

# Revolutionizing the Healthcare Industry in Nigeria: The Role of Internet of Things and Big Data Analytics

Oluigbo Ikenna V.<sup>\*1</sup>, Nwokonkwo Obi C.<sup>2</sup>, Ezech Gloria N.<sup>3</sup>, Ndukwe Ngoziobasi G.<sup>4</sup>

<sup>1\*</sup>Department of Information Management Technology, Federal University of Technology Owerri, Imo State, Nigeria

<sup>2</sup>Department of Information Management Technology, Federal University of Technology Owerri, Imo State, Nigeria

<sup>3</sup>Department of Information Management Technology, Federal University of Technology Owerri, Imo State, Nigeria

<sup>4</sup>Department of Information Management Technology, Federal University of Technology Owerri, Imo State, Nigeria

\*Corresponding Author's Email: [ikenna.oluigbo@futo.edu.ng](mailto:ikenna.oluigbo@futo.edu.ng), Tel: +2348052891410

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**Abstract:** The impact of Internet of Things (IoT) and big data cannot be overemphasized. The aim of this research is to propose a research model for predicting the role of data analytics and Internet of Things in revolutionizing the healthcare industry in Nigeria, and thereafter assess the impact of proposed IoT and big data analytics model to the healthcare sector of Nigerian economy. This study used a quantitative research approach and an analytical field survey, considering five federal medical centers across the country, as well as a number of IT experts and academician. In proposing a model for healthcare industry revolution through big data analytics and Internet of Things, six drivers was identified – Remote Sensing Technology, Cloud Computing, Big Data Center, Data Visualization, Standard User Interface and Display, and Wireless Network Gateways. The predicted model shows that all six drivers individually and collectively significantly influences healthcare industry revolution in Nigeria. In assessing the impact of the proposed model on the healthcare industry, the researcher identified five key operational and management areas. Based on the MANOVA result, the researcher concludes that the proposed model of IoT and big data analytics will have significant impact on healthcare industry in Nigeria if adopted. The researcher thus recommends that for a positive revolution of healthcare industry in Nigeria, the need for Internet of Things devices and technologies, as well as big data analytics is very paramount; Top management and relevant stakeholders should provide maximum support. The healthcare sector should also harness the various benefits of these recent technologies.

**Keywords:** Big Data Analytics, Collaborative Disease Management, Healthcare Industry Revolution, Internet of Things, Remote Health Monitoring

## I. INTRODUCTION

An excerpt from the work of [1] reads “If we had computers with knowledge about everything - using data they gathered without any help from us; we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. Computers need to be empowered with a means of gathering information, so they can see, hear and smell the world for themselves, in all its random glory”. This is the future we believe in - The Internet of Things!

In this current dispensation with evolving technology, changes are rapid and the modus operandi is constantly disrupted. Internet of Things (IoT) and big data analytics are such disruptive technologies; these technologies have the potential to change the way healthcare is delivered.

Internet of Things (IoT) basically networks physical devices containing embedded intelligent technology, which helps in communicating, sensing or interacting with their internal states or the external environment. The study of [2] describes IoT as the backbone core that allows people and things to be connected anytime with anyone and anything, ideally using any path/network and any service; irrespective of their geographical divide. An European Research posit that Internet of Things is a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual “things” have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network [3]. On the other hand, big data describes very large amount of information that can be analyzed and interpreted by data analytics to provide trends and patterns that constitutes

useful, actionable information. Businesses and organizations leverage big data analytics in a number of ways, such as to improve radically, the development of the next generation of products and services [4].

Internet of Things systems consists of a network of devices that connect directly with each other to capture and share vital information through a secure and dedicated network that connects to a central command and control server in the cloud [5]. Internet of Things and Big data analytics provides potential care, system, and societal gains in healthcare service delivery; resulting in significant interest in alternative and oriental medicine [6]. IoT and big data analytics can offer greater promises and potentials to the field of healthcare, to help improve access to care, reduce the cost of care, while increasing the quality of care. The impact of Internet of Things (IoT) and big data analytics cannot be overemphasized. In this ever growing and evolving technological world, IoT and Big data analytics play a vital role in extracting valid and useful information, and transmitting such information over interconnected devices. The impact of IoT and big data is also seen in the healthcare sector, alongside other sectors. The researcher examined the current state of the healthcare industry in Nigeria, and thereafter empirically analyzed the role of Internet of Things and big data in revolutionizing the ailing healthcare industry.

The aim of this research is to investigate the role of Internet of Things and big data analytics in revolutionizing the healthcare industry of Nigeria. In specifics, the paper intends to achieve the following objectives:

1. To discuss the concept of Internet of Things (IoT) and big data analytics; and identifying its drivers
2. To propose a model for healthcare industry revolution in Nigeria using the drivers of IoT and big data analytics
3. To assess the significant impact of the proposed model on the Nigerian healthcare subsector.
4. To make policy recommendations based on the subject matter.

## II. UNDERSTANDING INTERNET OF THINGS AND BIG DATA ANALYTICS

The Internet of Things (IoT) is generally entails connecting anything anywhere to the Internet (or a shared network) and using that connection to provide some kind of remote monitoring or control of those things. According to [7], IoT was described as a system in which objects in the physical world could be connected to the Internet by sensors. IoT illustrates the power of connecting Radio-Frequency Identification (RFID) tags used in corporate supply chains to the Internet in order to count and track goods without the need for human intervention. Today, the Internet of Things describes a scenario where a number of devices, objects and sensors leverages on internet connectivity and computing capabilities [8].

According to [1], Internet of Things comprises of three features known as the three C's.

