, 28(4), 1339-1371.
 40. Dion, M., AbdelMalik, P., & Mawudeku, A. (2015). Big data and the global public health intelligence network (GPHIN). *Canada communicable disease report*, 41(9), 209.
 41. Aborode, A. T., Adesola, R. O., Idris, I., Sakariyau Adio, W., Olapade, S., Oluwafisayo, G., ... & Jinadu, N. A. (2025). Challenges associated with PFAS detection method in Africa. *Environmental Health Insights*, 19, 11786302241310430.
 42. Gilbert, G. L., Degeling, C., & Johnson, J. (2019). Communicable disease surveillance ethics in the age of big data and new technology. *Asian Bioethics Review*, 11(2), 173-187.
 43. Matini, D. J. (2024). *Utilization of Health Management Information Systems at Vihiga County Referral Hospital* (Doctoral dissertation, Strathmore University).
 44. Owolabi, B. O., & Owolabi, F. A. (2025). Predictive AI-driven epidemiology for tuberculosis outbreak prevention in achieving zero TB city vision. *Int J Adv Res Publ Rev*, 2(5), 318-40.
 45. Jee, Y. (2020). WHO international health regulations emergency committee for the COVID-19 outbreak. *Epidemiology and health*, 42, e2020013.
 46. Fonka, C. B., Petersen, Z., & Christofides, N. (2025). Drivers of COVID-19 infections: Perspectives of managers in the Gauteng Department of Health, South Africa. *South African Family Practice*, 67(1), 6107.

-
47. Beacher, M., Arasu, T., Rodgers, M., Coit, D., & Senick, J. (2024). Assessing the Public Health Impacts: A Comprehensive Analysis of Health Externalities Related to Power Grid Expansion Plans. In *IISE Annual Conference Proceedings* (pp. 1-6). Institute of Industrial and Systems Engineers (IISE).
 48. Kalaiarasan, A. (2024, January). Health-Conscious Cities: Embracing Comprehensive Sustainable Approaches for Urban Well-Being. In *International Conference on Asian Urbanization Forging a Livable and Sustainable Urban Future* (pp. 337-347). Singapore: Springer Nature Singapore.
 49. Duke, S. (2020). The MANY MASKS OF ANTHONY FAUCI: America's COVID-19 guru Anthony Fauci contradicts himself so often that we literally can't believe anything he says. *The New American*, 36(20), 26-31.
 50. Rutledge, P. E. (2020). Trump, COVID-19, and the War on Expertise. *The American Review of Public Administration*, 50(6-7), 505-511.
 51. Idahor, C. O., Esomu, E. J. O., Ogbonna, N., Momoh, Z., Ogbeide, O. A., Ikhu-Omoregbe, O., ... & Oronsaye, N. J. (2025). Infectious Disease Surveillance in the Era of Big Data and AI: Opportunities and Pitfalls. *Cureus*, 17(10).
 52. Summers, C., Griffiths, F., Cave, J., & Panesar, A. (2022). Understanding the security and privacy concerns about the use of identifiable health data in the context of the COVID-19 pandemic: survey study of public attitudes toward COVID-19 and data-sharing. *JMIR Formative Research*, 6(7), e29337.
 53. Mendonça, A. D. O., & Mafra, C. (2025). The Landscape of High-Containment Biological Laboratories in Brazil: Current Status and Perspectives. *Applied Biosafety*, 30(1), 55-64.
 54. Sun, S., Cegielski, C. G., Jia, L., & Hall, D. J. (2018). Understanding the factors affecting the organizational adoption of big data. *Journal of computer information systems*, 58(3), 193-203.
 55. Egwuonwu, A., Mendy, J., Smart-Oruh, E., & Egwuonwu, A. (2023). Drivers of Big Data analytics' adoption and implications of management decision-making on Big Data adoption and firms' financial and nonfinancial performance: Evidence from Nigeria's manufacturing and service industries. *IEEE Transactions on Engineering Management*, 71, 11907-11922.
 56. Kazançoğlu, Y., Saġnak, M., Lafcı, Ç., Luthra, S., Kumar, A., & Taçoġlu, C. (2021). Big data-enabled solutions framework to overcoming the barriers to circular economy initiatives in healthcare sector. *International Journal of Environmental Research and Public Health*, 18(14), 7513.
 57. Jha, A., & Singh, S. R. (2025). Bridging the divide: capacity building for AI adoption in developing countries. In *AI strategies for social entrepreneurship and sustainable economic development* (pp. 133-150). IGI Global Scientific Publishing.

Copyright: ©2025 Ajodo, EU, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.