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Regular Research Manuscript

Evaluation of Business-Driven Reference Architecture for Big Data Analytics Implementation by Public Sector Organizations in Resource-Constrained Setting: A Case Study of Uganda

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ABSTRACT

Big Data Analytics (*BDA*) *is a new area at the nexus of agenda, public sector organizations, and government business. It may satisfy the growing need for trustworthy, cost-effective services in the public sector for better, more informed decision-making processes. BDA has been proposed on the planning schedules of several public sector organizations and the government. Therefore, from the previous work, using Uganda as a case study, specifically the Uganda Bureau of Statistics* (*UBOS*), *Ministry of Health* (*MoH*), *and Ministry of Education and Sports* (*MoES*), *this study aims to evaluate a designed Business-Driven Reference Architecture for Big Data Analytics Implementation* (*BRABDAI*) *in public sector organizations. Using a quantitative research method, the BRABDAI was analytically assessed using a structured walkthrough technique by 18 IT experts in the fields of data analysis, IT/IS management, and solution architecting. The assessment criterion was composed of three components: functionality, usability/applicability, and traceability. The Statistical Package for the Social Sciences* (*SPSS*) *software was used for data analysis. The findings showed that the BRABDAI was useful for resolving the key issues preventing the successful implementation of the BDA in public sector organization settings and that it was also understandable and traceable. To improve the usage and acceptability of BDA implementation in public sector organizations, the study advises more research on this topic.*

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INTRODUCTION

Organizations in the developing public sector are becoming more and more aware of the potential benefits that big data and its analytics may provide. Through their routine operations, such as administering pension and allowance payments, tax collecting, national health systems, recording traffic statistics, and issuing official papers, public sector organizations create and gather enormous amounts of structured data. The demand for big data applications today, meanwhile, extends beyond

structured data to semi-structured and unstructured data, which includes, among other things, emails, phone calls, messages, social media conversions, pictures, videos, and music as well as machine signals and satellite images. Developing public sector organizations have always had difficulty utilizing the ever-growing data for better public service delivery, improved decision-making, policy-making, and revamped citizen participation in government programs because these services and infrastructure are typically less readily available (Aggarwal and Manuel, 2016; Desouza and Jacob, 2017). Public sector organizations are under pressure to figure out how to use so-called big data for changes in public service delivery (Alharthi et al., 2017). However, BDA solutions are viewed as one response to this issue. This is so that data from all kinds of sources may be gathered, ingested, stored, processed, analyzed, visualized, and presented (Vasilyeva and Richardson, 2022). BDA, which encompasses visualization, ML approaches, and algorithms, is an evolving collection of tools and methodologies to manage and evaluate the exponential expansion of digital information (Shi, 2022; Vasilyeva and Richardson, 2022; Tamym *et. al*., 2023).

For individuals whose business operations are inevitably data-driven, BDA efforts provide the opportunity to address difficulties that arise within the public sector industry (Klievink et al., 2017). These projects contain artifacts in the form of models, reference architectures, frameworks, and platforms for use on the web and mobile devices. However, it is suggested that a developed artifact has to be assessed using well-founded evaluation methods to be confirmed for quality, efficacy, and efficiency (Collatto *et. al*., 2018). A designed artifact may be assessed based on its completeness, correctness, functionality, dependability, consistency, traceability, understandability, usability, and application (Larsen et al., 2020). In a companion study, the scientists used observational, analytical, experimental, testing, and descriptive assessment approaches to thoroughly assess constructed artifacts (Vom Brocke et al., 2020). The artifact evaluation should be carried out through lab tests, pilot applications that is to say the instantiation of prototypes), simulation techniques, and expert reviews, that is to say, the structured walkthrough approach and the Delphi technique approach), and field tests, that is to say, in various applications of the organizations (Deng and Ji 2018). This paper, therefore, is aimed at evaluating a designed business-driven reference architecture for big data analytics implementation in public sector organizations, taking the Uganda Bureau of Statistics, Ministry of Health, and Ministry of Education and Sport in Uganda using the expert judgment evaluation method.

