DATA GOVERNANCE MODEL FOR THE MINISTRY OF EDUCATION MALAYSIA USING ENTERPRISE ARCHITECTURE APPROACH

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Abstract

Ministry of Education Malaysia is one of Malaysia's largest ministries. It oversees the entire country's public education system, including pre-school education, primary schools, secondary school, and pre-tertiary education. The spread of more than 10,000 schools and several teacher training and development institutions shows that the Ministry meets its growing operational needs by adopting new digital capabilities. The Ministry operations depend on three main entities: students, teachers, and learning institutions. Learning institutions are the primary data source, with teachers and learning institution administrators responsible for performing data entry. Data governance is a procedure that defines the roles and duties of the person in charge of data management in an organization to gather and appropriately use educational data, ensure the protection of personal data, and establish data standardization, consistency, and adequate educational data use across agencies. The adoption of Enterprise Architecture will be a significant factor in delivering the new age of digital services. For the data handling in the Ministry of Education Malaysia, the combination of data governance and Enterprise Architecture will produce a data-driven architecture that accelerates time to value and demonstrates accurate results to stakeholders. Thus, this paper aims to propose a data governance model for the Ministry of Education, Malaysia.

Keywords: *data governance, data management, enterprise architecture, education*

1. Introduction

Various organizations, particularly the government sector, publish and make official public data to enable the community and varying society organizations by having appropriate datasets to strengthen how they do things or perform daily transactions. Organizations, particularly those in the public sector that routinely store large amounts of data, are eager to pursue new opportunities and develop new services but are frequently constrained by data-related issues [1]. While cases of quality, availability, and accuracy appear to be distinguishable limitations, resolving them provides only temporary solutions. It is necessary to improve the fundamentals of data management, but this is not a job for the IT department alone. Instead, the organization requires focus, and data governance has emerged as a promising approach in this regard. According to Bruck [2], data are nothing more than a collection of characters with no meaning unless viewed in their context of use.

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The explosion of digital and disruptive technologies has introduced new dimensions to implementing technologies. Therefore, governing this approach is the idea that businesses and ICT teams should co-operate differently. The business will use best-of-fit technology to architect the enablement. Thus, adopting Enterprise Architecture will significantly deliver the new age of digital services [3]. For the data handling in the Ministry of Education Malaysia, the combination of data governance and Enterprise Architecture will produce a data-driven architecture that accelerates time to value and demonstrates accurate results to stakeholders. Therefore, there is an urgent need to develop a Data Governance Model (DGM) for the Ministry to resolve data format, data standard, data privacy, and data limitation or segmentation of governance, as highlighted above. The DGM will also help the Ministry enhance education data exchange among stakeholders efficiently.

2. Related Works

Many organizations already have governance for specific applications, business units, or functions, even if the processes and responsibilities are informal. It is about instituting systematic, formal control over these processes and responsibilities as a practice. This can assist organizations in remaining responsive, mainly as they grow to a size where cross-functional tasks are no longer feasible for individuals to perform. Various data management benefits can be realized only after establishing systematic data governance [4]. There are multiple data governance models available, but they all adhere to the same fundamental principles. Each model specifies specific controls [5], [6] that organizations must implement and human roles [7] that must be filled to ensure the data governance equipment runs smoothly. The researcher chose four frameworks developed by bodies or institutions that manage data management for this study.

DAMA DMBOK developed a data governance framework separated from the overall data management process, such as data, policies, guidelines, and strategies structured as separate governance areas [8]. However, DGI [9], IBM [10], and PwC [11] view data governance as a concept that is more extensive than existing practices, which include data policies, guidelines, and strategies. While good data governance is not a new concept, the Ministry struggles to practice as costly, cumbersome, and time-consuming. Moreover, the lack of governance exposes the Ministry to cyber risks, especially with high volumes of sensitive data stored. Therefore, to serve the nation with a relevant data governance model in today's digital era, the Ministry needs to harness data efficiency. To do so, the Ministry must allocate the right ownership of data, define data collected and stored, assign the exemplary stewardship and custodians to roles, and provide an effective data governance program for the next-generation platforms.