**Communication:** IoT communicates information to people and systems from sensors that monitors an individual's vital signs. In previous times, access to this information is almost impossible or it was collected manually and infrequently [9]. GPS-enabled devices for example can communicate their current location and movement. In the healthcare industry, IoT can help a hospital track the location of everything and everyone from wheelchairs to beds to doctors. In the transportation industry, a business can deliver real-time tracking and condition of parcels and items.

**Control and Automation:** In a connected environment, a firm will have visibility into a device's condition. In this instance, the firm or consumer will also be able to remotely access and control a device. Meanwhile, IoT can be used in a number of interesting ways. IoT can also be used to remotely lock/unlock a car or start a pumping machine. Once a performance baseline has been established, a process can send alerts for anomalies and possibly deliver an automated response.

**Cost Savings:** Many companies adopt IoT to save money. Businesses, particularly industrial companies, lose money when operational equipment fails [10]. With new sensor information, IoT can help a company save money by minimizing equipment failure and allowing the business to perform planned maintenance. Sensors can also measure items, such as driving behavior and speed, to reduce fuel expense and wear and tear on consumables. New smart meters in homes and businesses can also provide data that helps people understand energy consumption and opportunities for cost savings [1].

With an array of vast computing, advanced database systems, wireless sensors, mobility and social networking, it is now possible to bring together and process big data using profitable techniques [11]. Big data solutions attempt to cost-effectively solve the challenges of large and fast-growing data volumes and realize its potential analytical value. Millions of data are produced and processed every minute worldwide; there is therefore the need to understand the concept of big data. Big data refers to technologies that involve data that is too divers, fast changing or massive for conventional database technologies, skill and infrastructure to address efficiently [12]. In a layman understanding, the volume, velocity, variety, veracity and value (5 V's) of data interrelation is too great. Big Data analytics therefore assists a firm in data creation, gathering, retrieval, management, analysis and in decision making that is remarkable in terms of the 5 V's highlighted in [13]. These 5 dimensions of big data are intertwined.

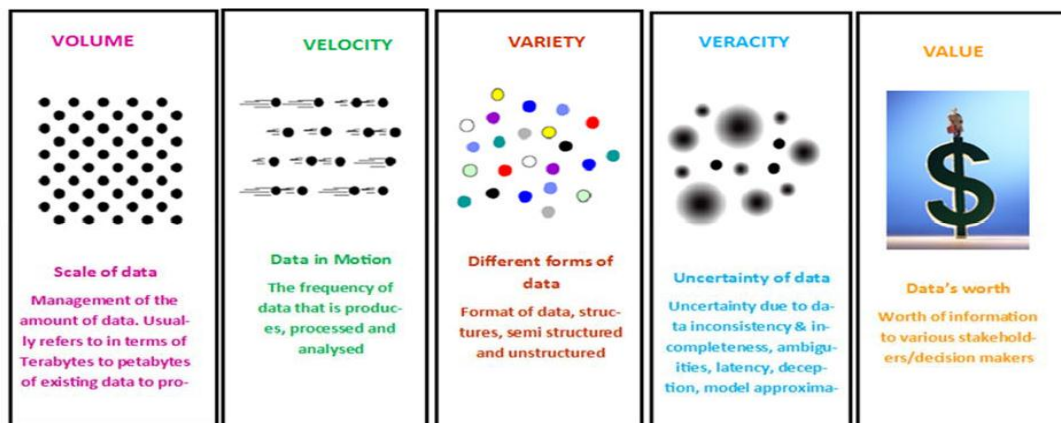


Figure 1: The Five Dimensions of Big Data (Source: [14])

1. Volume: At present the data created is in terabytes. In no distant future, we are likely to generate data in excesses of petabytes. The social media, financial institution, medical institution, government, Sensors, Logs produces data in terabytes every day and this amount of data is difficult to be analyzed using traditional analytic techniques. Volume basically refers to the size of data.
2. Velocity: At present, the rate of change of data occurs at a very high speed and so rapid through archived and legacy data collections or through streamed data from multiple resources sensors, traditional file records, cellular technology, social media and connected networks. Velocity refers to the speed of data.
3. Variety: it refers to the structure of data, whether structured, semi structured, unstructured. At present data comes in different forms including data-streams, text, and multimedia format. Unstructured data is difficult to analyze with traditional tools and techniques. It is therefore difficult to analyze data which is constantly in motion using the traditional techniques.
4. Veracity: Veracity of data includes data consistency (or certainty) and data trustworthiness. Data can be unreliable due to incompleteness, ambiguities, deception and uncertainty resulting from data inconsistency.
5. Value: It is defined by the added-value that the collected data can bring. It refers to the value that the data adds to creating or contributing to existing knowledge. It is of the opinion that valuable information somewhere within the big data.

Data variability refers to data changes during processing and lifecycle. Increasing variety and variability also increases the attractiveness of data and the potentiality in providing unexpected, hidden and valuable information.

### Internet of Things in the Healthcare Sector

The healthcare industry have experience radical changes over the years. Today, we now have more medical devices and technologies that are increasingly integrated and connected together – wearable health monitoring devices are prime examples.

