AN OVERVIEW OF THE IMPORTANCE AND EFFECTS OF BIG DATA ON THE CLIMATE CHANGE: A NEED FOR ADEQUATE REGULATIONS

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ABSTRACT

The world has been digitalized, and as a result, every facet of human beings activities depends so much on technologies, which generate big data. The big successes of big data analytics in diverse areas over the past decade have also prompted the expectation of its efficacy on the problem climate change is experiencing due to the persistence and continuous usage of big data by human beings which is more than what traditional way of analyzing data can handle. However, the big data has its own effects on the climatic change, which monitors and prevents climatic hazard against human existence. Thus, this paper seeks to examine the extent at which big data has been favourable and unfavourable to the climatic change and how energy law and policy can be of help. In doing this, the research adopts doctrinal method of research by using both primary and secondary sources of materials such as statutes, online materials, published journals and articles to arrive at just determination of this paper. This paper concludes that big data if not well managed will negatively affect the climate change and as result, it will pose threat to mankind. Hence, this paper recommends that proper control measures should be made by the international bodies on the regulations and usage of big data in relation to climatic changes in the midst of heavy storage of big data in the cloud.

Keywords: Big data, Generation, Climate change, Energy policy

INTRODUCTION

Digitization has brought about different social network platforms, usage of hand-held and wearable digital devices, blogs and heavy usage of the internet, which generates huge amount of data on continuous basis.[i] It is hard to deny that internet has changed the way businesses operate, functioning of the government, education and lifestyle of people around the world. Sometimes around year 2000, the emergence of social media, cloud computing and processing power (through multi-core processors and GPUs) contributed to the rise of big data.[ii] As of December 2015, Facebook has an average of 1.04 billion daily active users, 934 million mobile daily active users, available in 70 languages, 125 billion friend connections, 205 billion photos uploaded every day, 30 billion pieces of content are sent on Facebook and over 2.7 billion likes and comments are being posted.[iii] This trend is in a transformative stage where the rate of data generation is very high, the type of data being generated surpasses the capability of existing data storage techniques. It can be said that these data carry a lot of information than ever before due to the emergence and adoption of Internet.[iv]

Over the past two decades, there has a tremendous growth in data usage. This trend can be observed in almost every field. According to a report by International Data Corporation (IDC), a research company claims that between 2012 and 2020, the amount of information in the digital universe will grow by 35 trillion gigabytes.[v] The volume and variety of data produced by individuals, things or the interactions between them have exploded over the last few years. According to recent IBM estimates, over 2.5 billion Gigabytes of data are created everyday around the globe, and the creation rate is growing continuously.[vi] Whereas, this big data generated as being stored somewhere in the cloud, it is opined that the continuous storage of big data in the cloud if not monitored and control can affect the climatic change in which its negative effect will affect the sustainability of humanity.

WHAT IS BIG DATA?

Big Data as a concept has no generally acceptable definition because it has many descriptions. The lack of unified definition poses conceptual problems and this is because the big data of today would easily become the little data of tomorrow. Although, there is still no commonly agreed universal definition of big data, the term is often used to describe the exponential growth and availability, as well as the variety of data and speed at which it is produced and transferred.

Key bodies such as the U.S. National Institute of Standards and Technology (NIST) and the Research Analyst Gartner have promoted a definition encompassing three dimensions which are; Volume (i.e. the amount of data), Velocity (i.e. the speed of data), and Variety (i.e. the array of data types and sources).[vii] Recently, technology giants, including IBM have extended the relatively standard 3Vs definition of big data to include another V which is 'Veracity' (i.e., the quality and accuracy of data).[viii]

Furthermore, big data has also been defined as datasets, which could not be captured, managed, and processed by general computers within an acceptable scope.[ix] It is a datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze.[x] International Data Corporation (IDC) defines big data technologies as a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery, and/or analysis.[xi] In addition, big data is described as huge size of unstructured data produced by high-performance heterogeneous group of applications that spans from social network to scientific computing applications.[xii] The datasets range from a few hundred gigabytes to zetabytes that it is beyond the capacity of existing data management tools to capture, store, manage and analyze. It must be noted that, although, big data has been defined in various forms, some of the definitions explained what big data does while just a few focused on what it is.