Enterprise Architecture (EA) is the arranging concept for business processes and information technology infrastructure [12], illustrating the integration [13] and standardization requirements of the firm's operating model [14].

Additionally, this architecture is a conceptual blueprint that establishes an organization's structure and operations [15]. An Enterprise Architecture seeks to ascertain the most effective means of accomplishing its current and future goals. According to Gartner [16], by 2021, 40% of organizations will use enterprise architects to help ideate new business innovations made possible by emerging technologies.

The ArchiMate is a modelling technique that supports Enterprise Architecture development by providing a uniform representation for diagrams that describe Enterprise Architecture [17]. The Open Group published ArchiMate 3.0 in 2016 as a significant update to ArchiMate 2.1 regarding specification features [18]. ArchiMate is a tool that enables enterprise architects to clearly describe, analyze, and visualize the relationships between various architecture domains [19]. It consists of concepts for clearly defining an interconnected architecture, viewpoints tailored to specific stakeholders, and techniques for language customization. This language provides a unified architectural approach for describing and visualizing various architecture domains and the underlying relationships and dependencies between them [20]. In addition, its language framework implements a mechanism for structuring architecture domains, layers, and aspects.

Activities related to the data domain in Enterprise Architecture directly contribute to the alignment and control of data. Data architects frequently serve as liaisons between the business and data governance activities. As a result, Enterprise Data Architecture and Data Governance must be well-aligned. Ideally, each subject area and entity within a subject area should have both a data architect and a data steward assigned. Additionally, business and process oversight should be coordinated. For example, the subject areas of business events should be aligned with business process governance, as each event entity typically corresponds to a business process. Therefore, aligning these two practices will give the organization a data-driven architecture, reducing time to value and show actual outcomes to the stakeholders.

3. Methodology

In proposing the Data Governance Model for The Ministry of Education Malaysia, the researcher explores significant models by comparing and analyzing existing models and frameworks to uncover trends and patterns. This review will provide insight and direction for developing the Data Governance Model for the Ministry of Education Malaysia. Two essential parts are required in constructing the model are the domain area and the component. To obtain the proper dimension areas and components, the following steps will be taken:

a) Compare, and analyze the existing models and frameworks.

b) Conduct analysis of domain areas.

c) The initial finding of domain areas and components.

d) Propose conceptual model (Data Governance Model for Ministry of Education Malaysia)

4. Result and Discussion

This study compares seven models used for the data governance model or framework focused on the search findings in the education sector. All the related models and frameworks are as follows, determined by an extensive review and analysis of the relevant literature:

a) DGM1: Information Architecture Model for the Successful Data Governance Initiative in the Peruvian Higher Education Sector [21].

b) DGM2: Development of data governance components using DEMATEL and content analysis [22].

c) DGM3: Data Governance Framework for Big Data Implementation with a Case of Korea [23].

d) DGM4: Research on the Path of Smart Campus Construction Facing Data Governance [24].

e) DGM5: Proposed Amendments of Public Information Act Towards Data Governance Framework for Open Government Data: Context of Thailand [25].

f) DGM6: The Current State of Data Governance in Higher Education [26].

g) DGM7: Towards an Integrated Model of Data Governance and Integration for the Implementation of Digital Transformation Processes in the Saudi Universities [27].

Table 1 shows the detailed description of the data governance models and frameworks.