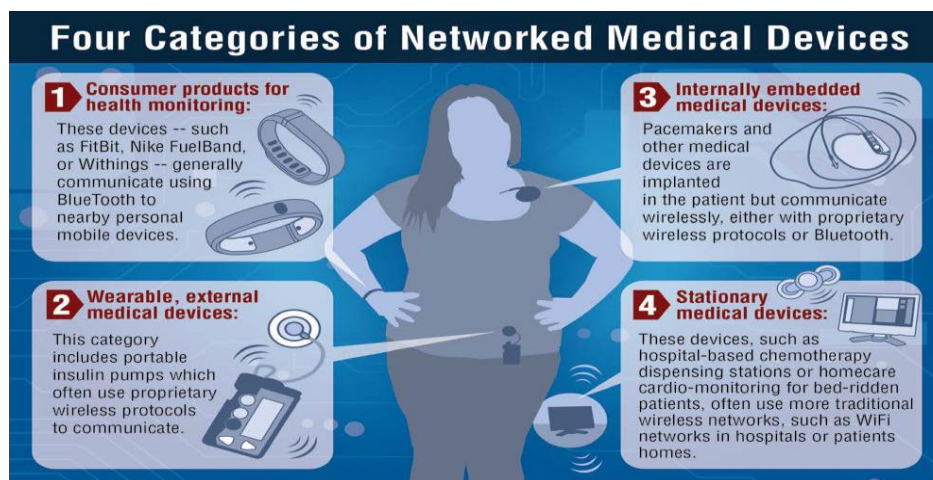


Figure 2: Networked Health Devices (Source: [10])

Figure 2 depicts Internet of Things (IoT) technology in the healthcare industry. The IoT devices fall into four main categories (technologies); consumer products for health monitoring, wearable external medical devices, internally embedded medical devices, and stationary, but networked, medical devices [10]. These technologies can help improve outcomes and quality of life, improve access to care, empower patients, and reduce healthcare costs [15]. Internet of Things promises to manage the personalization of care services and can maintain a digital identity for every person.

Wireless Sensor Network (WSN) is an important enabling technology of IoT. It connects a number of sensor and actuator nodes into a network through wireless communication. This integrates the network into a higher level system through a network gateway [16]. Connecting WSNs to the Internet is possible in three main approaches. The first proposed approach consists of connecting both independent WSN and the Internet through a single gateway shown in Figure 3. This approach is currently adopted by most of the WSNs accessing the Internet, and presents the highest abstraction between networks. The second approach shown in Figure 4 forms a hybrid network which shows an increasing integration degree. It is composed of both, a considered network structure which remains independent and a few dual sensor nodes who can access the internet. In the third approach in Figure 5, multiple sensor nodes can join the Internet in one hop (router) [17].

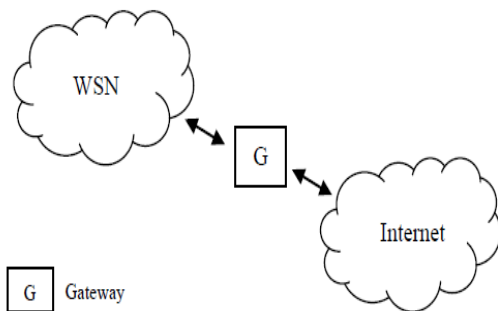


Figure 3: Independent Network

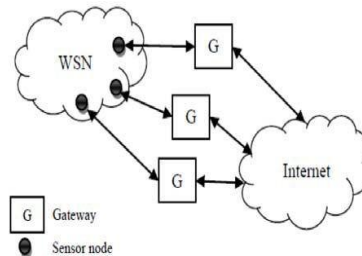


Figure 4: Hybrid Network

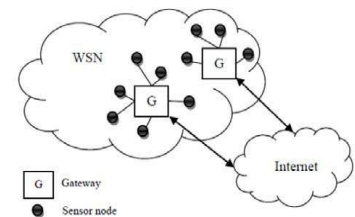


Figure 5: Access Point Network

Other enabling technologies of Internet of Things includes:

**Radio Frequency Identification:** Radio Frequency Identification (RFID) is a system that transmits the identity of an object or person wirelessly using radio waves in the form of a serial number. RFID technology provides a reliable, secure, inexpensive, efficient and accurate means of solving identification issues of objects or services.

**Electronic Product Code:** Electronic Product Code (EPC) comes in either 64 bits or 98 bits; and it is recorded electronically on an RFID tag, which serves as a massive upgrade over the barcode system. EPC can store information about the type of EPC, product's serial number, specification, and manufacturer information.

**Wireless Fidelity:** Wireless Fidelity (Wi-Fi) is a broadband technology that allows computers and other devices to communicate via wireless signals. Wi-Fi provides an efficient and high speed wireless network connectivity across a local area (homes, offices, airport, and schools) or metropolitan area (towns and rural communities). The integration of Wi-Fi into notebooks, handhelds and Consumer Electronics (CE) devices has accelerated the adoption of Wi-Fi to the point where it is nearly a default in these devices [18]. Wi-Fi technology support any of the IEEE 802.11 together with dual-band, 802.11a, 802.11b, 802.11g and 802.11n.

**Bluetooth:** Bluetooth wireless technology is an inexpensive, short-range radio technology that eliminates the need for proprietary cabling between network devices and other peripherals. Bluetooth has an effective range of 10 - 100 meters, and it communicates at less than 1 Mbps. Bluetooth uses specification of IEEE 802.15.1 standard.

**Actuators:** An actuator converts energy into motion, which means actuators drive motions into mechanical systems. It takes hydraulic fluid, electric current or some other source of power. Actuators can create a linear motion, rotary motion or oscillatory motion. Three types of actuators includes electrical actuators (ac and dc motors, stepper motors), hydraulic actuators (uses hydraulic fluid to actuate motion), and pneumatic Actuators (uses compressed air to actuate motion).

