

Enterprise Architecture on Hadoop Eco-System Development for Political Tendency Support Analytics in Malaysia

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Article history

Received:
18 Sept 2022

Received in revised
form:
25 Nov 2022

Accepted:
10 Dec 2022

Published online:
15 Dec 2022

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Abstract

This study proposed a conceptual idea on the establishment of a Big Data ecosystem for political tendency analytics support in Malaysia. This whole concept is represented as an Enterprise Architecture (EA) framework using the (The Open Group Framework) TOGAF approach. The business process of gathering different types of data from more than 33,000 localities in Malaysia political boundary and how these data being processed to provide leads and insight for ground operations shall be discussed. The discussion on the implemented business process described within 3 layers as per TOGAF Architecture Development Method (ADM). Those are the business, application, and technology layer. The established framework in the form of building blocks indicate how business, data, application, and technology can be associated with one another. EA is a proven approach that can be used to improvised current business processes which enable integration of both advanced technology and established strategies. The proposed EA for Big Data implementation on real-time analytics for the political tendency analytics can be a guideline for political parties to implement this approach as their 'performance' monitoring tool.

Keywords: *Big Data, Enterprise Architecture, Hadoop, Political Sentiment, Data Analytics*

1. Introduction

Political tendency support is a very important indicator especially for the incumbent party which administered the government at both federal and state level. This indicator reflects the public's satisfaction on the efficiency of government administration and quality of service delivered, therefore will enable pro-active improvisation in terms of service and governance.

Since the establishment of a government at federal and state level depends on numbers of seats secured by political parties during the election, there are needs to strategize and mobilize their resources at every constituency seat based on several key evaluated data points that might influence public sentiments. The evaluated data points shall be considered from the smallest political boundaries and aggregated up to parliamentary boundaries whereby all associated factors to be taken into consideration.

As an example, a representative from a political party could have performed an excellent work at his or her constituency with numbers of public related projects execution and continuously engaged with people within the assigned boundary, though negative news or rumors associated with other individuals from the same party might affect the local sentiments despite the excellence service delivered by the representative. On another note, different perceptions from the public should be also observed and measured at different demographics and administrative levels.

Political tendency support is always dynamic, getting tremendous public support during elections, does not guarantee the same support for the upcoming election. Therefore, the analytics of political tendency support should not solely be based on static historical data as the public tends to change their opinions towards political parties over time based on current issues, activities, wish lists, promises and delivery which are usually highlighted in either main-stream or social media. Some of this information might also require party machineries assistance for the inputs.

The fundamental concept of data analytics indicated that better insight could be derived whenever different sets of detailed data sources are included. The key word here is 'detailed' whereby the information of both historical and current type of data as per described above shall be obtained for more than 33,000 localities all over Malaysia. This requires an ecosystem capable of handling huge capacity of data in terms of storage and processing.

The enablement of this initiative can be kick-started with the implementation of the EA approach. Business strategy and IT strategy must be aligned whereby clear direction on the implementation can be mutually agreed by related stakeholders. Implementation of EA within a political party in Malaysia to operationalize a certain workflow is an interesting use case as not many related references can be found on the internet. Most of these references point towards either business or government related organizations. It is important to implement EA for this initiative as the IT elements heavily influence the outcome.

1.1. Problem Statement

There are 6 problem statements highlighted in this study. The first 3 related to operational issues and the following 3 related to technology issues. These issues include lack of data points for strategic planning, silos & redundant operations, uncertainty on decision making process, lack of capability from legacy data platform, delayed stream of information and migration from old to new platform.

1.2. Study Objectives

The objective of this paper is to propose the EA framework of Hadoop Big Data ecosystem within the scope of data ingestion, data storage, data processing and data visualization for political tendency support analytics in Malaysia. The architecture to be represented using TOGAF guided by ADM. TOGAF is a framework for EA that focuses on the business, data, application, and technology architecture domains that are typically used. The objective of this study is based on TOGAF architecture domain which includes business, application, and technology layer. We want to propose conceptual architecture for each of these layers by considering numbers of research questions. For the objective on business layer we want to know what are

the typical business process? Who involve in the business process? And what are the expected outcome from the business process? As for application layer, we want to know what are the existing platform? What type of data generated from these platforms and what kind of report can be produced? Finally for the technology layer we want to know what kind of technology utilized to support the architecture at application layer.

