

Leveraging Data-Driven Analytics to Rejuvenate Nigerian Tertiary Institutions: The Need for Intervention

Williams Kennedy George & Edidiong Isonguyo Silas, PhD

Department of Technical Education

 <https://orcid.org/0009-0007-4207-834X>

Email: georgekennedyresearchers@gmail.com

<https://www.linkedin.com/in/researcher-george-w-kennedy>

Akwa Ibom State College of Education, Afaha Nsit, Nigeria.

Catherine Ubong Akpan, Ph.D

Department of Curriculum and Teaching

Akwa Ibom State College of Education, Afaha Nsit, Nigeria.

Email: katebrilliant14@gmail.com

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Abstract

This study explored data-driven analytics to enhance the quality of teaching and learning in Nigerian tertiary institutions. With a focus on leveraging data-driven approaches, the research investigated the potential benefits and challenges associated with integrating data analytics in the educational institutions. The research methodology primarily relied on literature including journals, scientific research articles, theses, and conference reports. The findings of this study revealed the pivotal role of big data in tertiary institutions, highlighting its capacity to strategically leverage information technology resources for enhancing the quality of education and providing valuable guidance to students. Effectively processing data sets generated daily poses a challenge in extracting meaningful knowledge for students, instructors, administrators, and the public in Nigerian tertiary institutions. The study noted Nigerian tertiary institutions lack adequate information technology infrastructure, tools, and human expertise required for proficiently collecting, cleansing, analyzing, and visualizing data. The study recommended the adoption of data-driven strategies as a catalyst for innovation and improvement in Nigerian tertiary institutions aimed at fostering data literacy and analytical skills among all stakeholders, including staff and students in Nigerian tertiary institutions. Furthermore, the study maintained that educational institutions and industries should invest in programs geared toward bolstering students' performance in the Nigerian tertiary institutions.

Keywords: Big data, Nigeria, Tertiary institutions, Challenges, Way Forward

Introduction

In an era characterized by rapid technological advancements and an unprecedented proliferation of data, the educational system stands on the cusp of transformation. The importance and utilization of big data in tertiary institutions worldwide cannot be overstated. It is imperative for these institutions to ensure the judicious application of big data to acquire knowledge that can benefit their environments. Addressing a myriad of significant challenges, the application of big data analytics in the educational system has been recognized as pertinent (Marsh, et al., 2014). Given the increasing necessity to incorporate big data into tertiary institutions, both in developed and developing nations, it becomes pertinent to define what exactly constitutes "big data." While there is no universally accepted standard definition, researchers have offered their nuanced interpretations of this concept. Murumba and Micheni (2017), Youssra and Sara (2018) characterize big data as the evolutionary and technological utilization that timely delivers pertinent information from the vast and exponentially growing data in our society.

In education, various institutions are tasked with recording diverse academic-related data. Tertiary institutions, in particular, serve as repositories for vast volumes of data (Sintayehu, 2018). Tertiary institutions, are entrusted with the responsibility of systematically recording a wide array of academically relevant activities, spanning tutor data, student records, registration details, course information, and assessment data (Minimol, 2018). The adoption of big data analytics in tertiary institutions holds immense potential, with some applications already in practice and others yet to be explored. The benefits derived from the effective utilization of big data are substantial and manifest in various projects. It is undeniable that big data plays a significant role in shaping the future of the tertiary education sector. Its impact on these institutions leads to transformative activities, ultimately enhancing the teaching process and knowledge acquisition.

According to Drigas and Leliopoulos (2014) and Kelechi (2020) big data provide comprehensive feedback on students' progress, thereby improving the overall educational experience. Furthermore, big data proves invaluable in advancing research projects, enabling academic scholars to apply analytics to a wide array of data, enhancing the research's overall value. It facilitates the efficient storage and management of vast volumes of research data, streamlining the research process. Technology integration is a deliberate strategy employed in tertiary institutions to enhance various processes, including the management of course materials, student records, assessment data, and tutor information. The advent of information technology has also catalyzed a shift toward online social interactions in the academic community. These online interactions contribute to the accumulation of extensive datasets, which, when analyzed, constitute big data.

