An Integrated Metamodel for Enterprise Architecture using Open Government Data Approach: A Conceptual Framework

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Abstract. The government is always looking forward to providing citizens with excellent service. One of the government's significant agenda is to identify ways to improve the quality of service and deliver the best service to their citizens. Both Malaysia Open Government Data (MOGD) and Malaysia Government Enterprise Architecture (MyGovEA) initiative play a vital role in assisting the government in providing excellent service deliverables to the citizens. These domains must integrate each other towards the country's economic and social growth. In this paper, we propose the new conceptual model on a new metamodel for the OGD using the Government Enterprise Architecture (GEA) modeling process. Based on the OGD problem and challenges define map with the Archimate metamodel notation to classify the OGD context with the EA metamodel. The study becomes an opportunity for the MyGovEA team and the researchers to highlight EA integration across industry and agencies.

1. Introduction

The most significant of the government's agenda is always looking forward to providing an excellent service deliverable to the citizens. Recently, the innovation on re-strategized their National Information, Communication, and Technology (ICT) Agenda (NITA) by incorporating the EA initiative, strengthening the policy, standards, and practices in the context of ICT plays a vital role in empowering this agenda [1]. Government Enterprise Architecture (GEA) initiatives are the strategic management tool that helps to consolidate the development of business strategies [2]. Malaysian digital transformation and e-government programs require the integration between the agencies in the context of business and ICT towards achieving the agency's functionalities preparing the useful data and information for the decision-making to provide seamless services to the citizens and help the country economic and social growth.

Open Government Data (OGD) was part of Big Data initiatives that emerged globally with the intention of getting public data available to anyone as free and without restrictions [3][4]. Initially, OGD promoting government transparency and accountability but deep interest from the other sectors creates an opportunity for the country's economic growth [5]. The government now days are the biggest social entities with high data complexity. The rising data demand creates rapid data growth and contributes to the massive data management process [6]. Listed ‘massive data collection effort and poor quality EA model data as the most frequently appeared [7].
In Malaysia, both GEA and OGD initiatives were introduced in 2014 and become parts of the Malaysian Public Sector ICT Strategic Plan (2016-2020) main agenda to support the 11th Malaysia plan. GEA presented as the holistic approach that aligns the Malaysian government IT resources with the agencies' business processes and strategies through MyGovEA [8]. This is due to the increasing number of IT applications that exist in silos at every government agencies but then it serves the same functionalities. Hence, these circumstances cause redundancy in cost, technology, and even IT experts that develop those applications. This has urged MAMPU, the IT centralization agency in MPS to encourage the usage of the shared resources which can be achieved through MyGovEA [9].

On the other hand, OGD initiative in the Malaysian Public Sector (MPS) aims to publicly and freely share government data using the online platform [10]. However, the implementation of OGD in MPS faced a quality challenge such as lack of data integration between agencies and the nonexistence of OGD metadata [11] cause the data owner is required to update data repeatedly. Furthermore, the government data policy which is not gazettes yet, also one of the hindering factors for the successful OGD implementation in MPS [12].

GEA and OGD should have a bilateral relationship to support new data management techniques [13] to enable industries and businesses the fastest growth. Looking at these issues exists, this study aims to investigate the possibility to integrate the OGD metadata structure in the context of problems and challenges with EA metamodel on top of data layers. Currently, there is no yet exist a specific metamodel GEA data layer that utilizes OGD. This paper will propose the new conceptual framework on a metamodel for GEA based on OGD.

2. Literature Review

2.1. Enterprise Architecture Overview

Enterprise Architecture (EA) defines as the business process management in a large-scale organization with an understanding of the information system supporting the business function. Basically, it consists of the functional description as "input-process-output" to develop the business strategy to be linked with the information system [14]. It also helps the organization in designing its various organization facets such as business, data, application, and information to achieve the organizational goal. EA fundamentally starts from the introduction at the first stage is to familiarize the concepts and functionalities towards understanding, planning, and implementation. In a wide, the discipline EA visualizes clear artifacts that help the organization to identify its various organization facets among business, data, application, and information layer to achieve the organization's goals and objectives [15].