1.3. Study Significance

We believe the outcome of this study will enable further research for service improvement that enable governance enhancement, transparency promotion and proactive delivery. The integration of BDA ecosystem will enhance practice of governance in any organization whereby information being systematically stored, secured, analyzed, and distributed. The establishment of an ecosystem whereby every single piece of data which related to the organization activities such as projects, funds, visits, and other activities that being recorded is an indicator of transparency and a mechanism to combat corruption. A proactive delivery is an outcome of the predictive and prescriptive analytics from BDA ecosystem which strategically aligned with the business process within the organization.

2. Literature Review

The literature review of this study investigates previous research on the improvement of good governance and quality public service by considering research related to governance and political influence, processes, technology utilization and bridging architecture.

Based on the analysis made from the collected data, a study conducted by Nor, R Gain. et. al., 2022 had confirmed the elements of commitment, entrepreneurship and professionalism within the civil apparatus became the stimulus to improve public service quality. It is pretty clear that people's attitude within the organization reflects quality of the services that being delivered. This finding can be interpreted as whatever implemented process flow, strategy or technology that being adapted will fail without the above-mentioned qualities from the organization's member. Another similar study by Khawaja, S., & Khalid, S. U., 2022 include accountability as additional factor for public service quality measurement and a check and balance system shall be established. Both studies however did not discuss further on how these elements can be measured, whereas only confirmed on those ethics and values factors via qualitative research. Using sample data from 22 local governments boundaries in Flemish Region, Belgium, the public service delivery externalization options indicated that these local governments have preference on public-public collaboration and public-private partnership (PPP) compared to the idea of corporatization (Vos, D., & Voets, J., 2022). As highlighted in this research, the externalization option preference related to consideration on being realistic of cost capability in single handedly managing public service in a local government. This study suggests the element of political influence can be excluded for the externalization options and the fact that policy maker also consider future challenges. Based on this study, the authors implied that public service delivery quality can be enhanced by working together with the external parties. While the administration cost can be reduced, there are needs to manage the partnership

effectively thus an enabler to monitor service delivery performance is required. On another note, political intervention somehow can also influence how the local governments performed. A case study in Nigeria suggested that public service delivery in rural area is critical due to lack of responsiveness from the local political office holders (Popoola, A. et. al., 2022). Another study conducted by Woodhouse, E. F., Belardinelli, P., & Bertelli, A. M., 2022 indicated that delivery of infrastructure can influence voters' preference however this voting preference would not last if the infrastructure projects failed to be materialized. Project materialization arguably depend on the local government constraint on projects delivery. There will always be hiccups at the higher level of administration which eventually effect the execution process. Chen, X., 2022, in his study find that local government within homogeneous residents with granted autonomy had significantly show positive effect on allocation management whereby development expenditures reduced. This statement suggested that the autonomy given enable options for service corporatization or public-private partnership. Grossman, G., & Slough, T., 2022 in their empirical literatures analysis highlighted government responsiveness consist of three type of actors which are the politicians, bureaucrats and the publics or citizens. The study indicated relationship between these actors on the responsiveness of government delivery. Another study which highlighted the element of responsiveness is by Manaf, H. A. et. al., 2022. Based on their study 3 main public concern on local government service quality include lack public participation before any decision being made, actions to complains and delayed respond on mitigating problematic basic public infra. Here we can observe that elements of public inclusivity within the local government administration is crucial. Based on the above studies the involvement of every stakeholders either from the internal or external parties of the governing entity plays important roles on the reflected public service quality. Each of these stakeholders seemed to connect and communicate to one another whereby these interactions produced data that can be analyze for the sake of planning and strategizing. The scenario will definitely require digital technology adaptation.

The E-Government service approach had been implemented for quite some time. Government entities around the world had created many applications to engage with their citizens. The adaptation of E-Government benefit both government and citizens. Study by Lichtsteiner, A. et. al., 2022 highlighted that technology investment is compulsory as it proven to enhance the delivered service. On top of that the embarkment of E-Government can also reduce the bureaucratic corruption as every transaction leave digital footprint which enable simple forensic investigation (Sadik-Zada. et. al., 2022). The implementation of E-Government also enables data sharing between agencies which produced improvised insight for better service delivery. However, it depends on the administrative policy implemented. Study by Ma, D. et. al., 2022 suggest the policy implemented within government administration influence the data sharing initiative between agencies. The E-Government also have several other challenges which include the process of adaptation and acceptance from both government and citizen. This is a timely process, in a study conducted by Tan, H. et. al., 2022, the authors highlighted the tendency of an E-Government project initiative to fail as it do not perform as expected. The authors claimed that this event is due to project performance dictated by political environment whereby project motivation is due to political