In higher education institutions, the impact of big data has, to date, been somewhat limited (Vatsala, Rutuja & Sathyaraj, 2017). Many higher education sectors grapple with deficiencies in essential components such as IT infrastructure, tools, and the requisite human expertise for the effective collection, analysis, cleansing, and visualization of data. Similarly, while collecting and analyzing student data, institutions of higher education encounter multifaceted challenges, including issues related to privacy, security, and data safety (Minimol, 2018). Given the challenges confronting most tertiary institutions, particularly those in developing countries, it becomes imperative to devise comprehensive management systems and guidelines aimed at helping these institutions surmount the myriad obstacles associated with the implementation of big data

initiatives in higher education. This need is especially pressing in a developing nation like Nigeria, where addressing these challenges is pivotal for realizing the full potential of big data in the tertiary education sector.

Concept of Big Data Analytics

In everyday language, the term "data" refers to raw and unprocessed information. According to Merriam-Webster (2019), data involves factual information, such as statistics or measurements, that serves as a basis for decision-making, discussions, or calculations. Data include both relevant and irrelevant information, often requiring various levels of cleaning or processing to extract meaningful information. According to Kale (2017) data represents a collection of facts that have the potential to be transformed into useful information. Data can take on various forms, with structured or traditional data being the most common, consisting primarily of numerical figures and textual information. In contrast, unstructured data involves a wide range of formats, including images, sounds, ideas, pictures, recordings, and factual content. The tremendous generation of data, expected to reach 180ZB in 2025, give data a leading role in change and growth of the 21st-century shaping a new "digital universe" with the transformation of markets and businesses (Economist, 2017). Digital information from complex and heterogeneous data coming from anywhere and at any time introducing a new era, the era of "Big Data" (Sivarajah, et al, 2017). Nowadays, in the 4th Industrial revolution era, organizations and governments focus on the development of capabilities that provide knowledge extracted from large and complex data sets, commonly known as "big data".

The concept of "Big Data" has been defined diversely by researchers, each offering their unique perspective. Daniel (2015), and Kelechi (2020) approach Big Data from a technical standpoint, characterizing it as vast datasets that exceed the processing capabilities of manual techniques, such as Database Management Systems (DBMS). Iyilade (2015) defines Big Data as massive and diverse datasets that can be analyzed to extract trends or actionable insights. In the same vein, Cope and Kalantzis (2016) assert that Big Data encompasses the recording of all learning activities and interactions in digitally mediated environments and includes different types of data that are both analyzable and actionable.

Iyilade (2015), Morabito (2015) and Daniel (2019), describe Big Data as vast, massive and complex datasets. These datasets typically consist of a mix of structured and unstructured data and can be processed to discern trends, patterns, associations, and deviations from previously unknown or unseen trends. The term "Big Data" earns its name due to its sheer size and the rapid pace at which it is generated, rendering manual computing processing methods inadequate. To extract meaningful and actionable insights from these massive datasets, complex computer applications are required (Cope & Kalantzis, 2016). In a similar vein, Iyilade (2015) also characterizes these datasets as foundational to modern IT-related economic and educational activities. Big Data's primary objective is to glean valuable insights from extensive data volumes, regardless of their nature. Furthermore, Daniel (2019) stated that big data typically originates from various sources, including humans, applications, and machines, distinguishing it from regular data, which is primarily generated by humans alone.

Anikweze, Ugodulunwa, and Mainoma (2019), Kelechi (2020) describe Big Data as datasets that are exceedingly complex and vast, exceeding the capabilities of conventional data

processing methods. For instance, Big Data includes the sheer volume of data shared online daily, the number of YouTube videos viewed, location data from mobile phones, and Twitter feeds. With the advent of information technology, social interactions have increasingly migrated to online platforms. These online interactions can be traced, collected, and considered as components of Big Data, forming substantial datasets (Minimol, 2018). Big Data affords educational institutions valuable opportunities to harness their information technology resources effectively, promoting institutional development, advancing students' achievement rates, enhancing persistence, and improving overall student outcomes. Perry (2017) asserts that the essence of big data lies not solely in its volume but in the potential comprehension that can be derived from such data.