CLASSIFICATION OF BIG DATA

Big data can be classified into three categories and they are;

i. **Structured data:** Structured data refers to any kind of data existing in relational databases and spreadsheets that resides in a fixed field within a record or file.[xiii]
ii. **Unstructured data:** The phrase unstructured data usually refers to information that doesn't reside in a traditional row-column database.[xiv]
iii. **Semi structured data:** Semi-structured data is data that has not been organized into a specialized repository, such as a database, but nevertheless has associated information such as metadata, that makes it more amenable for processing than raw data.

FEATURES OF BIG DATA

One of the most obvious characteristics of big data is that the devices for capturing those data are either already ubiquitous or becoming ubiquitous.[xv] Examples of big date related are cell phones, digital cameras, digital video recorders, etc. When any data capturing device becomes ubiquitous,[xvi] there is a high probability that whatever data those devices are capturing will eventually become big data.[xvii] In addition, big data has some characteristics parts of which are;

i. **Volume:** Volume refers to the magnitude of the data that is being generated and collected. It is increasing at a faster rate from terabytes to petabytes. With the increase in storage capacities, what cannot be captured and stored now will be possible in future.[xviii] The classification of big data on the basis of volume is relative with respect to the type of data generated and time.

ii. **Velocity:** Velocity refers to the rate of generation of data. Traditional data analytics is based on periodic updates which can be daily, weekly or monthly. Hence, with an increase in the rate of data generation, big data should be processed and analyzed in real or near real time to make informed decisions.[xix]

iii. **Variety:** Variety refers to different types of data that are being generated and captured. This can extend beyond structured data and fall under the categories of semi-structured and unstructured data.

iv. **Veracity:** This is coined by IBM, veracity refers to the unreliability associated with the data sources. For instance, sentiment analysis using social media data (Twitter, Facebook, Instagram etc.) is subject to uncertainty. There is a need to differentiate the reliable data from uncertain and imprecise data to manage the uncertainty associated with the data.[xx]

v. **Variability:** Most times, the inconsistency in the big data velocity leads to variation in flow rate of data, which is referred to as variability. Data are generated from various sources and there is an increasing complexity in managing data ranging from transactional data to big data. Data generated from different geographical locations have different semantics.[xxi]

HOW BIG DATA IS GENERATED

Big data are usually generated through various means due to technological advancement human beings experience on a daily basis. Quite recently, in contemporary societies, big data encountered the semantic web and the internet. In 2015, eight Zettabytes (Zetta = 1021) were generated, which consisted mostly of unstructured (e-mails, blogs, Twitter, Facebook posts, images, and videos) data.[xxii] Twitter users generate more than half a billion of daily tweets.[xxiii] E-Bay Online Dispute Resolution system alone solves a large number disputes annually (considering the number of hours they will spend on each of the case and the volume of data that would be consumed through audio and video recording devices would be heavy).[xxiv] Apart from the social medial connected devices, data come from a wide range of sources, such as demographic data, climate data, scientific and medical data, energy consumption data etc. All these data provide information about the location of users of the devices, their travel, their interests, their consumption habits, their leisure activities, their projects and so on. With the ever-increasing number of internet and mobile phone users, the volume of digital data is growing rapidly.

In addition, there is a huge amount of data produced through the goggle services which can receive more than 4 million search queries every minute,[xxv] most companies have been storing and using huge amounts of information to run their company affairs.[xxvi] With technical progress, which is visible nowadays especially in the field of information technology, requirements and emphasis on storing, analyzing and processing information has increased significantly.