achievement. Another argument is based on a study produced by O'Brochta, W., 2022. As this digital applications purpose is to connect citizen with politician and bureaucrats, the responds obtained is quite low compared to direct engagement via personal connection. Though data of this study collected from Delhi-India, similar situation might occur in other developing nations. Based on this finding, the author suggest that the existence of E-Government platform does not guarantee improvement on government delivery. Politician especially can be more responsive to complaints which came directly to them as it can be translated into political mileage. This study implied that engagement should be made directly to the elected politician instead of public digital apps, therefore elected representatives within that particular constituency shall have them personalize digital platform. The E-Government implementation will eventually create peta-bytes of data and this required advanced technology that able to store, process and produce report from this massive data. Study by Vasilyeva, O., & Richardson, A., 2022 agreed that Big Data Analytics (BDA) can improvised government delivery. However, the technology adaptation within the public sector required through studies as it involve the existing policy and information systems. Since political environment also dictate government delivery, it is important to also analyze streams of data from the social media daily on sentiment observation. Sehgal, D. et. al., 2018 in their study addressed the importance of using Big Data technology such as Hadoop to process and analyze these streams of data from the social media. Utilization of BDA in politic had also been proven to assist targeted political campaigns and put the candidate in the advantage side whereby capability of data processing being handle by Apache Hadoop framework and Map-Reduce, this was highlighted in a study conducted by Jagged, G. 2017.

The adaptation of BDA in the existing eco-system require deep understanding on the existing business process and IT system that supported this process. Gong, Y., & Janssen, M., 2021 in their study find that the adaptation of BDA can be initiated either internally or externally. The internal strategy is to integrate BDA eco-system into the existing IT components whereby it will be a time-consuming process. The external strategy is to introduce separate eco-system which can be a faster option, however this will create another kind of silo. They illustrate two basic approaches to include EA into BDA adoption and implementation as a process and as a blueprint. Although the EA as a process method allowed for faster accomplishment of BDA benefits, it did not consider existing systems, which could lead to long-term integration issues. The EA as a blueprint approach, on the other hand, was focused on the long-term benefits of BDA adoption. Study by Kearny, C. et. al., 2016 indicated that Enterprise Architecture (EA) can be implemented to incorporate Big Data Analytics (BDA) within any organization using various types of EA approach, specifically TOGAF ADM to support a data driven enterprise. When data is used to its full potential as part of a business strategy, TOGAF ADM can be fitted in numerous ways. Other study by Lnenicka, M. et. al., 2017 highlighted the importance of stakeholders such as executive decision makers, developers, and designers to understand how BDA requirements can influence the strategic management of EA.

There are 4 main key points extracted from the literatures related to this study. The first point related to the importance of stakeholder understanding, participations

and sponsorship for EA enablement in any organizations. The second point is on the highlight on requirement of faster, targeted and efficient business process. The third point is related to the data management whereby efficiency, data consumption and governance being stress out. Finally, on integration and adoption of proposed EA with the cost impact and rate of acceptance within the organization.

3. Methodology

This study was conducted by utilizing 3 out of 7 steps from hypothetico-deductive model as introduced by Sekaran & Bougie in 2016. We focused on the problem definition which considering academic and non-academic reference, and look for the gaps, we also determine tool and measures that can be used to close these gaps. Next, we evaluate the measure in term of business, application and technology perspectives which contributed to the establishment of research question and objectives. Finally, we propose our architecture which satisfy the research questions and objectives.

3.1. Instrumentation

This section will discuss the development of TOGAF 4 architecture domains (Business, Data, Application and Technology) via ADM. Based on these domains, the architecture developed according to the scope of data ingestion, data storage, data processing and data visualization within the Hadoop ecosystem for political tendency support analytics in Malaysia. The ADM is a generic architecture development method designed to address most system and organizational needs. However, it will often be necessary to modify or extend the ADM to suit specific needs. The developed architecture is represented in building blocks.

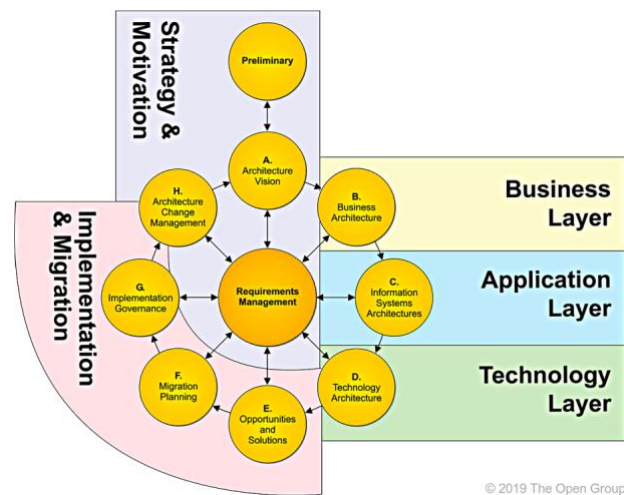


Figure 1. TOGAF ADM

The business architecture proposed to be developed based on observation of typical political structure and related organizations or people involved in the process to collect, ingest, store, process and visualize related data for the prediction modelling purpose whereby the produced insight shall be utilized as leads in the strategy development and implementation. The elements focused on the business

architecture include business objectives, processes, people, and organization involved.