Table 1: Comparative and analysis of data governance model and framework

Code	Model	Description	Theory	Domain Area	Component
DGM 1	Enterprise Information Management Model	This model is used to integrate data management practices with good management of information technologies. This model shows the interaction between IT governance and information governance, being the intercommunication between the good	▪ Kalido Data Governance Framework ▪ IBM Data Governance Framework ▪ The DGI Data Governance Framework	Management of Information Architecture	▪ Availability ▪ Precision
				Information Risk Management	▪ Control ▪ Standard
				Information Value Management	▪ Application
				Information Security Management	▪ Privacy ▪ Protection
				Information Services Management	▪ Accessibility ▪ Distribution
				Information	▪ Accuracy

Code	Model	Description	Theory	Domain Area	Component
		practices of both governments.		Quality Management	▪ Completeness ▪ Consistency ▪ Timeliness
				Continuous Improvement	▪ Change management ▪ Operability
DGM 2	Data Governance Framework using DEMATEL and Content Analysis	This model is used to ensure that high data quality exists throughout the complete data lifecycle	▪ DEMATEL ▪ Content Analysis	Data Compliance	▪ Strategy ▪ Policy ▪ Methodology ▪ Metrics ▪ System architecture
				Data Management	▪ Data lifecycle ▪ Data monitoring ▪ Quality management ▪ Quality value ▪ Data security
				Data Organization	▪ Role and responsibility ▪ Organizational structure ▪ People
DGM 3	A Framework for Data Governance in the implementation of Big Data in Korea	By summarizing policy considerations in addition to technical feasibility, this framework for Big Data governance helps avoid policy failures. By analyzing risk factors in advance and preventing the recurrence of problems, a governance framework can ensure the effective execution of Big Data.	The DGI Data Governance Framework	Personal Information Protection	▪ Definition of data protection level ▪ Development of systematic protection devices
				Data Quality	▪ Timeless ▪ Trustfulness ▪ Meaningfulness ▪ Sufficiency
				Data Disclosure and Responsibility	▪ Definition of responsibility for data ownership and management ▪ Disclosure scope
				Organization	▪ Big data management responsibility ▪ One-turn data verification ▪ Data Quality ▪ Information security management
				Standardization and Guideline	▪ Definition of data formats, storage, and processing ▪ Guideline of data structure and processing method
				Policies and Processes	▪ Supervision and measurement of data flow ▪ Data changing procedure and processing methods
				Audit and Control	▪ Data collection ▪ Data process ▪ Data Analysis ▪ Data Visualization
DGM 4	Standard Data Governance Model	The Standard Data Governance Model is used to establish the overall objectives of the intelligence campus. It integrates applications, businesses, data, data classification, and data application. It is a comprehensive data	Not available	Foundation support platform	▪ Unified identity authentication platform ▪ Public data platform ▪ Information Portal
				Data Governance	▪ Data standards ▪ Metadata ▪ Big data centre
				Data Domain	▪ Human resources domain ▪ Student management domain

Code	Model	Description	Theory	Domain Area	Component
		governance model. The shared data platform is divided into functional domains based on the school's information system and business processes, including human resources, student management, teaching management, and scientific research management.			▪ Financial asset domain
				Big Data Application	▪ Data analysis ▪ Algorithm model ▪ Model iteration ▪ Leadership decisions
DGM 5	A framework of Data Governance for Open Government Data	This framework describes the roles and responsibilities of the data manager in a government agency to get and use open government data, protect personal data, and link and utilize available data in agencies.	▪ The DGI Data Governance Framework ▪ The IBM Data Governance Council Maturity Model	Mission and Vision	▪ To create and distribute the valuable data ▪ Public access and accountability must be ensured concerning the public data.
				Goals, Governance Metrics/ Success Measures, Funding Strategies	▪ Equal treatment for citizens for access to public information and sensitivity to decision-making ▪ Success measures
				Data Rules and Definitions	▪ Public data ▪ Personal data ▪ Data Asset ▪ Enterprise Data Inventory ▪ Information System ▪ Machine-Readable
				Decision Rights	▪ Standard procedures ▪ Standard system
				Accountabilities	▪ Roles and responsibilities ▪ Activities ▪ Duty
				Controls	▪ Data risks ▪ Data sensitive ▪ Data standard ▪ Data control ▪ Level and type of data ▪ Data privacy ▪ Data security
				Data Stakeholders	▪ People inside and outside an organization ▪ Data owner ▪ Data steward
				Data Governance Office (DGO)	▪ Chief of Information Officer ▪ Steering Committee ▪ Data Governance sponsor ▪ Data Governance Head ▪ Data Governance Lead ▪ Data Owners ▪ Data Stewards ▪ Technology Stewards
				Data Stewards	▪ Data stakeholder ▪ Skill ▪ knowledge of Data Management, Databases, and management information systems ▪ Develop data management, database