Characteristics of Big Data Analytics

Big Data Analytics is a term that describes the massive volume, velocity, and variety of data generated in today's digital age (Iyilade, 2015; Kelechi, et al., 2020). Understanding the characteristics of big data according to Youssra and Sara (2018) is essential for harnessing its potential for informed decision-making, innovation, and business transformation. The key characteristics of big data are:

1. **Volume:** Volume refers to the sheer amount of data generated every day. Big data is characterized by its vastness, often exceeding the storage capacities of traditional databases (Cope & Kalantzis, 2016; Perry, 2017). This data can come from various sources, including social media, sensors, IoT devices, and more. Managing and storing this enormous volume requires scalable and cost-effective solutions like distributed file systems and cloud storage.
2. **Velocity:** Velocity signifies the speed at which data is generated, processed, and analyzed. With the advent of real-time data streams, businesses need to make decisions swiftly to remain competitive (Iyilade, 2015). Big Data applications often involve data that flows in continuously, requiring real-time or near-real-time processing capabilities. This necessitates powerful streaming technologies and real-time analytics tools.
3. **Variety:** Variety refers to the diverse types of data that make up Big Data. It includes structured data, semi-structured data (e.g., JSON and XML), and unstructured data (e.g., text, images, and videos). Big Data systems must be capable of handling and integrating this heterogeneous mix of data types, as insights can come from analyzing different sources together.
4. **Veracity:** Veracity highlights the quality and reliability of data. In the Big Data landscape, information can be inconsistent, inaccurate, or incomplete. Ensuring data veracity involves data cleaning, validation, and quality assurance processes. Poor data quality can lead to erroneous comprehension and decisions, emphasizing the importance of data governance and quality control (Firican, 2017; Daniel, 2019).
5. **Validity:** Validity concerns the accuracy and appropriateness of a dataset for its intended purpose. It underscores the importance of effective data governance policies to ensure that the data is suitable for analysis (Firican, 2017).
6. **Value:** The ultimate goal of Big Data is to extract value from the information it contains. This value can be in the form of insights, improved decision-making, cost savings, or new revenue streams. To achieve this, organizations must employ advanced analytics techniques, such as

machine learning and data mining, to discover hidden patterns, correlations, and trends within the data (Rouse, 2018).

7. **Visualization:** Visualization is crucial for making sense of Big Data. Human beings often struggle to comprehend large datasets without the aid of charts, graphs, and dashboards. Effective data visualization tools enable stakeholders to grasp complex information quickly and make data-driven decisions.
8. **Vulnerability:** The vast amounts of sensitive information within Big Data make it a target for cyberattacks. Ensuring the security and privacy of data is paramount. Robust security measures, encryption, access controls, and compliance with data protection regulations are essential components of Big Data management.

The advent of Big Data offers the means to process the vast data at its disposal, extracting value, meaning, and trends that inform the formulation of public policies, programs, or projects (Daniel, 2019). Big Data's characteristics of volume, velocity, variety, veracity, value, variability, visualization, and vulnerability make it a complex but invaluable resource for organizations (Iyilade, 2015; Kelechi, et al., 2020). Big data solutions also offer a means to tackle issues such as conflicting data, missing information, and the discovery of hidden relationships (Tulasi, 2013). Harnessing its potential requires a combination of advanced technologies, skilled data professionals, and a strategic approach to data management and analysis.

Importance of Big Data for Tertiary Institutions

Tertiary institutions serve as crucibles for knowledge enhancement and intellectual training to enrich both individuals and society as a whole (Banica & Radulescu, 2015; Adalia & Fawaz, 2017). These modern institutions of higher learning involve different disciplines, from conventional universities offering humanities, arts, and sciences programs to specialized institutions focusing on engineering, technology, agriculture, and more (Alemu, 2018). The significance of tertiary education is evolving and adapting to the challenges of modern times, with technology becoming a vital enabler for academic institutions to navigate these new frontiers. According to Banica and Radulescu (2015), in the quest to maximize the value of education, it is imperative to effectively harness the vast amount of data generated by the educational system to address contemporary challenges. In the view of Adalia and Fawaz (2017), tertiary education system, the meticulous management of student data across various departments and faculties holds undeniable importance.

The data in education can be accessed and disseminated through a range of devices, including mobile devices, personal computers, and laptops. In Big Data analytics, information management incorporates the entire lifecycle of data, including data collection, storage, analysis, retrieval, and output generation (Minimol, 2018). Big Data applications in tertiary institutions also extend to database systems capable of storing vast volumes of longitudinal student data, thereby capturing the dynamics of teaching and learning (Cope & Kalantzis, 2016). When students engage with learning technology, they leave behind a trail of data that can unveil clarity into their social interactions, intentions, connections, and goals.