The application and data architecture proposed to be developed based on the typical type of applications used to collect all related types of data available or required within any political environment in Malaysia and capabilities to implement the rest of the above-mentioned business processes. The application and data architecture includes 3 focus elements which are the service delivery, data entities and the applications used to ingest, store, process and visualize the data.

The technology architecture proposed to be developed based on the typical Hadoop eco-system deployment whereby name node (master) and data node (client) are operational within the cloud server This refers to the technological aspect in terms of hardware and software that is being utilized to support business processes applications and data. The architecture proposed shows the relationship between business services, business processes, application components, data components and technology components.

The data source shall be obtained internally and externally. The internal data includes anything related to the party's information which covers details of membership, branches, assets, financial, engagement activities, projects promised and delivered and list of people or places of interest within that constituency.

Some of the internal data such as membership, branches and assets can be retrieved easily from the administrator of existing IT ecosystem, on the other hand, data which required input from grassroots machineries such as activities conducted within a locality require development of digital application whereby this application can be accessed anywhere from the locality representative's mobile device.

The external data includes voters' information, election results, public administrative related information, news, and social media. This information can be obtained from numbers of external resources, whereby some of it requires approval upon acquisition process from the data owner. Other external data such as news and social media data can be easily scraped from the respective platforms.

All the obtained data will be extracted, pre-processed, transformed and loaded into the Hadoop Distributed Files System (HDFS) environment. To ensure uninterrupted operation, a proper data pipeline considering both DataOps and MLOps shall be designed accordingly as per business processes. DataOps combines an integrated and process-oriented perspective on data with automation and methods from agile software engineering to improve quality, speed, and collaboration and promote a culture of continuous improvement (Ereth, J. 2018, p. 104-112.). On the other hand, the practice of continuous delivery of machine learning is called MLOps (Mäkinen, S., Skogström, H., Laaksonen, E., & Mikkonen, T., 2021). Next, data processing and visualisation developed as per business requirement study, in this case it will be the political inclination analytics towards several outstanding political parties in Malaysia.

4. Proposed Architecture

This section will discuss thoroughly on the proposed architecture based on the business, application and technology layer as referred from TOGAF ADM in Fig.1.

4.1. Business Layer

Business architecture to be focused on 4 elements which include services that can benefit political strategizing and operation implementation, list of business processes that need to be implemented to materialize the provided service and connection with the organizations and people involved throughout the process. The business processes developed as per two main objectives which are for the sentiment observation and sentiment mitigation whereby advisory on ground operation can be delivered continuously.

As per Fig.2 related organizations can be also involved from certain government agencies where data from these agencies can be helpful to enhance data models for predictive analytics. Some of these agencies includes Suruhanjaya Pilihanraya Malaysia, Jabatan Kebajikan Masyarakat and other agencies which usually deal with public welfare.

On the other hand, involvement from all levels within the organization is required, therefore project sponsorship from the party leader at HQ level shall be acquired to ensure smooth operation. The whole process might be jeopardized if the messaging of the initiative failed to be distributed in every level since the involvement of party grassroots is important to gather and channel information from the ground to HQ.

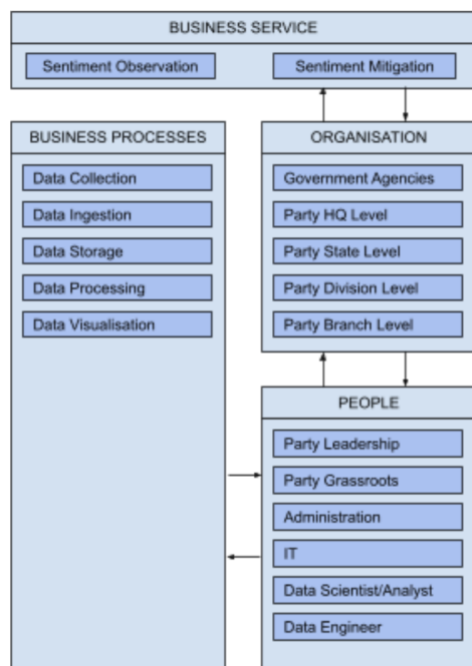


Figure 2. Business Process at Business Layer

4.2. Application Layer

Process of data retrievals from the internal source could be straightforward as the IT administration via the existing and legacy Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) applications had been collecting organization information since its establishment. On the other hand, data retrieval from the external sources which require 3rd party applications to access sometimes can be troublesome whereby strict pre-approvals process from the data owner might apply. The application layer of proposed data and application architecture shall be focusing on the data entities to be obtained, applications used to collect, ingest, store, process and visualize whereby business service can be delivered to the rightful stakeholders in terms of reporting and advisory.