Code	Model	Description	Theory	Domain Area	Component
					systems, securing data and information for agencies ▪ Procedures and analyze data quality
				Data Governance Processes	▪ Develop a value statement ▪ Prepare a roadmap ▪ Plan and fund ▪ Design the program ▪ Deploy the program ▪ Govern the data ▪ Monitor, Measure, Report
DGM 6	Data governance checklist in higher education	The main objective of this checklist is to fill a void in the literature on data governance in universities and colleges by evaluating current data governance practices at tier-one research universities in the United States.	The DGI Data Governance Framework	Data Governance Body	▪ A group of stakeholders who formalize the data governance practice at their organization ▪ Guidance
				Data Quality	▪ Accuracy ▪ Availability ▪ Integrity ▪ Data standards
				Data Access or Restriction	▪ Grant access ▪ Restriction policy ▪ Limitation
				Data Security	▪ System security ▪ Data protection ▪ Data privacy ▪ Data confidentiality ▪ Sensitivity data ▪ Data breach protection
				Data Stewardship, Ownership, and Roles	▪ Roles and responsibility ▪ Data stewardship ▪ Data ownership
				Metadata Documentation and Organization Structure	▪ Structure and methodology ▪ Data dictionary ▪ Metadata standards ▪ Thesaurus
				Business Process Integration	▪ Business strategies ▪ Processes integration ▪ Data governance practices ▪ Data governance documents ▪ Data governance policy
DGM 7	The Saudi Universities' Integrated Data Governance Model	This model demonstrates that data governance is an adequate method of implementing digital transformation mechanisms in higher education institutions and should be integrated into universities' initiatives to utilize digital technologies effectively. Appropriate data governance practices are required for a successful digital transformation to be streamlined.	The DGI Data Governance Framework	Data Governance Team	▪ Legal entities ▪ Compliance officers ▪ Risk management ▪ Human resources ▪ Information technology ▪ Success factors ▪ Key outcomes ▪ Potential risks
				Internal Data Governance Audit	▪ List of primary data sources ▪ Detail of data sources interaction
				Regulatory Compliance	▪ External retention requirements ▪ Evaluate and follow-up the legal and regulatory requirements
				Defining Data Governance Priorities	▪ Data evaluation ▪ Priorities of primary information governance activities
				Employee and	▪ Skill

Code	Model	Description	Theory	Domain Area	Component
				Faculty Training	▪ Knowledge of data governance ▪ Best practice
				Enforcement and Follow-up Standards	▪ Enforcement ▪ Follow-up standard and policy
				Data Government Assessment	▪ Data governance plans ▪ Data governance activities ▪ Data governance policies

4.1 Analyze initial domain areas

There are 44 domain areas identified in the previous study. The list of these domain areas then was mapped initially with the Knowledge Areas of the DAMA. The mapping table of domain areas with the DAMA Knowledge Areas is shown in Table 2.