### Big Data Analytics in the Healthcare Sector

The effective utilization of data is becoming very competitive since data is perceived to create value for businesses. However, the demand for greater insight and knowledge from information so as to make smarter, real time and informed decision has promoted the



evolution of big data tools, platforms and technologies [19]. Big data in healthcare refers to electronic health data sets so large and complex that it is difficult to manage with traditional or common data management methods and traditional software and/or hardware [12]. Some health care data are characterized by a need for timeliness and real-time; while some other kind of data are collected in batches. [12] categorized data in healthcare as follows;

**Genomic Data:** It refers to genotyping, gene expression and DNA sequence [20].

**Clinical Data and Clinical Notes:** Majority of this type data are unstructured documents, images and clinical or transcribed notes. Clinical data includes Structured data (laboratory data, structured EMR/HER), Unstructured data (post-op notes, diagnostic testing reports, patient discharge summaries, unstructured EMR/HER and medical images such as radiological images and X-ray images), and Semi-structured data (copy-paste from other structure source)

**Behavior Data and Patient Sentiment Data:** This kind of data includes Web and social media data (Search engines, Internet consumer use and networking sites like Facebook, Twitter, LinkedIn, blog, health plan websites and smartphone, etc.), and Mobility sensor data or streamed data which are from regular medical and home monitoring, telehealth, sensor-based wireless and smart devices.

**Health Publication and Clinical Reference Data:** They include Text-based publications (journals articles, clinical research and medical reference material) and clinical text-based reference practice guidelines and health product data.

**Administrative, Business and External Data:** This kind of data includes Insurance claims and related financial data, billing and scheduling as well as Biometric data: Fingerprints, handwriting and iris scans [21].

Other Important Data are Device data, adverse events and patient feedback, the content from portal or Personal Health Records (PHR) messaging (such as e-mails) between the patient and the provider team; the data generated in the PHR.

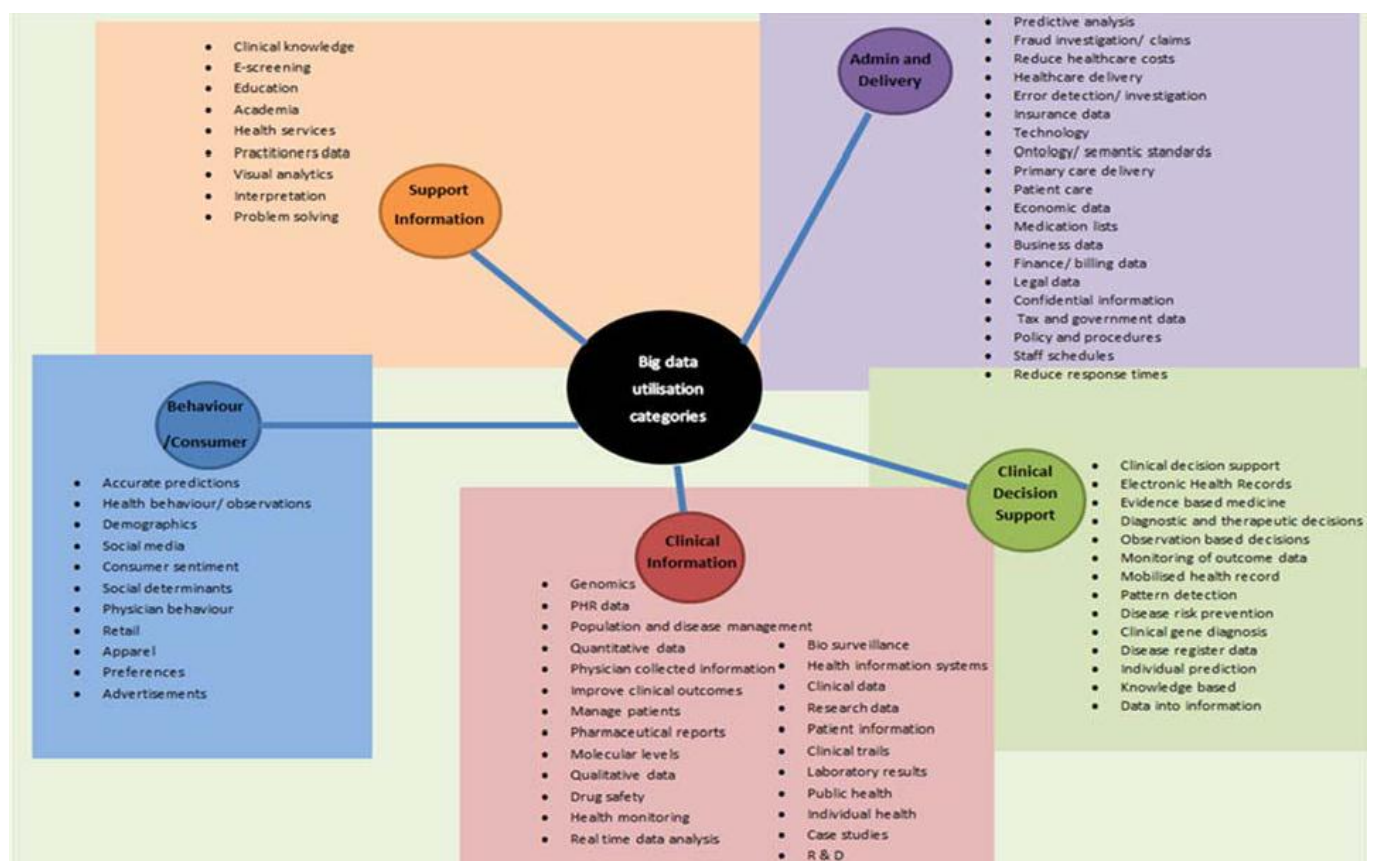


Figure 6: Big data Analytics Applications in Healthcare Categorization as pictured by [14]

### III. CONCEPTUAL FRAMEWORK

To develop an effective information systems or business plan, the organization must have a clear understanding of both its long and short term information requirements. Strategic or factors analysis approach argues that an organization's system requirements are determined by a small number of success factors. If these goals can be attained, success of the firm or organization is assured [22].