Marsh, et al. (2014), Murumba and Micheni (2017) stressed that to fully unlock the potential of Big Data in education, it is imperative to embrace comprehensive ICT integration, ensuring that every facet of learners' activities is meticulously captured and recorded. This includes

contributions in class, assignment submissions (or lack thereof), responses to questions and their timing, as well as students' moods and peer group interactions, all of which fall under the purview of Big Data (Cope & Kalantzis, 2016). This approach furnishes institutions with real-time information on student activities in the campus, including the utilization of facilities such as the sick bay, dining halls, libraries, and bus services. Consequently, Kalota (2015), stated that educational authorities gain understanding into student behavior, facility usage patterns, and areas that may require expansion, thus placing them firmly in control of campus activities. Teachers can create online learning environments using computer applications like Learning Management Systems (LMS), enabling instruction, assessment, and grading to occur seamlessly in a digital realm (Daniel, 2019). Big data has the potential to influence various aspects of tertiary institutions, from enhancing the student experience to improving academic programs and enabling more efficient data-driven decision-making.

Big Data Analytics in Nigerian Tertiary Institutions

Higher education institutions have recently shown a growing interest in big data, primarily due to its potential to revolutionize educational strategies. This keen attention stems from the belief that leveraging big data can enable educational institutions to strategically harness their information technology resources. In doing so, they can enhance the quality of education, enhance student completion rates, bolster resilience, and improve overall academic performance (Ugodulunwa, et al., 2019). Although the term 'big data' may not be entirely new to education policymakers in Nigeria, it has historical relevance. Anikweze (1992) notably utilized 'big data' sourced from State Primary Education Commissions and various Ministries of Education in Nigeria to assess the feasibility of implementing the national policy mandating the Nigeria Certificate in Education (NCE) as the minimum entry qualification for the teaching profession in Nigeria. Furthermore, educators across various levels of education have had to grapple with copious amounts of data arising from managing sizable classes and rigorously scoring test scripts. Nevertheless, the practical intricacies of assessing and analyzing extensive and intricate datasets remain a challenge for many lecturers within Nigerian tertiary education institutions. This challenge according to Okereke (2014) aptly result in skill gaps from the rapid pace of technological advancement. Additionally, the financial implications associated with conducting Big Data analytics further compound these challenges.

In the view of Anikweze, Ugodulunwa, and Mainoma (2019), the Nigerian higher education system is marked by its diversity, including universities, polytechnics, and colleges of education, each with its unique challenges and opportunities. In this intricate tapestry of academia, the integration of data-driven approaches offers solutions that address the specific needs of diverse learners and institutions alike (Kalota, 2015). As the nation seeks to bolster its educational system and improve learning outcomes, the judicious use of data emerges as an imperative avenue for progress. Anikweze (2019), Eguavoen, et al., (2022) posited that despite the undeniable relevance and potential benefits associated with the utilization of big data, there remain significant technical hurdles that need thorough examination and resolution in Nigeria. The generated big data from assessment in Nigeria are not correlated to provide feedback for enhancing students' learning and performance (Ugodulunwa, et al., 2019). Students' responses in assignments and examinations mainly serve as a measurement of students' performances in an area rather than to aid in data-

based decision making in Nigeria (Schildkamp, Ehren & Lai, 2012). According to Esomonu, Esomonu and Eleje (2020), one may wonder whether educators, policy makers, government agency, etc., are aware of the sources, types, proportions, uses, and future of assessment big data in Nigeria. Research on identification, generation and uses of assessment big data in education is a recent development that needs more work. It is scarce, if not completely unavailable.

Challenges Facing Big Data Utilization in Nigerian Tertiary Institutions

The educational system encounters unique challenges owing to the sheer speed, size, and variety of data involved. Eguavoen, et al., (2022) stated that the implementation of Big Data in Nigerian tertiary institutions holds great promise for enhancing education, research, and administrative processes. However, Nigerian tertiary institutions face several significant challenges (Bichsel, 2012; Kaisler et al., 2013; Fadiya, Saydam, & Chukwuemeka, 2014) such as:

