



Data Management and Challenges of E-Government Adoption in Nigeria

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ABSTRACT

Big Data refers to the massive amount of digital data being generated from different sources, extremely large, structured/unstructured that is too complex for analysis through conventional relational database techniques. Big data is one of the emerging and critical issues facing the government in this digital age. Global information has grown at a compound rate of 80% and is forecasted to reach approximately 2,500 exabytes (an exabyte is one billion gigabytes) by the end of 2023, based on a study by the International Data Corp. The three commonly cited features of big data are volume, velocity, and variety. Nigeria as a country is steadily moving towards digitizing some of the Government Departments, Schemes and Services at the Federal, State and Local government levels. Due to the increase in digital literacy of the people and the availability of data-intensive network access that is emerging, the need for use of E-governance applications is becoming imperative. Big Data is therefore redefining the landscape of data management, from extract, transform, and load, (ETL) processes to new technologies such as Hadoop for cleansing and organizing unstructured data in Big-Data applications, bringing up challenges of complexity, security, and risks as well as a need for new technology skills for analytics. This paper, briefly illustrates the model analytics of Big Data and how the transformation of the government can be increased in efficiency and effectiveness through the e-governance service with citizen engagement.

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INTRODUCTION

With the dawn of the technological age due to the wide spread of information and communication technologies (ICT), e-government is fast becoming of prime importance. It has the capability of promoting better governance, and transparency, raising service performance, eliminating bottlenecks in the service delivery process and tackling insecurity and insurgency. E-Government (or Electronic government) can be defined as the use of information and communication technologies to offer citizens and businesses the opportunity to interact and conduct business with the government by using different electronic media such as telephone touch pad, fax, smart cards, self-service kiosks, e-mail / Internet and so on.

Governments worldwide are integrating computer-based technologies as part of public administration reforms to digitize

the delivery of services and the process of governance. Under the right conditions, ICTs offer the government an effective resource to serve citizens and other stakeholders through electronic government ("e-Government"). E-Government, digital government and electronic governance (e-Governance) are three terms widely used to represent the use of Information and Communication Technologies in public sector organizations.

World Summit on the Information Society in 2005 Plan of Action recommends for governments to "Develop national e-Government initiatives and services, at all levels, adapted to the needs of citizens and business, to achieve a more efficient allocation of resources and public goods". Through e-Government, governments expect to improve the quality of services and reduce the costs of delivering services through the utilization of scarce resources, encourage citizen



participation, enhance accountability and transparency, expand the role of markets, and restore citizen trust and faith in government. The essence of this plan of action is to re-orient governments to treat citizens as customers of government services and improve the day-to-day management of financial and budgetary systems.

E-GOVERNMENT IMPLEMENTATION IN NIGERIA

Nigeria as a nation has strived to make use of ICT to improve the governance process at a different level. It can be said that there is relative success has been recorded in the country's quest to adopt and implement the e-Government process. However, the little success recorded by the country through these electronic and e-government projects has not been visible because there is no national framework that will guide the development of e-government projects and integrate them at various levels of development.

National Information Technology Development Agency (NITDA) developed the first national e-Government framework in 2010. The e-Government Framework for Nigeria is the most recent and comprehensive plan for Nigerian e- Government systems and their supporting infrastructure. A solid e- Government platform is a necessary delivery mode for the fast-tracked economic transformation aimed at vision 20-2020. In line with the National Vision, the vision for e-Government development in Nigeria was also set to achieve the top 20 ranks in the UN e-Government Survey by the year 2020.

The e-Government framework architecture is designed in three-tier layers, which incorporates the end users with the providers within the environmental factors to ensure the scheme's success. The tier 1 framework consists of the design and development of a super secure e-Government portal; "the enforcement of a directive that all federal, state and local government services be made progressively available on the e-Government portal between 2011 and 2015; and the assigning of Verifiable Digital Identity to citizens" (NITDA, 2010). This approach is to help create a consumer-centric marketplace. The tier 2 framework provides the architecture for integration of all services across all platforms through clearly defined interoperability policies;

security standards and policies; connectivity policies; centralized data exchange infrastructure; and back-end service policies. This approach is to spur specialized and unified services to ensure system consolidation and integration of key and common services such as client common interface, Network security, transaction gateways and the data exchange infrastructure.