The study of [13] proposed a comprehensive data analytics framework for smart healthcare devices. The study designed a Cyber Physical System (CPS) of collaborating computing elements controlling physical entities. CPS as proposed in the study is a network of interacting elements. In implementing CPS using Big Data, the study proposed three enablers; Sensor Technology, Big Data Center, and Cloud Computing. Sensor technologies increased smartphone penetration and reduced sensor costs enabling more users to carry sensors for long periods of time. Cloud computing allows computing services to be provided over a network.

In reviewing and understanding the applications of IoT in personalized healthcare to achieve excellent healthcare at affordable costs, [17] posited that Wireless Sensor technology is an important enabling technology of IoT. It connects a number of sensor and actuator nodes into a network through wireless communication. In addition, the study Healthcare efficiency is improved by enabling display devices to deliver a great deal of information with the help of graphics user interfaces (GUIs). The work of [2] also agreed that sensor technologies can transform healthcare through internet of things. Analytics and data visualization is becoming critical to the complete patient record in healthcare industry. Combining patient genomic data with clinical data helps cancer treatment ([12]; [14]).

The research of [15] posits that as wireless network gateways in the Internet of Things continues to mature, more and more exciting new IoT-driven healthcare applications and systems will emerge. Wireless network gateways are information hubs that collect sensor data, analyze it and then communicate it to the cloud via wide area network (WAN) technologies.

The Internet of Things and Big data analytics drivers adopted in this study includes ([13]; [17]; [2]; [15]; [12]; [14]):

1. Remote Sensing Technology
2. Cloud Computing
3. Big Data Center
4. Data Visualization
5. Standard User Interface and Display
6. Wireless Network Gateways

According to the reviewed literatures, these six drivers are the underlying dominant technologies that propels the growth, adoption and widespread diffusion of IoT and big data analytics in an industry or organization. These drivers were used in developing the model for predicting the influence of Internet of Things and Big data analytics to the healthcare sector of Nigeria.

### IV. MATERIALS AND METHODS

Research design is a framework or blueprint for conducting marketing research project. It provides details of the necessary procedures for obtaining the information needed to structure and to solve marketing research problems.

The researcher chose an empirical research approach and a quantitative field survey, which is aimed at conducting a thorough study of big data analytics and Internet of Things (IoT), determine its drivers from study of relevant literatures and observation of different techniques, and finally adopting a suitable analytical method on the drivers; first to help formulate a model for predicting the influence of big data analytics and IoT for healthcare industry revolution of Nigeria, and validating the role of Big data analytics and IoT by way of determining its benefit(s) to the healthcare industry in Nigeria. Five healthcare facilities were considered for use in this research; One hundred (100) IoT and big data analytics experts in the recently concluded 2017 NITEC conference were also reached for their input. The staff in these healthcare facilities and the field experts constitutes the population size for this study. A suitable sample size was calculated from the total population using the Yamann Taro formula for finite population. From the total population size of 22950 and a significant level of 0.05, the calculated sample is 293; corresponding to the number of respondents approached for the research. Both primary and secondary data was used in this study. The secondary data was gotten from relevant and related literature while the primary data was derived from administering a multiple choice structured questionnaire on the subject matter. The questionnaire is based on Likert five-point ordinal scale (ranging from "Strongly Agree to Strongly Disagree") and they were administered to the selected sample.

For this research, multiple regression analysis and multivariate analysis of variance (MANOVA) were the two methods of data analysis found ideal for use in this research to help achieve our aim.

## V. RESULT PRESENTATION AND INTERPRETATION

The respondents were asked their area of specialization. This is to enable the researcher make a better and informed recommendation. From Table 1, majority of the respondents are those that should make use of these IoT devices and big data analytics firsthand. Respondents specialized in laboratory and diagnostics, administrative services, pharmacy and IT experts polled highest representing 48, 42, 37 and 35 respondents respectively. The least response was from the academicians (17 representing 6.8%).

**Table 1: Respondent's Area of Specialization**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Academician	17	6.8	6.8	6.8
	IT Expert	35	14.0	14.0	20.8
	Administration	42	16.8	16.8	37.6
	Diagnostic and Laboratory	48	19.2	19.2	56.8
	Servicom	29	11.6	11.6	68.4
	Pharmacy	37	14.8	14.8	83.2
	Public Relations	22	8.8	8.8	92.0
	Nursing	20	8.0	8.0	100.0
	Total	250	100.0	100.0	

Source: Field Work

The coefficient of correlation (R) shows the relative relationship between the combined predictors and the dependent variable. The result on Table 2 shows that the independent variables combined were in a relationship with the dependent variable of 0.881 which is a very strong relationship. The R Square value tells us how much of the variance in the dependent variable is explained by the predictors in the model. It shows in details how much the independent predictors explain the dependent variable. What this means is that our model, using the six drivers Wireless Network Gateway, Cloud Computing, Data Visualization, Remote Sensing Technology, Big Data Center, Standard User Interface and Display explains about 76.3% of the variance in Healthcare Industry Revolution in Nigeria. This percentage variance explanation is very high (way above 50%). It shows that much of the independent variables (Wireless Network Gateway, Cloud Computing, Data Visualization, Remote Sensing Technology, Big Data Center, Standard User Interface and Display) explain the dependent variable - Healthcare Industry Revolution. Our model (using the predictors) is thus a good fit in determining the dependent variable. The adjusted R squared (R squared less error) provides a better estimate; providing a predictive explanation of 75% of the variance in the dependent variable.