Big Data Analytics in Public Sector Organizations

BDA is the emerging set of tools and methods to manage and analyze the explosive growth of digital information and includes visualization, ML techniques, and algorithms (Shi, 2022; Tamym et al., 2023). BDA is further termed as a process of harnessing, finding, and harvesting information and knowledge from a large number of datasets for informed decision-making (Watson, 2019). We can say that big data analytics is about two (2) things; big data and analytics as well as how the two (2) band up to create one of the most profound trends in Business Intelligence (BI) today. Public sector organizations are known with solid history to have potential numerous avenues from which big volumes of data can be obtained such as surveys, web, mobile applications, and records among others (Fredriksson et al., 2017). However, most of these avenues for data are not utilized by the public sector to address societal citizenry problems (Desouza and Jacob, 2017). Public sector organizations are uncertain about how to harness the advanced analytics tools to utilize ever-increasing data volumes and sources for the benefit of the public of improved public service delivery, justice and transparency, and saving money among others.

Public sector, the worldwide regretful problem of "food scarcity" can be eliminated by harnessing and leveraging big data and its analytics implementation by the government (Desouza and Jacob, 2017; Mishra *et. al*., 2018). They referred to this solution as "big data analytics to feed the earth". Moreover, BDA Innovative strategies can be used to predict and prevent disease outbreaks such COVID-19 pandemic from spreading (Kiganda and Akcayol, 2023). For public sector organizations not to be able to place BD and associated analytics into work, the consequences are bound to be pretty severe and negative (Mishra et al., 2018). The Gartner, big data research firm also adds that by 2023, sixty percent (60%) of business integrity abuses will occur through unsuitable implementation approaches of BDA tools in the public sector.

Therefore, from the above discussions, it can be observed that there is a need for implementing BDA in public sector organizations in a way that is in line with public sector organizations' mandates, interests, and business processes. It is asserted that eighty-five percent (85%) of the big data analytics implementation projects fail to bring the positive revolutions anticipated (Coyne *et. al*., 2018; Van der Voort *et. al*., 2019). Other organizations are even avoiding projects related to big data analytics altogether in fear of the registered high failure rate (Arora, 2019; Joubert *et. al*., 2023). BDA projects such as the Brexit project for predicting elections in the United Kingdom (UK) and the Flue Trend (FT) project by Google are known scenarios of big data analytics implementation failures in the global sphere. It can be deduced as an emphasis that there is a need for an approach in the form of business-driven reference architecture to guide the successful BDA implementation in public sector organizations. Figure 1 highlights some of the prominent promising applications for BDA in Public Sector Organizations.

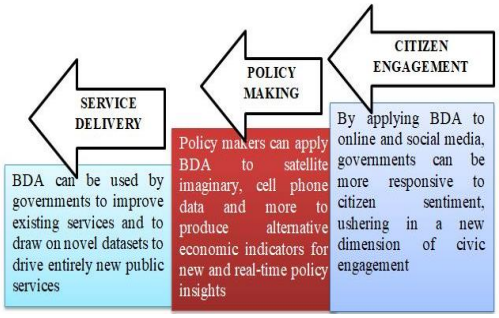

Figure 1: Some of the potential applications for BDA in public sector organizations.

Evaluation of Developed Artifact

Assessment is a crucial component of design science research methodology and artifact building (Baskerville *et. al*. (2018). This is because a fresh IT artifact has to show quantifiable advancements to show how technology has evolved, advanced, and therefore gained acceptability (Elragal and Haddara, 2019). Assessments show if a new technology created using design science research methodology (DSRM) functions or serves the intended objective. Without evaluation, DSRM results are unsupported claims that the developed artifacts will serve their intended function if put into use and deployed in practice (Plachkinova and Vo, 2022). Design science research methodology necessitates appropriate artifact evaluation to rigorously expose the quality of a created artifact (Peffers *et. al*., 2018). This outlines a systematic process to evaluate the artifact's completeness, effectiveness, and applicability. The assessment of a designed artifact is said to be possible on two levels: either directly or through one or more instantiations of the abstract artifact (Vom Brocke *et. al*., 2020).

Evaluation criteria are also organized according to system aspects and may be divided into a hierarchy of levels. Several generic evaluation methods may evaluate the same criterion. The type of assessment, supplementary participant, level of evaluation, and relativeness of evaluation are the four main criteria that differentiate generic evaluation systems (Vom Brocke *et. al*. 2020; Mwase et

al., 2022). Completeness, simplicity, clarity, homomorphism, style, degree of detail, and consistency may all be used to evaluate an artifact's structure (Pentek et al., 2017).