Today, most common forms of data are images, text, audio and videos, which are beyond the processing capability of conventional data to manage and analyze in precise period. For illustration, 10TB (Tera Bytes) data of image file where it needs processing and enhancement within a given time interval, the conventional methods will not be able to finish the task within the given time interval because the computing resources would not be enough.[xxvii] More than 2.5 quintillion bytes of data are created every day from sensors, posts to social media websites, digital pictures and videos, purchase transaction records, and cell phone GPS signals etc.[xxviii]

Moreover, some big data are also generated through duplication of heavy files from organization as backups of sensitive and confidential files. Also the airport surveillance video logs such as the closed-circuit monitoring systems (CCTV) in Nigerian airport, security

agencies networks and other big networking organizations are at every time on high definitions (HD) which increase the data volume further. This is different from the thousands of other security cameras placed to control crime rate in different cities, all lead to generation of big data in the cloud.[xxix]

IMPORTANCE OF BIG DATA

Big data is useful in numerous ways and in every facets of human life such as health sector, educational sector, economic sector, environmental sector and so on. Some of the general importance of big data can be understood under the following contents:

i. **Telecommunication:** Network analytics is the next big thing in Telecom and it all depends on big data. Through big data MSPs can monitor the network speed and manage the entire network. This helps to resolve the network problems within few minutes and helps to improve the quality of service and customer experience.[xxx]

ii. **Financial Firms:** Currently, capital firm and financial institutions are using advanced technology to store huge volumes of data. But increasing data sources like the Internet and social media require them to adopt big data storage systems. Capital markets are using big data in preparation for regulations like European Market Infrastructure Regulation (EMIR), Solvency II, Basel etc.[xxxi]

iii. **Law enforcement**

Law enforcement officials can predict the next crime location using big data which are stored to trace the records of the type of crime, place and time, social media data, drone and smartphone tracking.[xxxii] Researchers at Rutgers University developed an application called RTM Dx which requires big data to prevent crime and is being used by police department at Illinois, Texas, Arizona, New Jersey, Missouri and Colorado.[xxxiii] With the help this application, the police department could measure the spatial correlation between the location of crime and features of the environment. For instance, there a technology device called 'facial analytics' which examines images of people without violating their privacy.[xxxiv]

iv. Marketing

Marketing analytics through the usage of big data helps the organizations to evaluate their marketing performance, to analyze the consumer behavior, their purchasing patterns and marketing trends which would aid in modifying the marketing strategies like the positioning of advertisements in a webpage, implementation of dynamic pricing and offering personalized products.

v. Energy and Utilities

Consumption of water, gas and electricity can be measured using smart meters at regular intervals of one hour.[xxxv] During this interval, a huge amount of data is generated and analyzed to change the patterns of power usage. The real-time analysis can reveal energy consumption pattern, instances of electricity thefts and price fluctuations.[xxxvi]

vi. Education

With the advent of computerized course modules, it is possible to assess the academic performance real time. This helps to monitor the performance of students after each module and give immediate feedback on their learning pattern. It also helps the teachers to assess their teaching pedagogy based on the students' performance and needs. More practically, the essence of big data is practically seen more during this Covid 19 pandemic, in which students were required to run their courses and write their examinations online. Considering the number of schools in Nigeria alone, if all higher institutions only adopt online teaching or e-learning process a lot of data would be generated because small data generation cannot give the desired results.

BIG DATA AND CLIMATE CHANGE

The earth is a complex and dynamic system; as a result, big data analytics encountered more challenges in climate science than other subjects regardless of the extensive resources of big climate data.[xxxvii] Given the context of combating climate change, existing research has applied big data analytics mainly in the aspects of energy efficiency, intelligent agriculture, smart urban planning, weather forecast, natural disaster management etc.[xxxviii] Although, big data is not a

new concept but it appears much attention has not been paid to big data analyses on climatic change. Whereas, to monitor the climatic system critically for human safety, big data is required. It is important at this juncture to examine some ways big data can be beneficial to the climatic change.