**Table 2: Model Summary<sup>b</sup> for Healthcare Industry Revolution in Nigeria**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.881 <sup>a</sup>	.763	.750	1.49055	.763	34.944	6	243	.000

a. Predictors: (Constant), Wireless Network Gateway, Cloud Computing, Data Visualization, Remote Sensing Technology, Big Data Center, Standard User Interface and Display

b. Dependent Variable: HealthCare Industry Revolution

Table 3 represents the Analysis of Variance (ANOVA) report on the general model. In this ANOVA table, we have an outcome with the Probability value less than 0.05; we would thus say that there is a statistical significance for this model. Thus, the combination of all the drivers significantly predicts the dependent variable ( $F=34.944$ ;  $P=0.000<0.05$ ). We thus conclude from this model that the collective drivers (Wireless Network Gateway, Cloud Computing, Data Visualization, Remote Sensing Technology, Big Data Center, Standard User Interface and Display) **significantly influences** healthcare industry revolution in Nigeria.

**Table 3: ANOVA<sup>a</sup> on the General Model for Healthcare Industry Revolution**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	465.816	6	77.636	34.944	.000 <sup>b</sup>
	Residual	539.880	243	2.222		
	Total	1005.696	249			

a. Dependent Variable: HealthCare Industry Revolution

b. Predictors: (Constant), Wireless Network Gateway, Cloud Computing, Data Visualization, Remote Sensing Technology, Big Data Center, Standard User Interface and Display

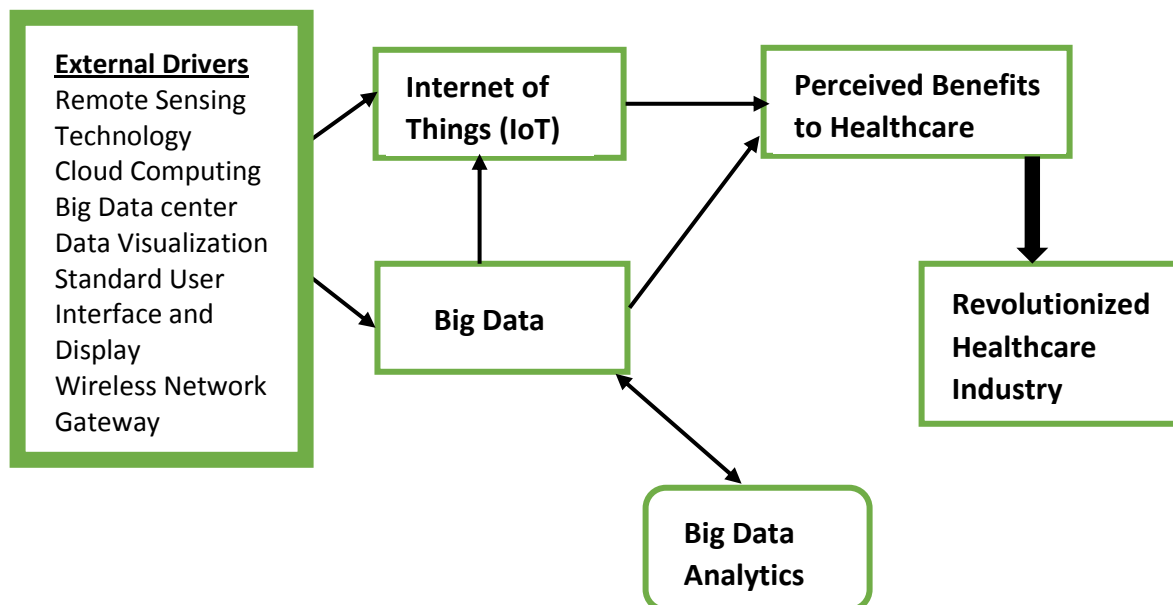
The coefficient summary of Table 4 evaluates the relative influence of each of the independent predictors in the model. What we want to know is the influence of each of the drivers in predicting the outcome (healthcare industry revolution).

**Table 4: Coefficients<sup>a</sup> Testing of the Relative Influence of Independent Predictors**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	-2.026	1.734		-1.168	.244	-5.442	1.390
Remote Sensing Technology	.421	.087	.323	9.015	.000	.333	.498
Cloud Computing	.374	.072	.304	8.426	.000	.303	.422
Big Data Center	.139	.081	.163	5.720	.011	.120	.298
Data Visualization	.285	.087	.249	6.655	.003	.214	.355
Standard User Interface and Display	.231	.075	.194	6.292	.008	.160	.272
Wireless Network Gateway	.366	.088	.285	7.019	.001	.293	.390

Result of Table 4 shows that all six drivers makes very strong significant and positive influence on healthcare industry revolution in Nigeria, with remote sensing technology (0.421 – 42.1%) having the strongest influence followed by Cloud computing technology (0.374 – 37.4%).

Considering the results from Table 2 to Table 4, the six drivers showed strong relative influence on healthcare industry revolution. This means that the model of IoT and big data analytics using the six drivers can thus be readily ensure the growth and revolution of the healthcare industry in Nigeria.



**Figure 7: Proposed Research Model**



Having ascertained that Internet of Things (IoT) and Big data analytics has significant influence to healthcare industry revolution, we try to assess the significant impact of the proposed model of IoT and big data analytics on the Nigerian healthcare subsector if the model is adopted and implemented.