The tier 3 framework provides the legal and leadership framework for the actualization of the e- Government dream. " On the legal front, the tier 3 framework suggests that a law called the Nigerian e- Government law should be promulgated to articulate the definition of e-governance in the Nigerian context along with its objectives and role; coordination and oversight mechanisms, support structures at various levels, their functions and responsibilities; roles, functions and responsibilities of government organizations at various levels; a mechanism for financial arrangements including public-private partnerships; specifying the requirements of a strategic control framework for e-Government projects dealing with statutory and sovereign functions of the government; responsibility for selection and adoption of standards and interoperability framework; and a framework for digital security and data protection " (NITDA, 2010). The bottleneck has been the political will to fully implement these developed frameworks.

NIGERIA'S E-GOVERNMENT RANKING – UN E-GOVERNMENT SURVEY 2020

The Department of Economic and Social Affairs of the United Nation produces the United Nations E-Government Survey every two years. It is the only report in the world that assesses the e-government development status of the 193 United Nations Member States. The survey aims to serve as a tool for decision-makers to identify their areas of strength and challenges in e-government and to guide e-government policies and strategies. The survey is particularly relevant to addressing the multi-faceted and complex challenges that the world is currently facing today.

SURVEY METHODOLOGY

Since its inception in 2003, the conceptual framework of the United Nations E-Government Survey has adopted a holistic view



of e-government development resting on three important dimensions:

- (i) The availability of online services.
- (ii) Telecommunication infrastructure.
- (iii) Human capacity.

The methodological framework has remained consistent across survey periods and it is based on the following guiding principles.

Firstly, the e-government in this Survey is considered a means to an end, the end being development for all. It is a powerful tool at the disposal of governments, which, if applied effectively, can contribute substantially to eradicating extreme poverty, protecting the environment and promoting social inclusion and economic opportunity for all.

Secondly, the Survey and its results must be juxtaposed in the context of the overall pattern and level of development of each country concerned. The assessment of the on-line presence of governments highlighted by the Survey must not provide a distorted picture of the progress made—and challenges faced—by the Member States. At the same time, it is equally important to underscore the promise of e-government. Therefore, the main measurements in this Survey are based on e-government readiness, which duly takes into account not only countries' specific e-government initiatives, as evidenced by web presence, but also their infrastructure and human resource endowments.

Thirdly, the focus of the Survey is on the provision of socio-economic and environmental services to the population through the use of e-government as a programmatic tool, as well as on participation and social inclusion.

Finally, the Survey assesses e-government readiness worldwide, taking the view that the ultimate objective remains the "inclusion of all" in development.

SURVEY RESULTS

Nigeria has recorded success in its e-government drive as it moves up from 121 to 102 positions in the African continent. The EGD rating is 0.3629 as against 0.2976 in 2018 (refer to appendix 1). The figure is slightly above the

regional average with 0.0368 points. There is an increase in online participation compared to the 0.5231 indexes of the 2018 survey. This can be attributed to the increase of web presence by MDAs after directives by the Federal Ministry of Communication to all MDAs through the National Council of ICT heads in MDAs, Mandating all MDAs to comply before the 2015 deadline. Telecommunication infrastructure also improved to 0.3714 from the index figure of 0.2979 in 2018. The National Broad Band policy was launched in 2013 and (recently reviewed in 2021) established the National Broad Band Implementation committee which has busted the Internet penetration drive. Despite the growth, there is still much to be done as currently, Nigeria is still far from the top 10 in Africa.