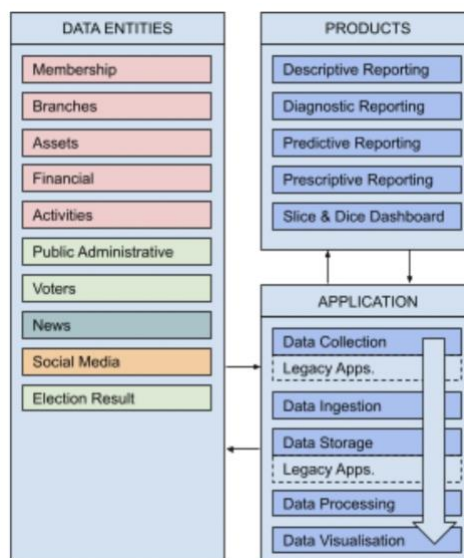


Figure 3. Business Process at Application Layer

4.2.1. Data Collection

Data collection from the internal source requires approval from the management and intervention from the IT administration to create access tokens for the Hadoop ecosystem to be able to ‘communicate’ to the existing data warehouse. However, some other data may require input from the party’s grassroots which requires an additional layer of information feed. An interface of web or mobile application to channel information from the grassroots to the party Headquarter (HQ) shall be developed. Raw data obtained from external sources may require manual processing before being stored into the organization data warehouse. This however is manageable since the incoming external data especially from government agencies is shared periodically, i.e., voters’ information being shared every quarterly.

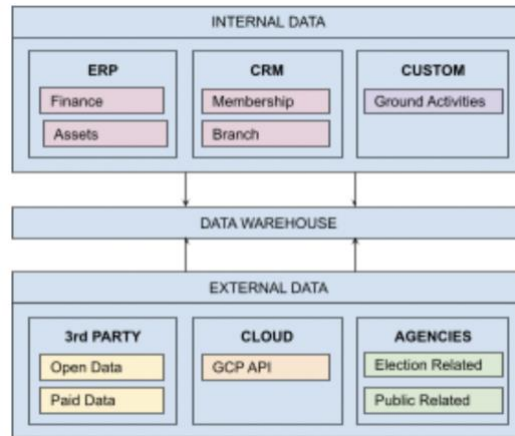


Figure 4. Data Collection

4.2.2 Data Ingestion

Considering all the data stored in SQL format, Apache Sqoop is being utilized to transfer bulk data from the data warehouse to the HDFS environment. Apache Sqoop enables efficient data transfer between Hadoop and other legacy’s structured data warehouses consisting of different types of relational databases such as Teradata, Netezza, Oracle, MySQL, Postgres, and HSQLDB.

Table 1. Type of Data

No.	Data Description		
	Type	Source	Category
1	Membership	IT (Existing)	Internal
2	Branches	IT (Existing)	Internal
3	Assets	IT (Existing)	Internal
4	Financial	IT (Existing)	Internal
5	Activities	IT (Develop)	Internal
6	Public Administrative	Gov. Agency	External
7	Voters	Gov. Agency	External
8	News	Internet	External
9	Social Media	Internet	External
10	Election Result	Gov. Agency	External

As a continuous stream of data from the news and social media platforms also need to be observed and analyzed, the application of Apache Flume will be deployed for the ingestion. It collects, aggregates, and transports a large amount of streaming data from multiple sources to HDFS. Apache Flume consists of 3 main components which includes source, sink and channel.