In achieving this objective, the researchers considered five main key areas in the operation and management of the healthcare industry:

1. Remote Health Monitoring
2. Collaborative Disease Management
3. Predictive Maintenance of Medical Equipment
4. Change in Decision Making Power
5. Foster Research and Development

The researcher aimed at analyzing the impact of big data analytics and Internet of Things in the healthcare industry in Nigeria based on these key areas identified.

Table 5 estimates the level of contributions of each of the six drivers on the five key healthcare industry areas. A look at table shows that all the six drivers making up the model for healthcare industry revolution significantly contributes to the five key areas. However, the level of contribution of the model differs. Standard User Interface and Display showed greatest contribution to Collaborative Disease Management, Predictive Maintenance of Medical Equipment, and Significant Change to Decision Making power. Deploying a good wireless network gateway would inherently ensure effective Remote Health Monitoring in the healthcare industry.

**Table 5: Healthcare Industry Revolution Model**

Dependent Variable	Healthcare Industry Revolution Model	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Remote Health Monitoring	Remote Sensing Technology	4.200	.087	4.028	4.372
	Cloud Computing	4.450	.087	4.278	4.622
	Big Data Center	4.150	.087	3.978	4.322
	Data Visualization	4.225	.087	4.053	4.397
	Standard User Interface and Display	4.325	.087	4.153	4.497
	Wireless Network Gateways	4.475	.087	4.303	4.647
Collaborative Disease Management	Remote Sensing Technology	4.225	.084	4.059	4.391
	Cloud Computing	4.425	.084	4.259	4.591
	Big Data Center	4.125	.084	3.959	4.291
	Data Visualization	4.225	.084	4.059	4.391
	Standard User Interface and Display	4.550	.084	4.384	4.716
	Wireless Network Gateways	4.325	.084	4.159	4.491
Predictive Maintenance of Medical Equipment	Remote Sensing Technology	4.300	.092	4.118	4.482
	Cloud Computing	4.400	.092	4.218	4.582
	Big Data Center	4.250	.092	4.068	4.432
	Data Visualization	4.300	.092	4.118	4.482
	Standard User Interface and Display	4.450	.092	4.268	4.632
	Wireless Network Gateways	4.275	.092	4.093	4.457
Significant Change in Decision Making Powers	Remote Sensing Technology	4.250	.090	4.072	4.428
	Cloud Computing	4.400	.090	4.222	4.578
	Big Data Center	4.250	.090	4.072	4.428
	Data Visualization	4.300	.090	4.122	4.478
	Standard User Interface and Display	4.550	.090	4.372	4.728
	Wireless Network Gateways	4.375	.090	4.197	4.553
Foster Research and Development	Remote Sensing Technology	4.475	.088	4.301	4.649
	Cloud Computing	4.225	.088	4.051	4.399
	Big Data Center	4.275	.088	4.101	4.449
	Data Visualization	4.300	.088	4.126	4.474
	Standard User Interface and Display	4.325	.088	4.151	4.499
	Wireless Network Gateways	4.325	.088	4.151	4.499

The benefit of the test result of Table 6 is to determine which of the five key areas (Remote health Monitoring, Collaborative Disease Management, Predictive Maintenance of Medical Equipment, Change in Decision Making power, and Fostering

Research and Development) have effect on the significant MANOVA result. The objective is to statistically determine if the proposed model using the big data and Internet of Things drivers have significant impact on the five key areas, and by extension having impact on the healthcare industry in Nigeria.

**Table 6: Tests of Between-Subjects Effects**

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Remote Health Monitoring	3.671 <sup>a</sup>	5	.734	2.415	.006	.409
	Collaborative Disease Management	4.787 <sup>b</sup>	5	.957	3.355	.004	.467
	Predictive Maintenance of Medical Equipment	1.221 <sup>c</sup>	5	.244	.716	.024	.215
	Significant Change in Decision Making Powers	2.621 <sup>d</sup>	5	.524	1.608	.012	.338
	Foster Research and Development	1.421 <sup>e</sup>	5	.284	.912	.019	.219
Intercept	Remote Health Monitoring	4446.204	1	4446.204	14627.934	.000	.984
	Collaborative Disease Management	4463.438	1	4463.438	15641.249	.000	.985
	Predictive Maintenance of Medical Equipment	4498.004	1	4498.004	13193.770	.000	.983
	Significant Change in Decision Making Powers	4550.104	1	4550.104	13959.022	.000	.984
	Foster Research and Development	4480.704	1	4480.704	14387.441	.000	.984
Healthcare Industry Revolution Model	Remote Health Monitoring	3.671	5	.734	2.415	.006	.409
	Collaborative Disease Management	4.787	5	.957	3.355	.004	.467
	Predictive Maintenance of Medical Equipment	1.221	5	.244	.716	.024	.215
	Significant Change in Decision Making Powers	2.621	5	.524	1.608	.012	.338
	Foster Research and Development	1.421	5	.284	.912	.019	.219
Error	Remote Health Monitoring	71.125	234	.304			
	Collaborative Disease Management	66.775	234	.285			
	Predictive Maintenance of Medical Equipment	79.775	234	.341			
	Significant Change in Decision Making Powers	76.275	234	.326			
	Foster Research and Development	72.875	234	.311			
Total	Remote Health Monitoring	4521.000	240				
	Collaborative Disease Management	4535.000	240				
	Predictive Maintenance of Medical Equipment	4579.000	240				
	Significant Change in Decision Making Powers	4629.000	240				
	Foster Research and Development	4555.000	240				
Corrected Total	Remote Health Monitoring	74.796	239				
	Collaborative Disease Management	71.562	239				
	Predictive Maintenance of Medical Equipment	80.996	239				
	Significant Change in Decision Making Powers	78.896	239				
	Foster Research and Development	74.296	239				

a. R Squared = .409 (Adjusted R Squared = .392)

b. R Squared = .467 (Adjusted R Squared = .447)

c. R Squared = .215 (Adjusted R Squared = -.196)

d. R Squared = .338 (Adjusted R Squared = .313)

e. R Squared = .219 (Adjusted R Squared = .202)