Moreover, it is important to state that the changes that may occur on the climate due to the global warming can be observed and monitored with the use of big data when it is incorporated with climate change study.[xxxix] In addition, multi-dimensional big data system has played a significant part over the past decades to obtain thorough observation and comprehensive parameters of climate change and earth observation technology.[xl] A more detailed review of the climate data sources and corresponding features can be found in the use of the satellites that are working in climate change research which are remotely censored and regulated by the United Nations Framework Convention on Climate Change, through an international agency.[xli]

IMPORTANCE OF BIG DATA ON CLIMATIC CHANGE

i. **Big data can be used to create geo-referenced datasets:**

Big data can be used to create geo-referenced datasets on factors affecting vulnerability such as population, habitation characteristics, economic status, location of sensitive infrastructure, trends for environmental conditions which are often lacking, outdated, patchy, or unreliable, especially in low- and middle-income nations.[xlii] Call detail records and geospatial big data such as high resolution remote sensing imagery for dynamic population mapping can be used to assess risk to natural disasters, characterize habitation patterns of high risk regions and track trends over time.[xliii] Natural language processing techniques can also be used to mine and analyze large volumes of text on how climate change discourse is evolving on social media to catalog perspectives on various components of vulnerability through big data analysis.

ii. **Early Warning:**

Surveillance and provision of early warnings is an important component of enhancing the capacity to respond to climate change. Many big data applications have been pioneered for use in early detection. Passive collection of data from the use of digital services comprising of big data have been variously used in detecting influenza epidemics based on flu-related queries coming into search engines via Twitter posts to

identify areas affected by earthquakes.[xliv]. Search queries through big data could be analyzed to monitor health-seeking behavior to detect outbreaks of climate related diseases. Changes in the magnitude and frequency of climatic risks could be detected through time series analysis of multi scale data, with the potential to detect leading indicators of abrupt and nonlinear changes of the climate.

iii. Monitoring and Evaluation:

Monitoring and evaluating adaptation is methodologically complex, it is more difficult to do when there is limited data on adaptation actions and outcomes. Big data can complement such work by providing metrics on how adaptations actually affect perceptions and behavior.[xlv] Cell phone or social media data could be used to examine how an adaptation program designed to provide how storm warnings actually affects people's movement before, during, and after a storm event and monitor how this changes occur over time.[xlvi] Big data can bolster the ability for monitoring environmental change and assessing risk at regional and global scales, with important adaptation applications for climate vulnerable sectors, such as agriculture.[xlvii]

In the context of climate resilience, sensor data such as Satellite Remote Sensing (SRS) helps monitor indicators that are key to anticipating precipitation extremes such as terrestrial and sea surface temperatures, atmospheric temperatures, sea level rise, ice melt and glacier retreat and changes in precipitation regimes.[xlviii] SRS through the usage of big data is also fundamental in assessing numerous environmental variables including detecting trends in growing season parameters and their impacts on crops, soil degradation or key variables of the water cycle.[xlix] Big Data can help in monitoring and understanding the drivers of climate change, detecting variations that can lead to negative impacts. A powerful example is the use of satellite observations to test critical feedbacks between water vapor and temperature at different atmospheric layers.[l]

iv. Reduction of carbon emission:

Big data can also support reduction of carbon emission mostly especially in the transportation sector. Carbon emission mostly contributes to climate change, producing roughly 23% of the global emissions of greenhouse gases.[li] The transportation sector appears to be the fastest growing consumer of fossil fuels and the fastest growing source of CO2 emissions.[lii] Big data contributes to low carbon systems in the energy sector both on the supply side and on the demand side. On the supply side, companies that

produce and sell energy sources can use remote sensors and big data-stream analytics to reduce carbon emissions by making real time efficiency improvement on the short term, identifying ways to improve existing infrastructure such as power distribution grids on the medium term, and better planning future projects.[liii]