- 1. Lack of Adequate Internet Connectivity:** Many parts of Nigeria still lack reliable high-speed internet connectivity, making it difficult to transmit and process large datasets efficiently. This connectivity issue hampers the real-time data processing capabilities that Big Data relies on.
- 2. Cost Constraints:** The cost of implementing Big Data solutions, including purchasing hardware, software licenses, and training staff, can be prohibitive for cash-strapped Nigerian institutions. Budget constraints may limit their ability to harness the full potential of Big Data.
- 3. Data Privacy and Security:** Data privacy and security are paramount in any Big Data implementation. Nigerian institutions often struggle with ensuring the security of sensitive student and faculty information, especially given the prevalence of cyberattacks and data breaches.
- 4. Skills Gap:** The skill set required to work with Big Data technologies is relatively specialized. Nigerian institutions often lack sufficient number of personnel with expertise in data analytics, machine learning, and data engineering. Training existing staff or hiring qualified professionals can be a time-consuming and expensive process.
- 5. Data Quality and Accessibility:** Ensuring the quality of data is a significant challenge. Data collected from various sources in these institutions may be incomplete, inaccurate, or inconsistent. Cleaning and standardizing data are essential but resource-intensive tasks. Additionally, making data accessible to relevant stakeholders while protecting sensitive information can be complex.
- 6. Regulatory Compliance:** Nigerian tertiary institutions must adhere to data protection regulations, and implementing Big Data solutions requires compliance with these regulations. Ensuring that data collection and processing practices align with the law can be challenging and may require legal expertise.
- 7. Resistance to Change:** Institutional inertia and resistance to change can impede the adoption of Big Data initiatives. Faculty, staff, and administrators often shows resistant to new technologies and workflows, making it difficult to gain buy-in for implementation.
- 8. Electricity and Power Supply:** Nigeria faces frequent power outages and unreliable electricity supply. This can disrupt data processing and storage, necessitating the use of costly backup power solutions like generators or inverters.

Way Forward to Harness Big Data in Nigeria Tertiary Institutions

Nigerian tertiary institutions can harness Big Data to enhance education, research, and administrative processes. According to Eguavoen, et al., (2022) implementing effective strategies is crucial to overcome challenges and fully leverage the potential of Big Data. Some of the strategies to harness Big Data in Nigeria tertiary institutions are:

1. Allocate resources to upgrade and modernize IT infrastructure. This includes investing in high-speed internet connectivity, servers, storage systems, data analytics software and ensure that the hardware and software can handle the volume, velocity, and variety of Big Data.
2. Invest in training and development programs to build a workforce with expertise in data analytics, machine learning, and data engineering. Encourage staff and students to acquire skills in data science through workshops, courses, and certifications.
3. Develop collaboration among Nigerian tertiary institutions for sharing best practices, data sets, and analytics tools. Collaborative efforts can reduce costs and accelerate the adoption of Big Data solutions.
4. Begin with small-scale pilot projects to test Big Data solutions in specific departments or research areas. Gather feedback and refine strategies based on the outcomes of these pilot initiatives.
5. Implement data cleaning, validation, and standardization processes to enhance data quality. Consider data governance committees to oversee these processes and maintain data integrity.
6. Invest in real-time data analytics capabilities to support decision-making processes. This is particularly relevant for administrative functions, where real-time clarity can lead to more efficient operations.
7. Empower researchers with access to Big Data resources for conducting cutting-edge research. Encourage interdisciplinary collaboration to address complex societal challenges through data-driven research.
8. Strengthen cybersecurity measures to protect sensitive data. This includes encryption, access controls, regular security audits, and staff training to prevent data breaches.
9. Establish clear ethical guidelines for data collection and use. Ensure that the rights and privacy of students and staff are respected when handling personal data.
10. Develop a comprehensive, long-term Big Data strategy aligned with the institution's goals and vision. Regularly review and update this strategy to adapt to changing technological and organizational needs.

By implementing these strategies, Nigerian tertiary institutions can unlock the transformative potential of Big Data, leading to improved educational outcomes, research advancements, and administrative efficiency. It will position these institutions as leaders in data-driven innovation and problem-solving in the country.

Conclusion

Enhancing effective utilization of data-driving revolution in Nigerian tertiary institutions carries positive impact and challenges. Overcoming issues of data privacy, security, infrastructure limitations, and the need for a skilled workforce requires concerted effort and resources. Yet, these challenges are not insurmountable, and the potential rewards far outweigh the obstacles. In a challenging environment, this initiative serves as a guiding strategy, presenting transformative

solutions that can elevate the standards of education, research, and administrative efficiency to unprecedented levels. The strategies discussed in this paper provide a roadmap for tertiary institutions to harness big data effectively to enhance pedagogy. From investing in modern infrastructure to fostering a data-driven culture, collaborating and sharing resources, starting with Pilot Projects and promoting a Data-driven Culture emphasized the pivotal role that data plays in reshaping the Nigerian educational system. By embracing data analytics, Nigerian tertiary institutions can gain deeper understanding into student performance, tailor educational experiences, and optimize resource allocation. Furthermore, data-driven research can pave the way for groundbreaking discoveries, addressing critical societal issues and propelling Nigeria onto the global stage of innovation.

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