2.2. Enterprise Architecture Modeling

Enterprise Architecture modeling is defined as a model as a simplification of reality in order to get a better understanding of the flow, system structure [16]. EA Modeling encapsulated the illustration of the complexity of the organization. The concept interrelated to operational aspects of the organizational weather on the holistic view or in-depth [17]. The first essential consist of the methodology and language use to develop the model [18]. The modeling approach usually used at the planning and implementation stage to identify the quality and satisfaction of information and system towards the organizational impact [15][19]. A study by Sudarsono et al [19] shows the emergence of the design comes from a series of interrelated concepts. It highlights the architectural elements to contribute to implementing the organizational strategies. The modeling procedures are based on the use of the information described in the models to support various enterprise tasks [20]. The integration is possible in the future long-term challenge is to involve the business people in the adaptation of EA and the implementation and adaptation of enterprise information systems.

The EA model proposed as the holistic view was at the strategic and business level. The modeling process is a crucial enabler for the solution to many business problems. There are different types of modeling tools used to model EA such as Open Source ArchiMate modeling and UML modeling. This
paper will be using ArchiMate Modelling as the most closely related to research modeling [16]. Figure 1 shows the modeling approach as a solid basis for this future challenge.

**Figure 1.** The modelling approach for continuous business-IT alignment. (Hinkelmann, Knut, et al. 2016)

TOGAF Architectural Development Method (ADM) combines with Archimate Modelling Approaches consists of designing and implementing the component Strategy and Motivation, Business Layer, Application Layer, Software Layer, and Implementation and Migration. It serves not only as an EA framework but also tools to promote architectural development [20]. Figure 2 depicts the ADM as discussed.

**Figure 2.** Archimate Modelling (TOGAF www.opengroup.org)

### 2.3. Enterprise Architecture Metamodel

Metamodel describes a set of artifact models develop from the process of defining the problem statement, analysis, and construct the problem into the useful and applicable model. Meanwhile, EA metamodel is a clear common language and structure view that shows the relevant dependencies and
relationship between business, data, application, and technology. The metamodel is located between formal and informal expressions [8].

It is a formal basis that ensures that models can be interpreted unambiguously and are ideal for automated analysis [21]. The fundamental organization of a system is often represented by models of the ‘as-is’ state or the ‘to-be’ state of a system. Korean government's EA describes the EA metamodel as the compilation of EA deliverables standard that organizations need to establish and disclose towards the EA government-wide Information Technologies interoperability among the agencies. It is also a foundation model used to determine the EA business by specifying the architectural information required and their relationships [22].

EA modeling plays an essential role in the practice, as shown in Figure 3 shows the ArchiMate metamodel, which is now adopted by the Open Group interconnecting the business, application, and technology in a top-down view of the actors. It built the easy and understand model which will support the existing and develop the new form flows of integration organizational functional process [23]. This generic metamodel will be used to map on top of the OGD problem and challenges discussed to classify on OGD issues and which layer should take the responsibility to expend the proper metamodel on problem and challenges solution.

![Figure 3. The ArchiMate Meta-Model (http://www.archimate.org)](http://www.archimate.org)

2.4. Open Government Data

Open Government Data (OGD) is a government set of data sharing publically to their citizens. It helps the citizens to understand their countries better with facts and figures as the information can be openly shared and viewed by the citizens [24]. Three different approaches contribute to OGD are the government data approaches, open data approaches, and open government approaches [25]. All the approaches interconnected each other as illustrated in Figure 4.

The main features of OGD are transparency, participation, and collaboration. Transparency means the acquired information collected by the government’s institutions are available to the public with the certain data policies provided. Meanwhile, participation refers to allow the citizen to participate in the decision making as well as contributing idea. Finally, collaboration refers to both private and public
sectors to increase government decision-making and improve the effectiveness of government services deliverables [26].