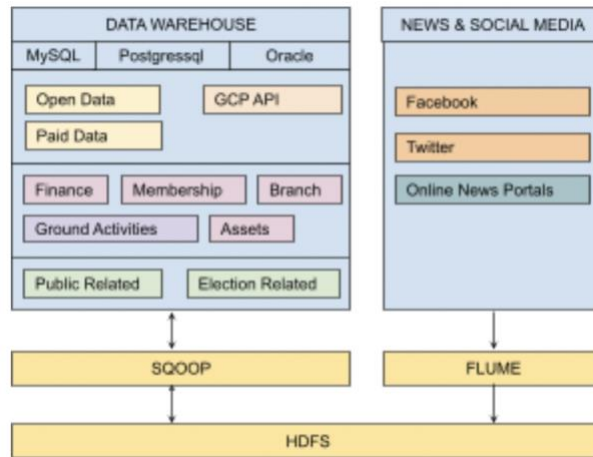


Figure 5. Data Ingestion

4.2.3 Data Storage

The data storage will be using typical HDFS architecture whereby number of slaves nodes (or data nodes) will be managed by a master node (or name node). As for the scope of this project, the implementation consideration shall include storage scalability. Some regions in Malaysia could produce a bigger size of data compared to the others, therefore the data nodes proposed to be grouped into 5 different regions in Malaysia consisting of Eastern, Northern, Central, Southern and East Malaysia. Conceptually, data nodes from each of these regions consist of states originating data within that region.

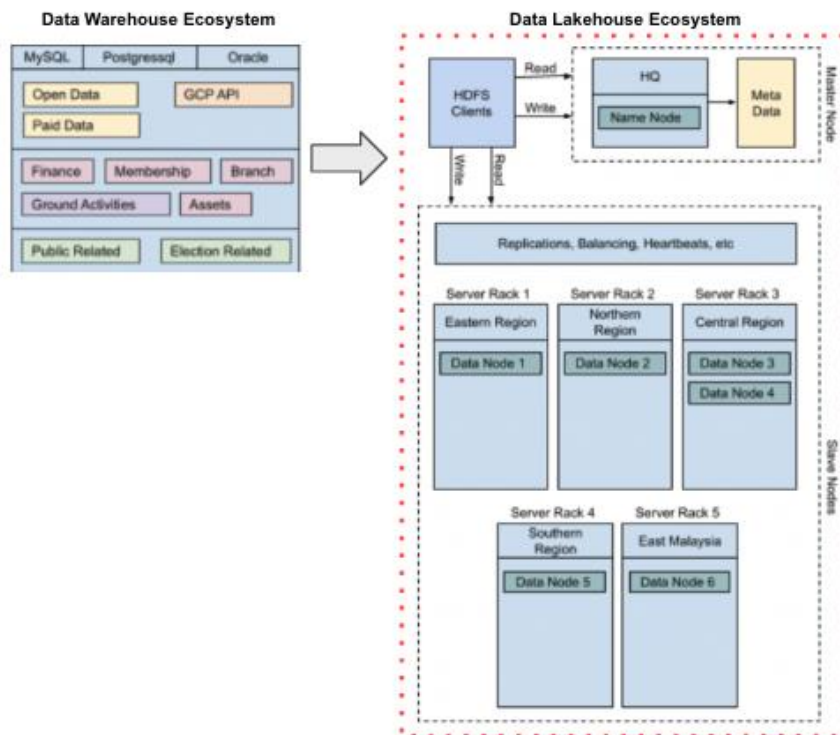


Figure 6. Data Storage

4.2.4 Data Processing

There are multiple approaches in data processing activity, though this study will be focusing on the activities that involve data querying, modelling and machine learning using applications that enable execution of Hadoop jobs in MapReduce.

The Hive application query data from databases which integrated with HDFS via HiveQL and transformed the request into MapReduce. This application can execute analysis for large datasets. 4 main components in Hive architecture include Hadoop components (HDFS & MapReduce), Metastore, Driver and Hive Client.

Like Hive, Pig is another application that can analyze a large dataset whereby it translates Pig queries into Java MapReduce code. This application enables its user to spend more time on problem solving instead of complicated Java coding in MapReduce. Pig also enables ETL processing within the data pipeline which can be useful in any DataOps.

The Spark application is an alternative for Map Reduce whenever a smaller workload is required. Compared to MapReduce where data processed on the disk, Spark processed in-memory retained data whereby this approach increased its processing speed almost 100 times compared to MapReduce. This advantage enables Spark to deliver real time analytics. Spark can be used for data ingestion, data pipeline integration and Machine Learning.