Table 2: The mapping of initial domain areas with DAMA Knowledge Area

No	Domain Area	DAMA Knowledge Area											
		Definition	Goals	Activities	Inputs	Deliverables	Roles and Responsibilities	Suppliers	Consumers	Participants	Tools	Techniques	Metrics
1	Management of Information Architecture			√									
2	Information Risk Management			√									
3	Information Value Management			√									
4	Information Security Management			√									
5	Information Services Management			√									
6	Information Quality Management			√									
7	Continuous Improvement												√
8	Data Compliance					√							
9	Data Management		√										
10	Data Organization	√											
11	Personal Information Protection	√											
12	Data Quality					√							
13	Data Disclosure and Responsibility						√						
14	Organization				√								
15	Standardization and Guideline					√							
16	Policies and Processes											√	
17	Audit and Control											√	

No	Domain Area	DAMA Knowledge Area											
		Definition	Goals	Activities	Inputs	Deliverables	Roles and Responsibilities	Suppliers	Consumers	Participants	Tools	Techniques	Metrics
18	Foundation support platform										√		
19	Data Governance		√										
20	Data Domain				√								
21	Big Data Application											√	
22	Mission and Vision		√										
23	Goals, Governance Metrics/ Success Measures, Funding Strategies		√										
24	Data Rules and Definitions	√											
25	Decision Rights						√						
26	Accountabilities						√						
27	Controls										√		
28	Data Stakeholders						√						
29	Data Governance Office (DGO)						√						
30	Data Stewards							√					
31	Data Governance Processes						√						
32	Data Governance Body						√						
33	Data Access or Restriction										√		
34	Data Security										√		
35	Data Stewardship, Ownership, and Roles						√						
36	Metadata Documentation and Organization Structure					√							
37	Business Process Integration										√		
38	Data Governance Team						√						
39	Internal Data Governance Audit			√									
40	Regulatory Compliance					√							
41	Defining Data Governance Priorities	√											
42	Employee and Faculty Training						√						
43	Enforcement and follow-up standards											√	
44	Data government assessment			√									
Total		**4**	**4**	**8**	**2**	**5**	**10**	**1**	**0**	**0**	**5**	**4**	**1**

4.2 The initial finding of domain areas and components

DAMA Knowledge Area consists of 12 areas, as stated in Table 2. According to the total number in Table 2, two knowledge areas are unmapped to any of the domain areas. To select an appropriate knowledge area for this study, the researcher chose the knowledge areas with the domain areas number greater than the average of 3.67. As a result, seven knowledge areas outperformed this average: definition, goals, activities, deliverables, roles and responsibilities, tools, and techniques. However, in developing the DGM, the researcher combined DAMA Knowledge Areas and four Architecture Domains consisting of business, data, application, and technology. As a result, the final DGM domain areas include roles and responsibilities, principles, change management, methodology, assessment, training and skill, policies, compliance, references, ETL process, and ICT infrastructure, as shown in Table 3.

Table 3: Initial findings of domain areas and components

No.	Domain Area	Components
1	Roles and responsibilities	Data producer, data steward, data custodian, a data consumer, steering committee, and technical team
2	Principles	Accountability, standardized rules and regulations, data quality standards, and transparency
3	Change management	-
4	Methodology	Metrics and data lifecycles
5	Assessment	-
6	Training and skill	-
7	Policies	-
8	Compliance	-
9	References	Data definition, enterprise data model, and data dictionary
10	ETL process	-
11	ICT Infrastructure	Tools, data warehouse, network, and security

4.3 The proposed data governance model

The proposed data governance model is designed to guide the Ministry in handling educational data. Figure 1 illustrates the proposed Data Governance Model for the Ministry of Education Malaysia.