Overall, OGD is still in a context of implementation that requires personnel with the necessary skills to manage data from multiple perspectives and views [12]. Since 2000, the OGD portal is developed widely to promote transparency, accountability, and value creation by making government data available to their citizens [10] [27]. OGD was expected to promote democratic governance and political engagement to foster improvements in service and industry and social innovation. According to McKinsey, OGD could potentially boost global economic growth worth $3 trillion by delivering better services, and greater transparency and accountability [28].

Open government data can bring many benefits for both government and society [27] but only five studies were found addressing various challenges related to policy, technology, financing, organization, culture, and legal frameworks is important to create an ecosystem and sustainable business models for OGD initiatives that can deliver the desired benefits [24]. In the context of data management, in the study conducted by Mourino et al. on top of Italian OGD, only 40% of the state and municipality portal were completely updated [11] in the context of OGD data quality observation. Furthermore, not many publications address this data quality challenge as most of the study more focuses on organizational OGD purposes [27].

![Figure 4. Foundations of Open Government Data (Adapted from Gonzalez-Zapata et al. 2015)](image)

2.5. Malaysia Government Enterprise Architecture

The Malaysian government launched the Malaysian Government Enterprise Architecture (myGovEA) in 2014 [8]. The principles being developed to initiate the EA practice in Malaysia. The principles are a fundamental set of overarching architectural standards that support the development of standardized and consistent architecture across the organization. They are often used to guide an organization to implement future initiatives in public sector agencies. They should be adopted when agencies begin to develop their business and technical architectures [29]. Figure 5 shows the MyGovEA Principles consist of the general, business, data, application, and technology. Another set of document develop are the framework and methodology for guiding the public sector agencies in Malaysia in building EA practices. It is the other new way of approaching the business and technology to be aligned together and establish a single view of the current business and technical environment for the particular public sector organization. However, some Malaysian government agencies are still hesitating to carry out this EA in their organizational structure due to organizational complexity, public values issues, and the political climate [30].

2.6. Malaysia Public Sector Open Government Data

Malaysia Public Sector OGD(MPSOGD) initiatives were launched in 2014 to encourage data sharing to support a reliable, fast, and transparent delivery system. The implementation was expected to have a
significant impact on the economic growth, social well-being, and the society of the country to increase the competitiveness of a country in the digital initiatives [31]. Both MyGovEA and MPSOGD represent different functionalities in the government sectors but the most similar in its goals, which is towards government digital transformation. Most of the EA study focused on EA understanding, implementation, and management but not many on EA modeling study [32]. Until now there is a lack of an EA model that entirely enables integrated enterprise modeling. The architects keep on using their modeling techniques and principles, tool support, visualization techniques for each architectural domain [21]. Even though the data layer where stated closed to the business layer, there is yet a proper interlink between this business layer and the data layer [33]. In this point, highlighted Malaysia EA expert and practitioners also plays a vital role in EA data management [34].

![Figure 5. MyGovEA Principles (MAMPU 2016)](image)

3. Methodology
This study adapting the Design Science Research Methodology (DSRM) by Hevner [35] to design the conceptual framework on the metamodel for the MyGovEA data layer using the OGD. Figure 7 shows the Design Science Research Methodology used in this study. The problem identifies shows that both MyGovEA and OGD are having the same responsibility in obtaining data objects, data set to be interpreted, and providing valuable data to the citizens.

Both of the domains MyGovEA and OGD in a context of technical perspective holding a different role with similar function supplying the end product or valuable data to support the decision-making process and contribute to the country's economic growth. The next step is keyword searching which is related to the topic of integration and domain public sector, MyGovEA, and OGD.

The next step is keyword searching which is related to the topic of integration and domain public sector, MyGovEA, and OGD. A literature review is done to validate knowledge and getting the essential information to fill the novelty for the current study [36]. Effective literature searching defines the related topic to analyze and contribute to the writing process [37]. Four major activities in Figure 7 such as searching gathering, screening categorizing, analyzing, structuring, and writing have been done accordingly to fit the purpose and ready to put in into writing.