Parameters for the Evaluation

A designed artifact can be evaluated in terms of functionality, completeness, consistency, accuracy, performance, reliability, usability, fit with the organization, and other relevant quality attributes (Venable et al., 2016; Baskerville et al., 2017). Evaluation of artifacts takes too much time mainly because it involves a lot of parameters and at the same time some parameters are difficult to apply (Baskerville et al., 2018). Due to time constraints, the study adopted three parameters for the evaluation criterion of the Business-Driven Reference Architecture for Big Data Analytics Implementation (BRABDAI). In addition, it was considered more important to determine whether the reference architecture performed its functions well (functionality), was easy to use (usability/applicability), and had traceability. Each of the evaluation parameters is explained below:

Traceability (T): Traceability is defined as the ability to chronologically interrelate uniquely identifiable entities in a way that matters (Masudin et al. 2022). The reference architecture's stages and phases' links and interdependencies were assessed using this parameter. Generally, this parameter was used to measure how well the reference architecture steps and guidelines/principles can be traced in the designed reference architecture. It looks at how the reference architecture requirements can be traced from the origin through the interconnections and interdependences. The considered criteria include; determining if components interact, whether reference architecture variables are rationally ordered, and whether reference architecture phases are interconnected with one another.

Application/ Usability (A/U): Applicability is the degree to which a product can be used by specified users to realize intended objectives with efficiency, effectiveness, and satisfaction in a specified context of use (Mwase et al., 2022). Generally, the purpose of this parameter is to identify areas of confusion and ambiguity for the users which, when improved increase the efficiency and quality of a user's experience with the reference architecture. The considered criteria include; whether the reference architecture is simple to understand, simple to use, and simple to learn.

Functionality (F): This is intended behavior, interpretation of its behavior under a goal, a kind of hierarchical abstraction, or effects on the environment of the entity (Harahap et al., 2023). In simplicity, this parameter was used to measure the reference architecture's functionality in addressing all the major challenges for the successful implementation of BDA in public sector organizations. The considered criteria include; reference architecture designed to make it easier to implement BDA in public sector organizations by outlining the rules and standards that must be adhered to, and the thoroughness of the steps/activities to be followed during the BDA implementation in public sector organizations.

Structured Walkthrough Technique

Additionally, evaluation criteria are arranged in a hierarchy of levels and according to system components. The same criterion may be evaluated using one of numerous generic evaluation techniques. The four primary factors that distinguish generic evaluation systems are the kind of assessment, additional participants, degree of evaluation, and the relativeness of evaluation (Vom Brocke *et. al*., 2020; Mwase et al., 2022). An artifact's structure may be judged based on its completeness, simplicity, clarity, homomorphism, style, degree of detail, or coherence (Pentek *et. al*., 2017).

The main objective of a structured walkthrough is to find issues and improve the product's level of quality. The purpose of the structured walk-through is error identification rather than error repair (Green, 2021). After the walkthrough, it is up to the work product's author(s) to make

any necessary adjustments. Additionally, it can be carried out in various ways, with various degrees of formality, and with various types of participants. This tactic is useful when the opinions and ideas of experts are needed. During an organized walkthrough, the group of certified specialists should examine the intended artifact for the following things: whether it satisfies objectives, whether it accurately depicts the system, whether there are any errors or ambiguities, and whether it is easy to understand.

METHODS AND MATERIALS

This section outlines the methodology (approach) used to carry out the study. It is a strategy for demonstrating how goals were met (Schoonenboom, and John, 2017; Ishtiaq 2019; Elsayed and Elsayed, 2021). The main scientific approach used to carry out the full investigation is described in this chapter's part. For this inquiry, the Design Science Research Methodology (DSRM) was employed. DSRM is a paradigm in information system science for comprehending, carrying out, and evaluating studies that attempt to produce new and unique artifacts meant to answer problems observed inside the organization (Vom Peffers et al., 2018; Brocke et al., 2020). It focuses on technology and tries to make things that help people. Artifacts include things like constructs, models, procedures, architectures, and representations.

The evaluation exercise was conducted using a quantitative research strategy. Quantitative research enables academics to respond to theoretical and real-world inquiries about how people interact with various objects, such as computer systems and apps (Bloomfield and Fisher, 2019). A sample of between 2 and above specialists produces sufficient findings when the structured walkthrough approach is used (Peffers et al., 2018; Leßenich and Sobernig, 2023). Therefore, for this study, 18 IT experts (Data Analysts, IT/IS managers, and Business Analysts (Data Solution Architects)) in two roles (Database administrator and IS/IT manager) were purposefully chosen from industry and academia within the two public sector organizations of Uganda (Ministry of Health, Ministry of Education, and Uganda Bureau of Statistics). Data was gathered using a questionnaire using a five-point Likert scale. Data analysis was done using Statistical Package for the Social Sciences (SPSS), and descriptive statistics were produced.