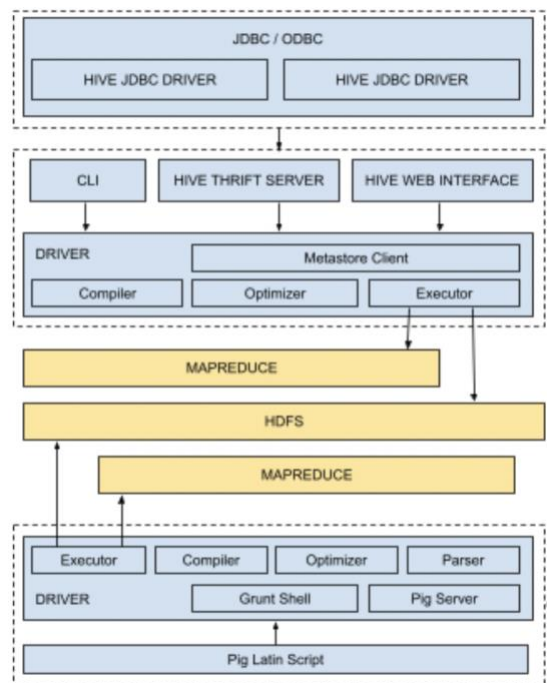


Figure 7. MapReduce Data Processing

4.2.5 Data Visualization

The data visualization tools, or applications can be flexible. The reporting approach could be either in the form of a dashboard or pdf formatted report. The dashboard shall be displayed in the organization command center for live monitoring whereby a detailed printed report shall be prepared. Tableau server application can be used as the dashboard visualization tool, on the other hand Jasper Report application can be used as the pdf reporting tool.

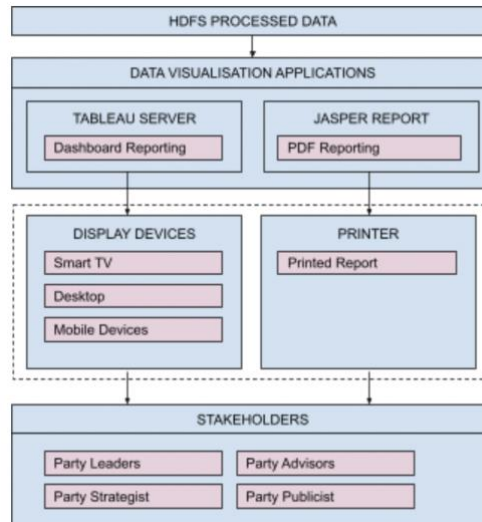


Figure 8. Data Visualization

4.3. Technology Layer

Two main technologies that shall apply to ensure the Hadoop ecosystem can be operationalized are software and hardware. These technologies must be able to support all the indicated business processes from data collection up to data visualization. The installation setup and maintenance shall be advised and managed by someone competent and with adherence to an establish data governance policy.

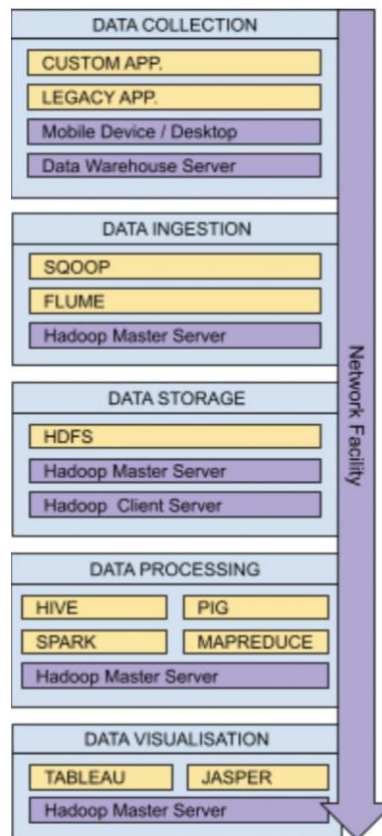


Figure 9. Business Process at Technology Layer

5. Conclusion

EA is a proven approach that can be used to improvised current business processes which enable integration of both advanced technology and established strategies. The proposed EA for Big Data implementation on real-time analytics for the political tendency can be a guideline for political parties to implement this approach as their 'performance' monitoring tool. Implementation of this ecosystem can be made into a few stages or batches. Another alternative is by small scale implementation, whereby the entire process to be implemented and experimented in one locality. The advantage is the process can be refined before scaling up to the entire nation. The currently developed framework within the block diagram can be further enhanced by using ArchiMate as the common EA language. By considering the propose conceptual architecture, we came into 4 main conclusions. The first conclusion is improvisation. EA approach can be used to improvised current business processes by integration of advance technologies and established strategies. Second conclusion is the guideline. The proposed architecture can be a guideline for political organization to integrate BDA technology in their ecosystem. Third conclusion is flexibility. The proposed framework indicate flexibility for technology integration whereby stages of implementation can be plan. And finally, the adaptability. In the event where technology improves, the same framework can still be utilized with replacement of the existing technology.

Acknowledgment

This paper was written based on-site experience on several political operations which adhered to a few strategies and knowledge sharing established by Tan Sri Datuk Seri (Dr.) Alies Anor Abdul and Datuk Khan Mohd Akram Khan.