The objective of the solution is done through the literature review on GEA and Open Data related to the government sector. Finally, at the design and development, we choose the Archimate metamodel as
the base model to be a map on top of the OGD issues founded during the OGD implementation [27] and leverage the new conceptual model to be integrated with the technical design OGD initiatives [12]. The next study will cover the context of demonstration, evaluation, and validation that will be using some cases to show the usefulness for achieving the purposes.

Figure 6. Design Science Research Methodology (Peffers et al. 2008)

Figure 7. Basic flow on the literature review process

3.1. Data Collection
Five databases were used to conduct the literature are the Scopus, Science Direct, Web of Science, IEEE, and Google Scholar. The keyword used for this study is ("enterprise architecture"), ("open government data"), ("integrate*") then the boolean use is “AND”. The most essential information requires is the integration between both of these GEA and OGD. Most of the study on OGD highlighted the main problem and challenges affecting the OGD initiatives. This problem and challenges will be defined and map with the Archimate metamodel. Two studies highlighted the most similar OGD problem appear are the organizational, policy and legal, economic, and financial posses of a similar perspective of the problem.

3.2. Data Analysis
To extract the required OGD problem and challenges qualitative content analysis is taken into action. Inductive and deductive analysis help to build the categorizing from the bottom technical content towards the organizational content [39]. Table 1 shows the findings from the data analysis process. Based on the researcher's perspective conclude having a similar understanding of OGD problem and challenges categorize such as Organizational, Policy and Legal, Economic, and Financial. Citizens/Cultural were combined as one category as some of the perspectives of the study are similar. Data Quality and Technology as category problems and challenges related to service deliverables. Each
of these categorizes problems and challenges still arise, will be aligned to the Archimate metamodel as the guideline for the new study in the theme of integration between the GEA and OGD.

4. Discussion

The integration between EA and OGD is still new in any government initiatives. EA in the public sector gains attention as an approach to strengthening the e-government function. This hierarchical approach helps the government a lot strategically aligning the business by integrating the information structures, procedures, organizational units, and staff in the enterprise. In the sense of Malaysia's public sector perspective, OGD, as an initiative connected to the Digital Economy Transformation Program, launched to embed with the Malaysian Government's National Agenda the sharing of sets of data that civilians can freely access.

Table 1. Main Problem and challenges affecting OGD initiatives

| Categorize                 | In the perspective of [27]                      | In the perspective of [38]                      |
|----------------------------|------------------------------------------------|------------------------------------------------|
| **Organizational**         | Authority involvement                          | Institutionalization                            |
|                            | Awareness                                      | Overlapping Scope                               |
|                            | Benefit metrics                                | Technical Support                               |
|                            | Competition                                    |                                               |
|                            | Institutionalization                           |                                               |
|                            | Inter-organization collaboration                |                                               |
|                            | Motivation                                     |                                               |
|                            | Policy                                         |                                               |
| **Policy and legal**       | Copyright & licensing                          | Copyright/Licensing                             |
|                            | Liability                                      | Liability                                      |
|                            | Regulations                                    | Regulations                                    |
|                            | Privacy & data protection                      | Privacy/Data Protection                        |
| **Economic and financial** | Budget provision                               | Conflicting                                    |
|                            | Cost metrics                                   |                                               |
| **Citizens / Cultural**    | Public participation                           | Public Participation                            |
|                            | User skills                                    | Awareness                                      |
|                            |                                               | Motivation                                      |
|                            |                                               | Competition                                     |
| **Data Quality**           | Data accuracy                                  |                                               |
|                            | Data ambiguity                                 |                                               |
|                            | Data completeness                              |                                               |
|                            | Data formats Data                              |                                               |
|                            | Data misuse Data                               |                                               |
|                            | Data quality                                   |                                               |
|                            | Data representation                           |                                               |
|                            | Data scarcity                                  |                                               |
| **Technical**              | Data access                                    | Formats                                        |
|                            | Data interoperability                          | Ambiguity                                      |
|                            | Storage capacity                               | Discoverability                                |
|                            | Technical knowledge                            | Representation                                 |
|                            | Technical support                              | Capacity                                       |