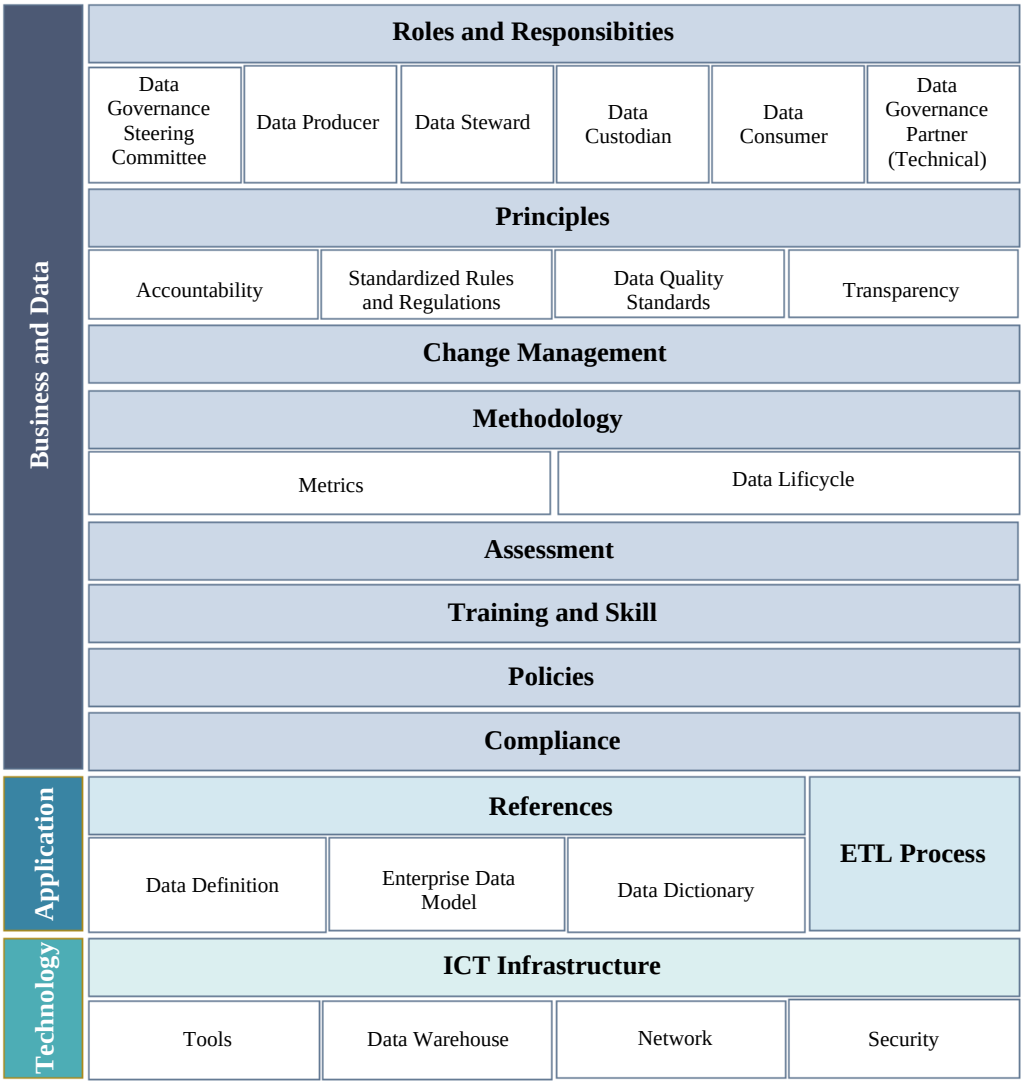

Figure 1: The Proposed Data Governance Model for the Ministry of Education Malaysia

a) Roles and responsibilities

Roles and Responsibilities explain how individuals and teams contribute to domain area activities. Roles are conceptualized, emphasizing the groups of roles that are required in the majority of organizations. The description of roles and responsibilities for this DGM are as follows:

i. Data Governance Steering Committee (DGSC) - The data governance steering committee (DGSC) consists of the Ministry's principal, and the highest-authority data governance organization is responsible for data governance oversight, support, and funding. They are composed of senior executives from a variety of functional areas. The DGSC's role is to oversee the development and maintenance of data governance standards to manage educational data collection and access and promote a proactive approach to data quality and security.