With a minimal error for all five key areas, and a significant probability value less than 0.05 ( $p < 0.05$ ), all five identified key areas (Remote Health Monitoring, Collaborative Disease Management, Predictive Maintenance of Medical Equipment, change in Decision Making Power, Foster Research and Development) are significant based on the model for predicting healthcare industry revolution in Nigeria. Also a careful study of the R-Squared value indicates that much of the variance in the five

identified key areas is explained by the healthcare industry model using the six big data analytics and Internet of Things drivers. Thus we conclude that healthcare industry revolution model have a significant impact on the all five key areas. Having considered all the statistical significance from the MANOVA result of Table 6 on the impact of the model using the six drivers on healthcare industry in Nigeria, we can conclude that the predicted model of Figure 7 using the six drivers will have positive significant impact on healthcare industry in Nigeria.

The research also found out that adopting and implementing Big data analytics and Internet of Things technologies in the healthcare sector of Nigeria will not only ensure Remote Health Monitoring of patient, Collaborative Disease Management, Predictive Maintenance of Medical Equipment, change in Decision Making Power as well as Fostering Research and Development; potential benefits such as Telemedicine (Virtual consulting), Genomic analytics, Epidemic outbreak prediction and control, Fraud detection and prevention, and Effective clinical care and support can also be derived.

## VI. CONCLUSION AND RECOMMENDATIONS

Based on results from the analysis and review of related literatures, the researcher draws the following conclusion;

It is paramount to state emphatically that there is need for radical growth and redevelopment in the healthcare industry of Nigeria. Owing to this need, the result from this study lay emphasis on the fact that big data analytics and Internet of Things – using the six identified drivers – have an important role to play in revolutionizing the healthcare industry in Nigeria, since all the drivers relates and influences this development and revolution by well over 75% as shown in Table 2.

In addition, the results from the study using the six predictor drivers agrees with some related literatures reviewed in the course of this research work. This result can thus be adopted by other researchers and further explored in details especially as related to the subject matter.

An industrious and revolutionized healthcare sector in Nigeria is to the benefits of every Nigerian. Applying the latest technological trends to healthcare operations and management will only help alleviate and/or eradicate the problems encountered in this system. Based on the above premise, we conclude that big data techniques as well as Internet of Things technologies are significant and influences healthcare industry development in Nigeria. What this means is that healthcare industries should pay very good attention to these technologies in other to ensure proper adoption and diffusion.

The researchers therefore recommends that top management and relevant stakeholders should provide their maximum support and contribution in realizing the potentials of these two technologies. In addition, these healthcare industries should provide adequate training for their staff to keep them abreast with the latest technology and other ICT techniques. Government agencies and relevant private sector should be keen on the current trends of global technological evolution, to enable them promulgate policies that encourage best practices for the growth of recent ICT technologies in the healthcare sector. Finally, the healthcare sector should harness the various benefits of these recent technologies; including for remote patient monitoring, fraud detection and prevention, epidemic outbreak prediction and control, as well as for telemedicine.

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#### AUTHOR'S PROFILE



Oluigbo Ikenna Victor has a B.Tech and MSc in Information Technology from Federal University of Technology Owerri, Nigeria (FUTO). He is a seasoned IT Researcher and a lecturer in the department of Information Management Technology, FUTO. He is a member of International Association of Computer Science and Information Technology, International Association of Engineers, Institute of Research Engineers and Doctors. In addition, he is a reviewer member of International Journal for Innovative Research in Science and Technology, and International Journal of Trends in Research and Development. He has published over fifteen research papers in recognised international journals. His research interests include Network Administration and Security, Data Science and Big Data, Green Technologies and Energy Efficient Networks, Impact of ICT and Internet Technologies, Research Methodologies, Quantitative and Qualitative Analysis.



Engr. Dr. Nwokonkwo Obi Chukwuemeka is an accomplished academic. He began his teaching career as an assistant lecturer in March 5 2003 and has progressed to the rank of Lecturer 1. He has a B.Eng in Electrical/Electronic Engineering, and an MSc and Phd in Project Management Technology. He is a corporate member of Nigerian Society of Engineers, Member of Computer Professionals of Nigeria, and a COREN registered Engineer. His research interest includes but not limited to digital systems, computer and systems engineering. He has published over 15 research papers in revered International journals, and have attended quite a number of conferences and other learned activities.



Ezech Gloria N. is a Lecturer in the department of Information Management Technology, FUTO. She has B.Eng in Electrical Electronics Engineering, MSc in Information Technology, and currently a Phd Researcher Student in Information Technology. She has attended several seminars, conferences and workshops. She has a passion for books on personal development. G.N. Ezech is a member of Computer Professional Council of Nigeria (CPN), Nigeria Society of Engineer (NSE) and Nigeria Women in Information Technology (NIWIT). Her research interests include Security, IT, Computer and Network Administration.



Ndukwe Ngoziobasi Ginika is a research scholar and a postgraduate candidate in the department of Information Management Technology, FUTO. She is an IT personnel with research interest in the Impact of Information Technology, Information Systems, and Internet of Things.