MyGovEA consists of the blueprint which includes the EA framework focus on business process solutions and technology, methodology, and implementation plan [2]. The people factors with significant EA talent and experts also play a vital role to ensure this integration can be understood and develop in the future [38]. EA modeling and metamodel still an ongoing topic in EA publication but significantly fewer than other EA topics [32] contribute to a lack of understanding deeply to integrate between the GEA to other domains. By the time EA should become the solution in a holistic view.

Eventually, since 2014, OGD introduces in the Malaysian public sector, the dataset is growing from 115 to 12,955 in the MOGD portal [10] shows the effort of the practitioner towards data sharing available to the citizens are actively ongoing promoted and run. The problem and issues that arise at the beginning of the OGD implementation still exist with unclear perspectives. Some other how, both the
MyGovEA and MOGD enroll similar roles must produce valuable data for decision making towards social and economic growth.

OGD problems and challenges are identified to be placed accordingly on top of the generic Archimate metamodel that highlights a similar problem and challenge category map on the EA aspect as in Figure 8. The categorize of Organizational, Policy and Legal, Economic, and Financial, suitable to be located at the Business level in the context of EA. The perspective in this problem and challenge categorize were suitable to be solved at this level as the categorize are still stated at the strategic view.

The Citizens/Cultural are closely related, they are the people and theme accessing the data through the application, the problem and challenges related to this category should be placed at this level as a total solution to data usability. Only two studies touched on the problem and challenges of Data Quality as poor data quality that may be ubiquitous and can impede the successful reuse of open data. The data collection process now forces data owners facing of updating data repeatedly [41]. This requires the new data management technique to be created at this level. Finally, technical problems and challenges related to infrastructure, hardware, and software readiness are placed at the EA technology level.

![Figure 8. Conceptual Framework metamodel for GEA map on OGD problem and challenge](image)

Data Quality problems become a significant topic highlight and suitable to be located at this application level should contribute more publication, awareness, competition, and motivation to be isolated at the EA application level. This level plays a vital role to ensure fully design and develop the data architecture or data layer to ensure the data structure interoperability towards the decision-making process [38]. The set of the new conceptual framework is proposing to bridge both EA and OGD to illustrate the new collaboration between both domains. Predefining and analyzing the clear problem statement by referring the problem and challenge categorize map towards each level as the guideline that will help the researchers and practitioners to develop the appropriate detail metamodel and metadata to reduce and overcome each category of problem and challenge. Finally, the future phase defines and validates the integrated metamodel for OGD according to the EA Archimate metamodel map with the problem and challenges of OGD perspectives as the next study contribution. Lack of research and publication on this topic contribute as an opportunity for academic and expert to further research.
5. Conclusion and Future Works

The innovation of ICT technology plays a vital role in empowering the service deliverables. Transitioning from e-government to digitalization requires to remodel and change management process to be implemented towards moving the digital transformation or digitalization. Integration among ICT tools and infrastructure across the EA domain and others become more significant topics to be the highlight. OGD problems and challenges are highlighted to enable the opportunity to detail research on the integration process between the EA and other domains. Public Sector OGD is still new approaches and only practicing the data sharing internally among the government agencies. The conceptual model should assist the practitioner and academician to initiate a detailed study on the integration process between GEA and OGD in a public sector to reduce redundancy on data management and increasing the services deliverables performance to the citizens and across the public and private sectors.

The new conceptual model integrating the OGD using EA modeling proposed and more new study should be discovered. The impact of this further study will contribute to a beneficial economy and a more systematic business solution. The future study will take into action in the context of implementation and modeling the specific metamodel on each level the integration between the GEA and OGD.

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