References

6.1. Journal Article

- [1] Nor, R., Gani, A., Saleh, C., & Amin, F. (2022). Organizational commitment and professionalism to determine public satisfaction through good governance, public service quality, and public empowerment. *International Review on Public and Nonprofit Marketing*, 19(1), 191-217.
- [2] Vasilyeva, O., & Richardson, A. (2022). Big Data and Data Analytics for Enhanced Decision-Making in the Public Sector.
- [3] Vos, D., & Voets, J. (2022). Why do Local Governments Externalise Public Service Delivery? An Empirical Analysis of the Drivers of Corporatisation, Public-public Collaboration and PPP in the Flemish Elderly Care Sector. *Lex Localis- Journal of Local Self-Government*, 20(1).
- [4] Chen, X. (2022). Local autonomy and service delivery: how does home rule shape the provision of local public services?. *Public Management Review*, 1-24.
- [5] Popoola, A., Magidimisha-Chipungu, H., & Chipungu, L. (2022). Towards rural inclusion: improving the governance of service delivery in Nigeria. *Cogent Social Sciences*, 8(1), 2118793.
- [6] Woodhouse, E. F., Belardinelli, P., & Bertelli, A. M. (2022). Hybrid governance and the attribution of political responsibility: Experimental evidence from the United States. *Journal of Public Administration Research and Theory*, 32(1), 150-165.
- [7] Khawaja, S., & Khalid, S. U. (2022). Retooling governance for improving public service delivery: Case study of right to public services commission, Khyber Pakhtunkhwa, Pakistan. *Governance*, 35(2), 421-436.
- [8] Grossman, G., & Slough, T. (2022). Government Responsiveness in Developing Countries. *Annual Review of Political Science*, 25, 131-153.
- [9] O'Brochta, W. (2022). Politicians' complaint response: E-governance and personal relationships. *Governance*.
- [10] Sadik-Zada, E. R., Gatto, A., & Niftiyev, I. (2022). E-government and petty corruption in public sector service delivery. *Technology Analysis & Strategic Management*, 1-17.
- [11] Lichtsteiner, A., Karavdic, S. D., & Delafrooz, F. (2022). Influence of Information Technology on Service Delivery among the Public Customer Care Centers in Switzerland. *Journal of Information and Technology*, 6(1).
- [12] Tan, H., Zhao, X., & Zhang, N. (2022). Technology symbolization: Political mechanism of local e-government adoption and implementation. *International Review of Administrative Sciences*, 88(2), 511-532.
- [13] Ma, D., Zhou, J., & Zuo, M. (2022). Inter-agency information sharing for Chinese e-government development: a comparison between vertical and horizontal dimensions. *Information Technology for Development*, 28(2), 297-318.
- [14] Manaf, H. A., Mohamed, A. M., & Harvey, W. S. (2022). Citizen Perceptions and Public Servant Accountability of Local Government Service Delivery in Malaysia. *International Journal of Public Administration*, 1-10.
- [15] Gong, Y., & Janssen, M. (2021). Roles and capabilities of enterprise architecture in big data analytics technology adoption and implementation. *Journal of theoretical and applied electronic commerce research*, 16(1), 37-51.
- [16] Kılınç, D. (2019). A spark-based big data analysis framework for real-time sentiment prediction on streaming data. *Software: Practice and Experience*, 49(9), 1352-1364.
- [17] Burmeister, F., Drews, P., & Schirmer, I. (2018). Towards an extended enterprise architecture meta-model for Big Data- A literature-based approach.
- [18] Sehgal, D., & Agarwal, A. K. (2018). Real-time sentiment analysis of big data applications using Twitter data with Hadoop framework. In *Soft computing: theories and applications* (pp. 765-772). Springer, Singapore.
- [19] Shaikh, F., Rangrez, F., Khan, A., & Shaikh, U. (2017, June). Social media analytics based on big data. In *2017 International Conference on Intelligent Computing and Control (I2C2)* (pp. 1-6). IEEE.
- [20] Lněnička, M., Máchová, R., Komárková, J., & Čermáková, I. (2017). Components of big data analytics for strategic management of enterprise architecture. In *SMSIS 2017: Proceedings of the 12th International Conference on Strategic Management and its Support by Information Systems*. Vysoká škola báňská-Technická univerzita Ostrava.
- [21] Kearny, C., Gerber, A., & van der Merwe, A. (2016, October). Data-driven enterprise architecture and the TOGAF ADM phases. In *2016 IEEE International conference on systems, man, and cybernetics (SMC)* (pp. 004603-004608). IEEE.