ii. Data Steward - Data Stewards are accountable for the data quality in their domain. Data Stewards act as the central point of contact for data governance activity and issue resolution. This task includes, but is not limited to, collaborating with other Data Stewards to define business terms and rules and managing and maintaining the data assets associated with the data under their scope.
iii. Data Producers - Data Producers work in administrative, educational, or learning institutions that collect or create data as part of their daily activities and responsibilities. For example, in the Ministry of Education, Malaysia, many departments produce educational data.
iv. Data Custodians – consist of system administrators accountable for managing and operating systems and servers that collect, manage, and make educational data accessible.
v. Data Consumer - Data consumers are educational departments, learning institutions, or external agencies granted access to educational data to carry out assigned duties or perform assigned roles or functions within the Ministry.
vi. Data Governance Partner (Technical Team) - Data Governance Partners are from the technical teams in charge of the network, operational, security, and servers.

b) Principles

The Data Governance Model (DGM) aims to help the Ministry manage educational data. The DGM creates the concepts, policies, processes, framework, metrics, and oversight required to handle educational data and govern all data management activity levels, guided by several principles. In the lack of defined principles, some organizations frequently adopt policies. Moreover, principles can often be in opposite directions from the policy. However, it is preferable to identify a core set of ideas and best practices as part of policy development. By referring to principles, potential resistance can be mitigated.

c) Change management

This domain area is responsible for developing and executing a change management plan involving the DGM roadmap, communication plan, and knowledge management.

d) Methodology

Two components are involved in this domain area, which is metrics and data lifecycle. Metrics are essential for assessing the effectiveness of information protection processes and ensuring they are operating as intended.

The data lifecycle is straightforward to comprehend conceptually. It involves processes that generate or acquire data and those that transmit, convert, and retain it. It also includes procedures that enable data storage and sharing and those that use or apply it. In addition, data can be cleaned, altered, merged, enhanced, or aggregated at any point during its lifecycle.

e) Assessment

This domain area is responsible for assessing the adaption and adoption of the proposed changes.

f) Training and skill

This domain area is responsible for planning, coordinating, and executing appropriate training. Besides, it also needs to ensure that all the related officers get enough knowledge and skill to govern the educational data.

g) Policies

The policies provide a based framework as guidelines on the verified data. Every data policy should have a data standard. Data standards will detail the data policy to be implemented.

h) Compliance

Compliance is the practice of ensuring that all sensitive data is handled and managed to enable the Ministry to adhere to its business rules while also adhering to applicable legal and governmental regulations.

i) References

The objective of this domain area is to provide helpful guidance to the DGM team.

j) ETL process

ETL is a process that extracts data from various source systems, transforms it (by performing calculations, concatenations, and so on), and finally loads the data into a Data Warehouse system. ETL stands for Extract, Transform, and Load. It contributes to productivity gains by codifying and reusing without requiring technical expertise.

k) ICT infrastructure

The ICT infrastructure for this DGM shall support these activities:

i. Identify and recognize educational data using tools and capabilities for discovery, profiling, and benchmarking.
ii. Validation, data cleansing, and data enrichment to improve the quality of educational data.
iii. Control educational data with metadata-driven ETL and ELT processes and data integration applications, which enable the tracking and tracing of data pipelines with end-to-end data lineage.
iv. Manage the data with active review and monitoring tools.

5. Conclusion

Data governance is a set of processes that ensures that important data assets are formally managed throughout the enterprise. It ensures that trusted information is used for critical business processes and decision-making. One of the essential factors in data governance is alignment with all teams and individuals in charge of

collecting, governing, and consuming the data. Ensure that everyone is on board and has clear goals, clearly defined processes, and explicit permission levels to make everything run smoothly. The key to data governance is effective collaboration. A suitable data governance tool should go hand-in-hand with these principles.

The Ministry's culture must value the educational data and data management operations to optimize data value as the Ministry asset. However, suppose the Ministry does not accept and manage change. In that case, even the most substantial data strategy, governance, and management strategies will fail. For the recommendation, the roadmaps for data governance and data governance program that are not covered in this research can be used as the basis for further study.

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