BIG DATA CONCEPTS

Gartner (2013) define Big Data as "...high-volume, high velocity and/or high variety information assets that demand cost-effective innovative forms of information processing for enhanced insight, decision making and process optimization". The continuous growth of the technology and the internet in today's digital world and the integration of computing into virtually every facet of human life are no doubt making the concept of Big Data a ubiquitous paradigm for deploying novel technologies/applications hitherto not practicable by conventional methods. New activities spring up, and more and more data sets are being created, faster than ever before. And these new sets, in some cases, hold the key to unlocking new streams of activities that will make both the government and the public a better understanding of business that will make it more efficient and effective.

Characteristics of Big Data

Phillip Russom (2011, 4th Edition) provided a similar definition to Gartner's idea with an emphasis on volume, variety and velocity, but with further insight on each of the 3V's. The summary of Philip Russom's definition is shown in the diagram below.

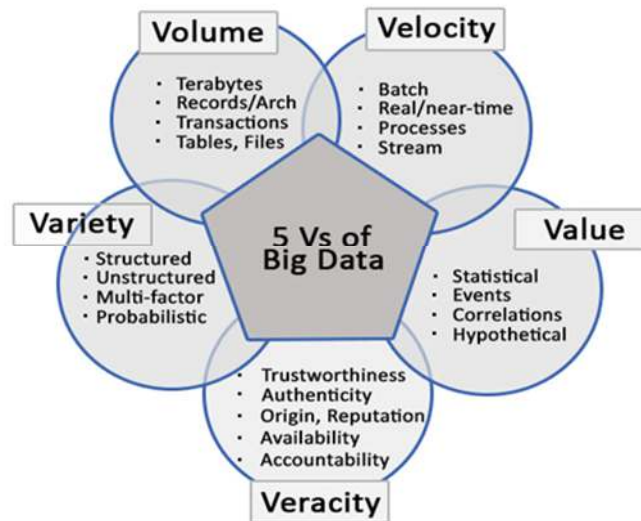


Figure 1: Summary of Big Data characteristics

Typically, big data is categorized based on three characteristics:

- **Volume:** How much data
- **Velocity:** How fast data is processed
- **Variety:** The various types of data

This is a convenient and simple categorization, especially on a relatively small amount of very disparate, complex data or even a huge volume of very simple data that can be structured or unstructured. Structured data is straightforward to analyze. Unstructured data is unpredictable in nature. Data from e-mails, blogs, digital images, videos, social media and satellite imagery are unstructured in nature. This type of data accounts for the majority of sources of data in both the private and public domains.

Other Vs that are important are the fourth V, *veracity* and the fifth V *value*. How accurate is that data in predicting business value? Do the results of a big data analysis make sense? Data must be able to be verified based on both accuracy and context. For example, an innovative business may want to be able to analyze massive amounts of data in real-time to quickly assess the value of that customer and the potential to provide additional offers to that customer. It is necessary to identify the right amount and types of data that can be analyzed in real-time to impact business outcomes.

BIG DATA ANALYTICS

Big data analytics refers to Data analysis being undertaken that uses a high volume of data from a variety of sources including structured, semi-structured, unstructured or even incomplete data. It is the phenomenon whereby the size (volume) of the data sets within the data analysis and velocity with which they need to be analyzed has outpaced the current abilities of standard business intelligence tools and methods of analysis.

Big Data analysis differs from conventional data management in the sense that traditional data analysis entails selecting a portion of the available data to analyze, such as taking a dataset from a data warehouse. Big Data analysis uses all the available data as raw as it is. The analysis is to explore the data to discover insights and understanding rather than interrogating the data. In traditional data management, the database is usually not optimized and the challenge is high-performance analysis, speed, scalability and availability.