The structured walkthrough was adopted as it is systematically used as a common technique for evaluating artifacts in DSRM. Artifacts should be evaluated for relevant quality attributes based on the requirements of the context of their implementation and should expose evidence that the artifacts can solve real problems, hence, the selection of the three evaluation parameters (traceability, applicability, and functionality). It is also difficult to evaluate the artifact with all the parameters due to time constraints. Under the traceability parameter, the criteria considered include; whether the BRABDAI stages are interdependent/ dependent on each other, BRABDAI components can communicate with one another, and also BRABDAI components are clear and presented well. In the case of the applicability parameter, the evaluation criteria considered include; whether the BRABDAI is easy to follow and use, BRABDAI is easy to comprehend and also learning BRABDAI is easy. Finally, the functionality parameter accounted for the criteria of whether BRABDAI phases are complete, key aspects of BDA implementation in public sector organizations are covered and also the process of BDA implementation in public sector organizations is simplified.

During the valuation exercise, the inputs included the reference architecture, the evaluation questionnaire, and the evaluation agenda. The agenda had the following elements;

1) Explaining the aim of the research study physically as well as their responsibilities as

participants in the evaluation exercise, 2) Presenting and explaining the reference architecture (Proof of concept version 2) to the selected respondents to study it through use of phone call and social networks, 3) Discussing the reference architecture steps with the participants, 4) Getting feedback about the reference architecture and how they can be improved in terms of traceability, applicability and functionality and 4) Sending an email containing a questionnaire with introductory information with instructions

Validity and Reliability of the Research Instruments

The questionnaire underwent testing to determine its face, construct, and content validity. In contrast to construct validity, which determines the type of psychological construct or characteristics being measured by the instrument, content validity measures how well an instrument includes a representative sample of questions that relate to the content domain being measured (Taherdoost, 2016; Mohajan, 2017). Experts and peers from Makerere University helped with the review to guarantee the instrument properly measured the variables it was meant to evaluate in the study. They also assured content and construct validity. Face validity was concerned with the format of the instrument and includes, among other things, peer-reviewed characteristics such as the legibility of the printing, font size, and type, suitability of workspace, and appropriateness of language.

The degree to which a survey instrument is consistent with the variables it assesses is referred to as reliability. The instrument was pre-tested using a sample of 10 operational IT employees from a data processing unit from Uganda's public sector, who were not necessarily in the main sample, to assure trustworthiness. It was decided to utilize 10 participants for the pre-test because 10–30 people are adequate to assess the reliability of a survey tool (Heale and Twycross, 2015). Pre-test findings demonstrated that the instrument was dependable since the sampled experts' answers to the questions were consistent and simple to understand.

The data collected from the participants during the survey and literature from the previous study were used to derive the following summary of data in terms of requirements (Table 1) on which the BRABDAI under evaluation in this paper was designed.

Table 1: Summary of the derived requirements, (Feld data, 2023)

Thematic Area	ID	Requirement Name
Understanding of Data Practices and Features	R1	Need to ensure that these business processes produce additional business value, it is necessary to first define the business need in terms of business process/operation.
	R2	It is necessary to support low, medium, and high data amounts.
	R3	Need to support data collection from various sources, including social media, surveys, dispersed and centralized data sources, and secondary data from government agencies, among others.
	R4	Need to ensure that the data sources for a particular choice may be quickly and readily expanded by including new data sources.
	R5	Need to support transactional systems like slow, medium, and fast data exchanges between data sources and the Big Data platform.

Tools for Data Life Cycle	R6	Tools for big data analytics must be integrated throughout the data pipeline (Derived from the Literature)
Analytical Processing of Data	R7	Support for a variety of processing and analysis is required (including stream, batch-oriented, real-time, and predictive, among others).
Measures for Data Security and Privacy	R8	Support for advanced data security mechanisms like temporal multiplexing and Key management is required.
	R9	Highly sensitive data must be protected and kept private to significantly reduce data and IT security threats.
	R10	It is necessary to verify adherence to national data privacy and security regulations (Derived from the Literature)

RESULTS AND DISCUSSIONS

This study adopted the expert judgment (structured walkthrough technique approach) evaluation method to assess the BRABDAI. This is because expert judgment relies on a group of experienced scientists with a good understanding of environmental problems and who are the most knowledgeable and capable members of society to judge the relative significance of interventions (Colson and Cooke, 2017). Expert judgment further plays a vital role in risk management, uncertainty analysis, and decision-making (Beaudrie, Kandlikar, and Ramachandran 2016).