On the demand side, the main mechanism for reducing carbon emissions through big data involves extending consumer decision making powers. Smart meters which relay information bilaterally and in real time between power companies and homes are expected to help consumers make more informed decisions about their power consumption.[liv]. Through big data, consumer can get email or SMS notifications when their consumption reaches a certain level or where there is shortages or peak usage in order to control and reduce their consumption rate.

v. Preparedness:

The damage to climate change be can be reduced by effective detection and monitoring. Remote sensing data is usually a big source of big data that helps to detect any abnormalities of weather and disaster probability. Satellite remote sensing can also be used for the detection of the adverse effect of climate change.[lv] Some natural disasters like flooding and fire can be monitored by remote sensing imagery that helps to take proper measures for mitigation. Early detection through the help of technology with big data such as Satellite-based flood mapping, and the Moderate Resolution Imaging Spectroradiometer (MODIS) can be used for effective monitoring disaster events.[lvi]

In addition, Mobile Metadata and call times though a great source of big data is also helpful for decision-makers to avoid any unexpected situation related to natural disasters. Through big data, information can be disseminated across the globe on how to prevent the dangerous effect of climatic change. For instance, the Overseas Development Institute (ODI) predicts that up to 325 million extremely poor people will be living in the 49 most hazard prone countries in 2030, the majority in South Asia and sub-Saharan Africa as a result of negative effect of climatic change.[lvii] These examples show that big data has potentials to improve and operationalize humanitarian efforts and develop an understanding of resilience and social vulnerability to climate change impact.

LIKELY EFFECTS OF BIG DATA ON CLIMATIC CHANGES

While on one hand big data technologies yield great promises, on the other hand, it raises critical issues such as security, legal restriction on privacy, and control over personal information and so on.[lviii] The big data can pose a great challenge to the climatic change because of the things that are launched, saved and tested in the cloud especially by the developed countries, which were generated through the big data. A good example is the test of some atomic and nuclear weapons, which can bring about the depletion of the ozone layer and climatic change deficiency. Besides, the usage of big data can lead to insecurity of nations especially among the developing countries who do not have control over the advanced countries to restrict all the harmful substances launched in the air for testing the effects on the developing countries.

In addition to this, the storage of big data in the cloud can cause a break and change of climatic condition. The data generation through human beings is increasing at rapid rate in every second. The advancement of the newly developed technology and increase in the network used has a negative impact on the climatic change. Recently, technology is gradually taking away 4G network to 5G network and the effect of this is that more big data will be generated by the people. The increase in population, digitalization and civilization increases data consumption, thus the storage of the big data generated will eventually become a problem for the climatic change. For instance those using iPhone can store their data on icloud, whereas, millions of people are using iPhone devices in different forms and the number keeps increasing with the new and latest designs coming out every years.[lix] It can be said that a time will come when the storage capacity of the cloud will be too heavy and gradually exceeding its limit thereby leading to breakage in which its effect will affect the climate changes and the result will be against humanity. Thus, big data can be unfavourable to the climatic change if the constant generation of it is not well controlled and well managed.

CONTROL OF THE USAGE OF BIG DATA AGAINST CLIMATIC CHANGE

It is not in doubt that big data is useful in the area of energy sector because of the increase in the population and consumption of energy through various means by human beings. The advances and innovations of big data is crucial for a sustainable energy system that includes

smart grid technologies, renewable energy sources, and greater energy efficiency. The climate science represents a big data domain that is experiencing unprecedented growth; as a result, close supervision must be paid to it to avoid negative consequence of climatic change on human beings.[lx] Although, there are some international bodies that monitor climatic changes such as Intergovernmental Panel on Climate Change (IPCC)[lxi], United Nations Environment Program (UNEP), the World Meteorological Organization (WMO), the UK Department of Energy and Climate Change, the Climate and Health Council and Climate and Development Knowledge Network. However, it appears that Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the in 1988 to provide the world with a clear scientific view on the current state of scientific knowledge about climate change and its potential environmental and socio-economic impacts. The IPCC is open to all member countries that are ready to join. Currently the list of IPCC member countries is 195 in which Nigeria is part of them.[lxii] Besides, there are some Energy regulations and policy which focus on proper usage of our environment to prevent negative effect of climatic change. Some of the policies are;

i. Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal (Basel, 22 March 1989)
ii. International Convention on Civil Liability for Oil Pollution Damage (Brussels, 29 November 1969)
iii. Convention on Early Notification of a Nuclear Accident, International Atomic Energy Agency, 1986
iv. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, International Atomic Energy Agency, 1986
v. Energy Charter Treaty, 17 December 1994
vi. Protocol to amend the Paris Convention on Nuclear Third Party Liability, 2004

It is believed that this international laws on energy can be used to monitor the negative effect of big data on the climatic change since the generation of big data has a nexus with energy. This is because most of the devices used to generate big data need the support of energy sources which can either be renewable or unrenewable. In this sense, the energy law, regulation and policy have impacts in the control, generation, consumption of big data.

CONCLUSION

The need for the usage of big data cannot be over emphasized due to the increase in population and technological advancement. This is because we are living in digitalized world and internet devices consumes and or generates huge amount of data especially through the social media platforms such as Facebook, twitter, Instagram and so on where billion users operate on it on daily basis. This paper examined the concept of big data as a dataset which is beyond what can be captured, processed or managed by the usual computer within the scope allowed due to large volumes of data generation.

The classification of big data which are structured, unstructured and semi structured were also examined in this paper. Big data generally has five features which are volume, velocity, variety, veracity and variability which determines whether the device used to capture the big data would either be ubiquitous or gradually becoming ubiquitous. Furthermore, the most common form of big data today are generated from images, texts, audio and videos which most big organization and large firms rely on to trade and carry on their daily businesses.

In addition, this work discussed the general importance of big data which cut across various sectors of life such as telecommunication, financial firms, energy and utilities, law enforcement, marketing, education and other infrastructural facilities. The relationship between big data and climatic change is very essential as discussed in this paper. In conducting adequate research on the climatic change, big data is needed to study the data analytics most especially in the area of weather forecast and any attempted natural disaster before the impact is felt. Other importance of big data on the climatic change can be illustrated through the creation of geo-referenced datasets, monitoring of early warning sign and evaluation of climatic change, reduction in carbon emission through introduction of advanced technology such as renewable energy and advancement in internet delivery methods, to mention a few.

This paper further the negative affect of big data on the climatic change if such is not well managed. Big data can prompt critical security issues, legal restriction of privacy, threat to the developing countries as a result of nuclear weapon being launched, save and tested in the cloud, depletion and deficiency in the ozone layer due to heavy storage of big volume of data. The generation and consumption of big data will continue to increase on daily basis due to the increase in the technological advancement which has brought about sophisticated devices and high network facilities into usage.

There is a need to put some international bodies into place to monitor and control of the use of big data to avoid or its negative effect on the climatic change and mankind as a whole. Some of these bodies are; Intergovernmental Panel on Climate Change (IPCC), United Nations Environment Program (UNEP), the World Meteorological Organization (WMO) and so on. Various policies have been made by these bodies to effect proper and adequate manage and control on the use of big data in relation to the climate change as listed above. The Intergovernmental Panel on Climate Change being the leading body in this regard, has 196 members state and is opened to any sovereign state who has interest to join. This paper concludes that we are in digitalized era and every sector of life is internet oriented through the help of big data which is generated on daily basis due to the advanced activities of mankind, however, if big data is not well managed and controlled, it can bring disaster on the climate change which can result to threat against mankind.

RECOMMENDATION

i. There should be adequate measure of control by the international bodies on the regulations and usage of big data in relation to climatic changes.
ii. Adequate provision and implementation of sanctions should be made by the internal bodies to restrict all the harmful substances launched or tested in the air which can affect the climate change and developing countries.
iii. There is a need for close monitoring through international laws and policies on energy to regulate excessive storage of big data in the cloud to avoid its negative consequence on the sustainability of mankind.

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