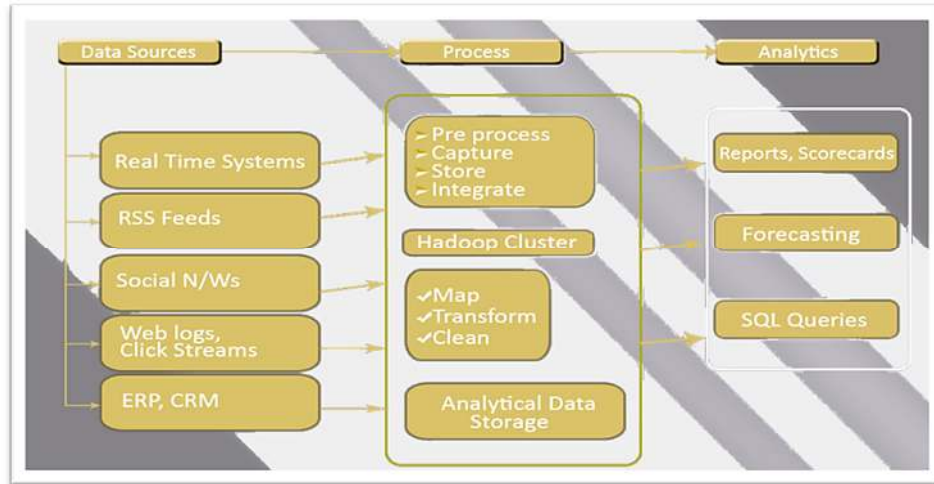


Figure 3: Big Data analytics process.

Big data analytics can be used to streamline service delivery, create opportunities for innovation, and identify new service and policy approaches as well as support the effective delivery of existing programs across a broad range of government operations - from the maintenance of our national infrastructure,

through the enhanced delivery of health services, to reduced response times for emergency personnel and national planning for economic growth and development. The uses cannot be over-emphasized. With proper Big Data analytics, the government can offer easy access to diverse and large quantities of data to its citizens.

Table 1: Characteristics of Traditional Versus Big Data Analytics

Traditional e-government	Big Data e-government
Only structured data	Raw, unstructured and semi-structured data.
Statistical analytics with a known condition	Discovery of unexplored business questions.
Tera-bytes of data	Large and messy data
Traditional analytics is batch-oriented and one needs to wait for transformation jobs to complete before the required insight is Text analytics.	Big Data Analytics is aimed at the near real-time analysis of the data using the support of relevant software meant for it.
Traditional analytics are based on the relational data model. Analytics based on the known relationship.	Graph, audio and video analytics.
Ad-hoc query report, high latency for a large Type of operation: relational and conditional	Very difficult to establish a relationship between all the information in a formal way, and hence unstructured data in the form of images, videos, Mobile generated Low latency, interactive, Visualization, decision-making Analytics: Sentimental, predictive, behavioural Machine Learning etc.

The benefits of government data with Big Data analytics are safer communities, smarter decisions, better-served citizens, improved fiscal performance greater innovation and citizen engagement, which is important in a democratic country like Nigeria.

Framework for Big Data Analytics

The Big Data analytics framework is a plan for Big Data analysis systems and their

supporting infrastructure, which maximizes the ability of a business to achieve organizational objectives. A good Big Data analytic framework should be able to support a range of technology with Big Data analysis capability and requirements such as availability, scalability, and high performance. Some important considerations in selecting a Big Data application analysis framework include the following:

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1. Support multiple data types.
2. Handle batch processing and/or real-time data streams.
3. Support NoSQL and other newer forms of accessing data.
4. Overcome low latency.
5. Provide cheap storage and Integrate with cloud deployments.

While all these characteristics are important, the perceived and actual value of creating applications from a framework is quicker time to deployment.

A Big Data framework for government should be able to support the four (4) basic components;

1. Resource Management,
2. Data organization and management,
3. Analytics and discovery,
4. Decision support and visualization report.

Below is a typical Big Data analytic framework that can suit any government for Big Data analytics.