Evaluated BRABDAI

In this study, the artifact is the designed business-driven reference architecture for BRABDAI in public sector organizations taking a case study of Uganda. This is presented in Figure 2.

The BRABDAI was designed based on adopted architectural components from existing reference architecture that is: The National Institute of Standards and Technology (Interoperability, 2015), and derived decisions from both primary data and mini-literature review. The various components of the BRABDAI were graphically illustrated using generic notations.

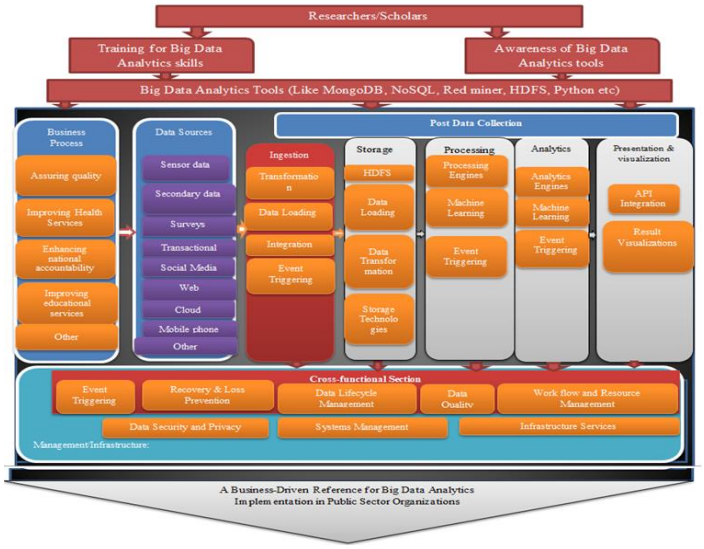

Figure 2: The Final BRABDAI version two (Field Data, 2023).

There are numerous notations and tools available, each with benefits and drawbacks, such as the Microsoft Office Visio, Unified Modeling Language (UML), and Business Process Model and Notation (BPMN). However, it is necessary to display data flow and workflow phases using a combination of unified modeling language sequence, component, and activity diagrams to reflect the new reference architecture which is more complex to comprehend. Existing architectures also applied generic representations; hence, as no standard notations exist for this reason, it was decided to apply generic boxes-and-lines notations. In addition, generic mapping notations were adopted to simplify an effective understanding of its overall reference architecture.

Explanation of the business-driven reference architecture for big data analytics implementation by public sector organizations in Uganda

Component of Business Processes Layer: What do organizations in the public sector want to accomplish with BDA? Does it seek to enhance decision-making procedures, comprehend its clients/citizens better, or look for new sources of income? It can begin the BDA implementation project after it is clear on its goals. These are the inquiries that the BRABDAI layer addresses

Component of Data Sources Layer: As from the previous work, what data does the public sector organization have, and where does it come from? Organizations will need to think about structured, semi-structured, and unstructured data and internal and external data sources.

Post Data Collection Layer:

Ingestion Component: From the previous work, this addresses the requirement that data from the data sources must first be input into the BDA tool. There are numerous ways to contribute data to the BDA tool, including batch loading and stream loading. The business-driven reference architecture that has been established depends on data intake since it dictates how data will be ingested, converted, and stored. Ingestion BDA tools include, among others, Apache Storm and Trident, Kafka, and Sqoop.

Storage Component: The main example of this element at the storage layer is Hadoop for BD storage. The HDFS itself, which contains all the data required for analysis in the public sector organization, is a crucial part of it. Different storage technologies, such as Column Databases (CDB), Key-Value Databases (KVDB), Graph Databases (GDB), Document Databases (DDB), and Analytical Databases (ADB), are used to implement the physical Hadoop depending on the data that needs to be stored and the associated business procedure. The component identifies the places where every piece of data required for analysis is stored. Big data analytics storage options include Neo4j, MongoDB, and Not Only Structured Query Language Database (NoSQLDB), to name a few.

Processing & Analytics Component: Data is processed to allow insights to be extracted using analytical and predictive algorithms, and data consumers (applications that need data for further processing) utilize the insights. New machine learning models may be created, trained on large data sets using currently existing ML concepts, and then implemented as a prediction service. For the data to be of good quality and available for use in the future, this processing and analytics step is essential.

Component of Presentation & Operationalization: The foundation of the component is the need for post-processing applications to be able to see and apply the outcomes of calculations produced in the analytics and processing phase to extract

insights from data. In conclusion, the creation of data visualizations that are simple for people to grasp is the responsibility of the data presentation and operationalization components. This element is crucial for making the data available for use in practical choices**.**

Infrastructure/Management Layer: The infrastructure layer is maintained in the new BRABDAI. Nevertheless, it has been enhanced by the inclusion of a cross-functional component that addresses all functional tasks required to support the fundamental components and span the whole post-data collection process. Infrastructure and all operational practices that support the BRABDAI's post-data collection components are included in this component or layer. It covers all aspects of post-data collecting. Here, metadata (data security and privacy) issues are dealt with, guaranteeing system security and adherence to data protection laws (metadata concerns). One of its components, Identity and Access Management, establishes the roles and privileges for data access. To ensure that the BDA platform complies with the Regulation for General Data Protection by following the rules of purpose for data consumption, data stewardship explains why a role has access to specific data sets and how it uses this data. Thus, the BRABDAI can be used to support successful BDA implementation in Uganda's public sector organizations since most of the challenges concerning BDA implementations have been addressed. Moreover, the experts' opinions have also been incorporated.

Evaluation Results

Study participants

A total of 18 experts were purposively selected to participate in the evaluation exercise. The participants included 6 Data Analysts, IT/IS managers, Business analysts (Data solution architects) from two public sector organizations, and 6 Business data analyst experts (see Table 2).

Table 2: Expert participants involved in the evaluation of the BRABDAI in public sector organizations in Uganda, (Field Data, 2023)

Participants	Public Sector Organizations and Number of Experts	No
Data analysts, IT/IS Managers	Uganda Bureau of Statistics (Data analysts 3, IT/IS Manager 3) Ministry of Education and Sports (Data Analysts 3, IT/IS Manager 3)	6 6
Business Data Analysts (Data solution architects)	Ministry of Education and Sports (Business Data Analysts (Data Solution Architects 3) and Uganda Bureau of Statistics (Business Data Analysts 3)	3 3
Total		**18**

Demographic Characteristics of the Evaluation Participants

The fact that 44% of participants were women and 56% of participants were men, suggests that there were no gender concerns throughout the evaluation procedure. The majority of the respondents were aged 30-39 years (67%) followed by those who were in the age bracket of 20 to 29 (22%) and finally, 11% of those who were in the age bracket of 40 to 49. The age results indicated that the respondents were mature enough to be suitable for the subject under investigation. The majority of participants (72%) had a bachelor's degree, while 28% had a master's degree or higher. This indicated that the evaluation participants had been instructed to

provide proper responses for the evaluation activity. Furthermore, the majority of respondents (78%) had 4-5 years of job experience, as shown below, followed by those with 6 and above years of work experience (11%) and those with 2 to 3 years of work experience (11%). This also showed that the respondents had enough knowledge to perform the evaluation exercise for the developed IT artifact (Reference architecture). Figure representations 3, 4, 5, and 6 summarize the demographic characteristics of respondents who participated in the evaluation.

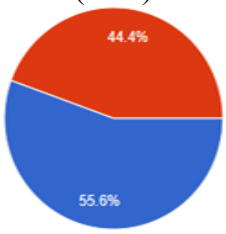

Figure 3: Demographic Findings: Gender with male (blue) and female (red), (Field Data, 2023).

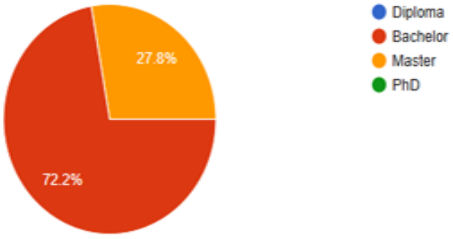

Figure 4: Demographic Findings: Level of Education, (Field Data, 2023).

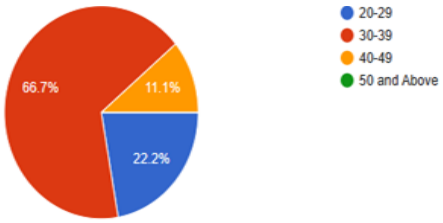

Figure 5: Demographic Findings: Age, (Field Data, 2023)

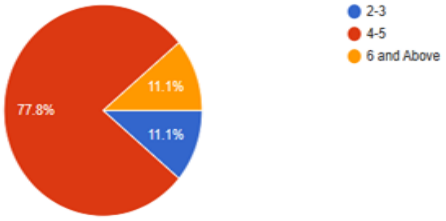

Figure 6: Demographic Findings: Work experience, (Field Data, 2023).