Spark, MPI etc. This approach is cost-effective with improvement in performance and sharing capability. (British Embassy Tokyo)

The data organization and management level in the diagram above is the software that processes and prepares all types of structured and unstructured data for analysis. Typically most data models are either - Relational Database Management System (RDBMS) or a NoSQL database management system. RDBMS is optimized for scale and speed in processing huge relational data i.e structured and static data sets. Big Data analytics Stack interacts with RDBMS through connector – Sqoop. The Sqoop tool above is designed to efficiently transfer bulk data between Hadoop-related systems (like HDFS, Hbase and Hive) and RDBMS (like Oracle, MySQL, Postgres, HSQLDB etc.). In the NoSQL database management system, Hbase and Cassandra are for columnar databases, MongoDB for documents and Neo4j for graph-based No-SQL databases. This layer is rich in

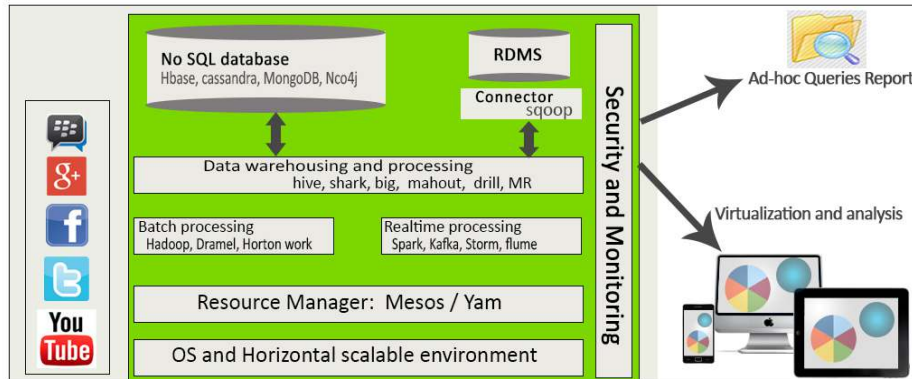


Figure 4: Big data analytic framework.

There are various frameworks developed in different companies with different strengths and own problem-solving capabilities for a certain class of application. In all, what is critical and ultimate for the developers of these frameworks is to stay on top and be in control of fast and reliable data processing capability. Resource management and scheduling platform - Mesos and Yam (Apache.org & Hadoop.apache.org), in the diagram above is a typical resource management component with the capability to increase resource utilization of clusters by sharing cluster resources among multiple processing frameworks like Hadoop,

functions and enough to serve all data types (British Embassy Tokyo).

Data Analytics is part of the framework designed to support offline and online data processing. The level has two layers with applications like Hadoop, Dramel, and Horton that works for offline batch processing on one part and application like Spark, Kafka, Storm and Flume for dynamic real-time analysis on the other part. Data mining, streaming and iterative computations are also carried out on this layer. The decision, support and virtualization layer is the analysis and reporting layer. It contains tools for user-friendly representation of information from various sources that can be analysed and used for decision-making. The report can be



visualized in a form normal to end users like the general public for analysis and informed decision making.

A good data analytic framework like the one in figure (4) above can analyse and explain trends or events that are transform and unique. The framework can carry out Predictive analysis, Behavioural analysis, Comparative analysis, Fraud analysis, Risk analysis, prediction and forecast and so many things with the information derived from the analysed data. Some government across the globe using Big Data Analytics includes: - (the Australian Government Information Management Office, Whitehouse office, British Embassy Tokyo office, Dutch flood control office etc).

CHALLENGES OF DATA MANAGEMENT IN NIGERIA

In Nigeria, with about approximately 250 million population, the challenge of data collection and mining is surely a big challenge, particularly with various organs of government that are involved in the management and usage of data for different purposes. Some of the agencies that are mandated to collect and manage data in Nigeria include:

1. National Bureau of Statistics (NBS) with the official mandate for the production of national official Statistics.
2. Federal Road Safety Commission (FRSC) for drivers' licenses and vehicle number plates.
3. National Identify Management Commission (NIMC) for national identity database.
4. National Population Commission is in charge of national demographic data.
5. Independent National Electoral Commission (INEC) for the voters' registration exercise.
6. Other organizations such as banks and the Telecommunication companies

Most of the data collected by these organizations are structured in nature and very suitable for current e-governance services. But due to a lack of central framework, inter-agency synergy and cooperation, the data is used presently for statistical purposes and does not solve any mission-critical challenge that can

improve the quality of the government service or schemes.