Results from the IT Experts

The functionality, traceability, and applicability of the created business-driven reference architecture for big data analytics implementation in public sector organizations were assessed using descriptive statistics in the form of mean, as explained below.

Traceability of the reference architecture: With a mean of 5.0, the respondents overwhelmingly concurred that the stages of the reference architecture are interdependent with one another. Furthermore, the BRABDAI components averaged 5.0 for interactivity (the capacity to interact with one another). The respondents highly agreed that the components and variables were presented correctly, with a mean of 5.0. Figure 7 presents these findings graphically for traceability evaluation parameters.

Applicability of the reference architecture: According to the evaluation's findings, public sector organizations can successfully execute big data analytics using the reference design. The experts overwhelmingly concurred that the reference architecture is simple to use, simple to understand, and simple to learn, with a mean of 5.0. Figure 8 presents these findings graphically for applicability evaluation parameters.

The Functionality of the Reference Architecture: According to respondents, the BRABDAI simplifies the process of implementing BDA (mean =4.7), addresses the main requirements or aspects impeding the successful implementation of BDA by public sector organizations (mean =5.0), and completes the steps taken to successfully implement BDA in the public sector (mean

=5.0). Figure 9 depicts these findings graphically.

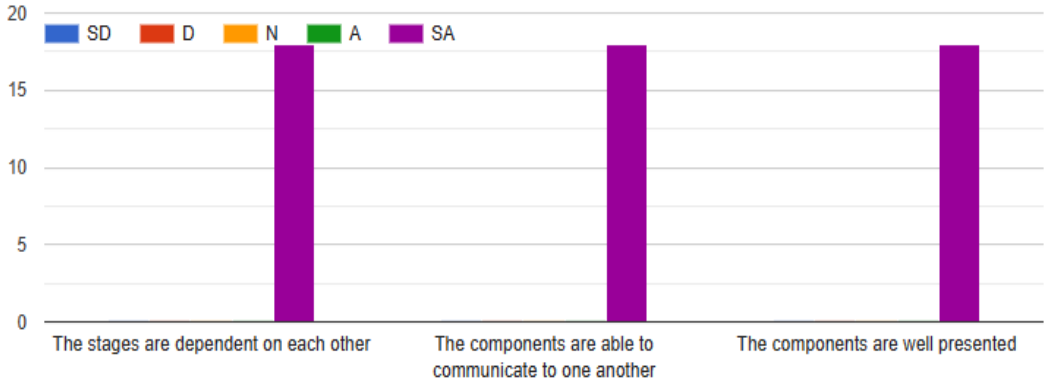

Figure 7: Evaluation results from expert's opinions based on the parameter of traceability (Field Data (2023)

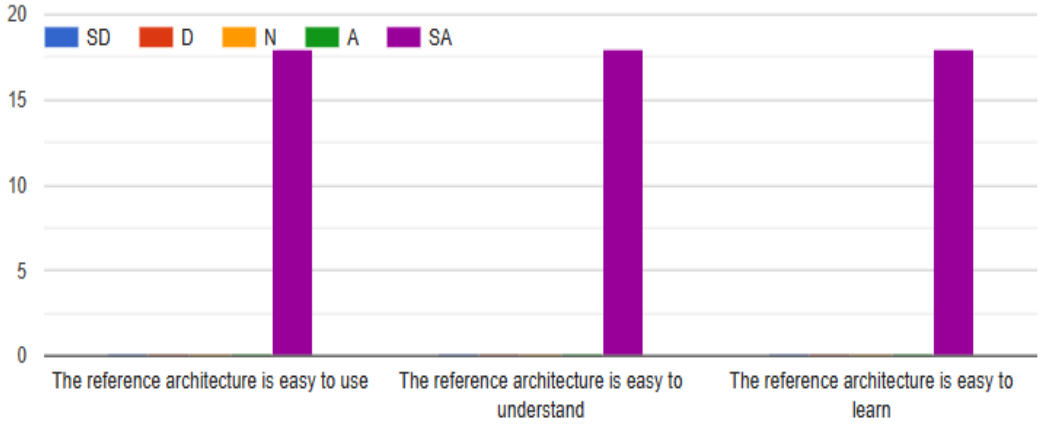

Figure 8: Evaluation results from experts based on the parameter of applicability, (Field Data (2023).