The amount of data is expected to grow as new technologies are adopted and an increasing amount of both structured and unstructured data becomes available from in and around the government. The application of Big Data analytics to this growing resource can increase the value of this asset to the government and the people. There is the need to have a national ICT strategy that will identify the need to have a framework for Big Data analytics to further develop government capability in Big Data. There is also a need to develop a policy that synergizes all the agencies that have the mandate to collect and manage data in Nigeria. This is to allow easy flow of information and exchange of data among the agency for the common good of the government.

A critical component of the decision-making process is information derived from the aggregation of data from various sources. The exponential growth and availability of structured and unstructured data are what make Big Data important. Depending on the purpose and volume of data, various strategies are being deployed in the management and usage of data for policy and planning purposes in organizations in both public and private settings.

RECOMMENDATIONS

For the Nigerian government to effectively explore the huge opportunities in Big Data analytics and run effective e-government services and digital economy the following guidelines are very necessary steps to follow:

1. Holistic Development and Implementation of a national master plan for e-government.
2. Development of a strategic plan to guide e-Government services and their adaptation
3. Understand the needs of all segments of the public through popular engagement that will enable citizens to participate in the implementation of e-Government services
4. Use well-established system development practices used by successful e-government nations like Korea and other advanced nations
5. Create a learning organization where employees are encouraged to



participate in developing and managing e-Government services including Big Data generation, capture and analytic process.

6. Develop effective Big Data governance mechanisms to assign roles and responsibilities for managing and making decisions about e-Government services and Big Data analytics.
7. Develop a Big Data analytic framework with capabilities for resource management, data organization and management, analytics and discovery, decision support and visualization report, and focusing on building a suitable ICT infrastructure to sustain long-term investments in e-Government, Big Data analytics and human capital development.
8. Create enabling environment for Big Data analytics business through a national Big Data analytics framework.
9. Provide a secure experience for web visitors by developing secured e-Government services, data security and disaster recovery plan.

CONCLUSION

Countries across the globe are trying to adopt big data technology in various domains like healthcare, crime prevention, agriculture, transportation, education, economy and natural disaster prevention management. Through Big Data analytics, Nigeria can lay a solid foundation that can solve the numerous problems militating her much desired and needed progress. Issues of a weak economy, unemployment, corruption, insecurity, weak private sector and many more can be tackled securely if we can convert the opportunities offered by Big data analytics by making proper analysis that will guide the leadership to make informed decisions, proper economic planning and policy formulation. The current drive for a digital economy would be in shamble if the problems militating against the full implementation and actualization of big data policy are not addressed or given the maximum political will.

Currently, most (if not all) serving e-governance applications are in silos. There is no

integration of these services through any integrating Enterprise Resource Planning (ERP) platforms like SAP, SAGE, DYNAMIX etc. At present most of the government data are in silos in the custody of various government institutions with limited or no sharing capabilities. Galaxy Backbone (GBB) which handles government data centres is yet to integrate all data into a common platform. The 1-gov.net-project design as a single window for source of information and data for government is still at the stage of mere web presence.

Effective e-government programmes can only be successful if there is a platform for data integration and applications for ERP systems. Developing countries like Nigeria have a huge population with the potential to generate a large volume of data, big data analytics can offer the government tools for good planning and better decision-making and provide better service. There is also a huge opportunity for revenue generation as organizations can outsource big data analytics services to the government at a cost. The open-source Big Data analytics framework above can provide a cost-effective solution and aid in effective service implementation. If implemented in our data centres, further resource management and scheduling mechanism can utilize the data centre resource efficiently. As we speak most of the e-government services are operating in silos and many with poor visibility. This has hindered the growth of the services in all sectors, most especially the public sector.

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