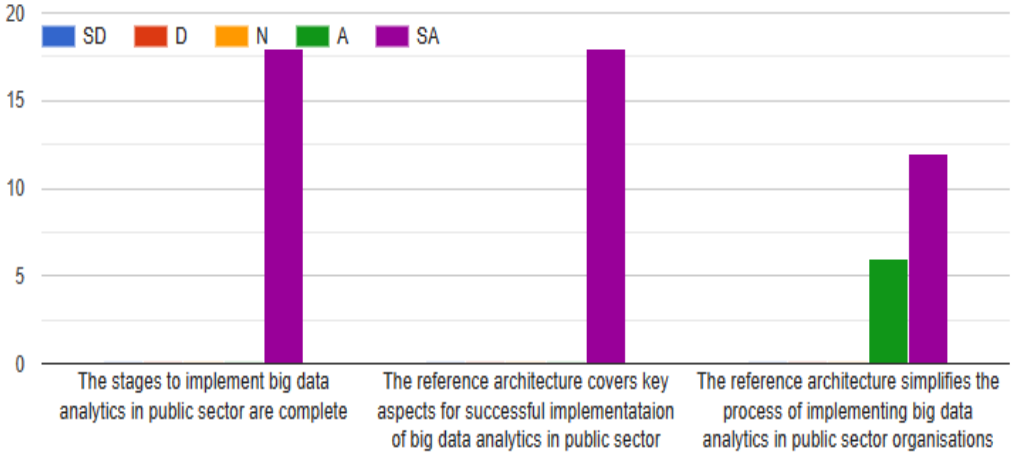

Figure 9: Evaluation results from expert's opinions based on the parameter of functionality, (Field Data, 2023).

General Expert Recommendations for an Improved BRABDAI

Eleven experts suggested the need to consider the component of integration and interoperability of information from existing legacy systems. This suggestion was put into consideration because experts asserted that the existing data management tools host a lot of essential data which can be of great importance for organizations if integrated with new forms of data. Therefore, the BRABDAI was fine-tuned and thus improved to incorporate the suggestions from the experts.

Thirteen (13) of the respondents (IT experts) further pointed out the significant impact of training big data analytics skills to be part of the BRABDAI. In the initial BRABDAI, the training for BDA skills was not considered one of the components. This change was reflected in the final version of the RA.

Experts further pointed out that researchers (scholars) and practitioners can also be part of the BRABDAI component as they play a major role in finding the fundamental valid principles and tenets of BDA projects in public sector organizations. This was taken into account and reflected in the final version of the reference architecture.

When it comes to directing the effective implementation of BDA by public sector organizations, the experts stressed the significance of the business process component as the primary component in the reference development process. Additionally, experts emphasized that areas in black needed to be colored in brighter hues, and arrows were to be improved to be more visible. The reference architecture's final iteration took these adjustments into account. Although processing and analytics may use the same technologies, sixteen (16) of the respondents noted that because processing and analytics provide different outputs in the data pipeline, they should be separated by having processing come before analytics. The ultimate reference architecture reflected this.

To capture the BRABDAI's general goal as well as the domain in which it was developed, the experts also suggested that the BRABDAI should include the title of the research, which is "A Business-Driven Reference Architecture for Big Data Analytics Implementation in Public Sector Organizations." The ultimate reference architecture takes into account this suggested adjustment as well. According to fifteen (15) respondents, the developed reference architecture should reflect BDA tools and awareness components because it is about the implementation of BDA solutions in public sector organizations. The final BRABDAI took this under consideration and addressed it.

All experts preferred to have independent component cutting across that represents the backup storage/Stage sites. They further asserted that this is very important in case of infrastructure outrages such as electricity, server breakdowns, and other outrages to avoid data loss. This component was put into consideration for improved BRABDAI in public sector organizations**.** Figure 4.9 shows the final Reference Architecture for implementing BDA in public sector organizations with all recommendations from experts addressed.

CONCLUSION AND RECOMMENDATIONS

This study focused on the concept of evaluating designed business-driven reference architecture for big data analytics implementation (BRABDAI) in public sector organizations in Uganda to ensure successful BDA projects deliver expected business value through the utilization of ever-increasing BD for public service delivery interests. The BRABDAI was evaluated using the structured walkthrough technique and the findings revealed that the reference architecture was useful, and the reference architecture layout was understandable and applicable. This affirmed that the BRABDAI can support the

BDA implementation project in Uganda's public sector organizations.

The potential benefits for effective use of BDA initiatives in public sector organizations for enhanced public service delivery are promising. Therefore, this study recommends that public sector organizations use the developed reference architecture (BRABDAI) when planning and implementing BDA innovations and projects. Further research should focus on developing a framework for enhancing the use and acceptance of BDA implementation in public sector organizations.

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