IJAIT (International Journal of Applied Information Technology)
http://journals.telkomuniversity.ac.id/ijait/

Implementation of Data Governance on the Open Government Data Management Platform to Improve Data Quality

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ARTICLE INFO

Received May 7th, 2023
Revised July 4th, 2023
Accepted July 5th, 2023
Available online August 21st, 2023

Keywords
Open government data, platform, SOA, DSRM, data governance, data management, data quality.

ABSTRACT

Currently, realizing good governance related to data disclosure in government agencies is an initiative as a manifestation of open government data. However, there are still problems with the quality of published data. As a solution, organizations need to establish policies, strategies, and initiatives for data management activities This paper proposes adding data management activities to the platform to enhance the quality of published data. As for the value of the quality of the data tested using the XYZ district budget, there is an increase in the uniqueness quality dimension from valid DQI 98.7203 to 100; the conformity quality dimension has also increased from 94.7368 to 100; the accuracy quality dimension also increased significantly from 0 to 100; integrity quality dimension increased from 66.6667 to 100. As a concern, the validity of the data is by manual checking after deleting data duplication.

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https://doi.org/10.25124/ijait.v7i02.5979
Paper_reg_number IJAIT000070202 2023

1. Introduction

The openness of public information is one of the essential characteristics of a democratic country to realize good governance. Open government is a form of transparent government. One of the crucial and fundamental points that support the realization of open government is open data [1]. Government agencies have adopted the science of open data. It is from now on known as an open government with several principles [2] that must be adhered to, including: (1) complete; (2) primer; (3) timely; (4) accessible; (5) machine-processable; (6) non-discriminatory; (7) non-proprietary; (8) license-free. The consequence of applying these principles is that users can only access data if they know the quality of the published data. Most studies show that most published open data need help with data quality [3], [4]. If there are data quality problems, this, of course, can result in the data being shared having no value by data users and cannot be defined as high-quality data [5].

High-quality data is defined as data that can meet the expectations and needs of data consumers. All disciplines in data management contribute to data quality and vice versa. High-quality data supporting organizational goals is the goal of all data management disciplines. A strategy is defined in data governance to plan, monitor, and enforce the management of data assets to be shared [5], with due regard to the data's quality. Research [6]–[8] states that establishing data governance initiatives, policies and strategies can improve the quality of open data. To support the implementation of data governance, platform availability is required to assist with activity and data changes related to data governance.

Currently, several platforms can be used to support open government data management, such as CKAN, DKAN, Socrata, JKAN, and Open Data. However, the platform was released without supporting open data policies, strategies, and initiatives [9]. For this reason, it is necessary to develop several existing data management activities in the platform to improve the quality of published data. Therefore, this paper aims to incorporate data management activities in the domain of data governance with a platform to improve the quality of published data. In addition to that, it aims to assess the success of data governance implementation.

2. Related Study

2.1. Open Government Data Management Platform

Currently, many countries have implemented open government data management platforms including the United States, Europe, Brazil, and many others [10]. One of the most well-known and used is Comprehensive Knowledge Archive Network (CKAN) as a platform to select and visualize data as key features related to open government data flows. This study uses CKAN as baseline platform to be developed in line with its popularity is used in various countries [10].

Incorporating platforms and data governance was carried out by [7] to examined the relationship between data governance and open government data management by applying the strategies defined in the Organization for Economic Co-operation and Development (OECD) model and implemented in open government data management. Research [11] proposes a theoretical model which regulates the demand and supply sides to facilitate the development of platform ecosystems by leveraging data governance. Study [8] analyzed UK and US data strategies. It concluded the main elements that should be included in a data strategy that have an essential role in managing data quality. The current trend of open government

data that continues to grow demands a developed platform to maintain the quality of published data assets to present data that data users can reuse. SUDAMA [12] introduced as a framework to produce open government data that is sustainable and can be utilized over the long term. The study successfully created and tested an automated data publishing system to meet governance requirements for data quality, accessibility, usability, and timeliness. This was achieved through the implementation and validation of data management systems, bots, and registry API.

2.2. Data Quality

At the data management level, all disciplines contribute to data quality, and high-quality data that can support organizational goals is the goal of all data management disciplines. High data quality can be defined as data that is suitable for use and meets the goals set by data users [13]. Dimensions of data quality [5] that can be assessed include: (1) completeness, referring to all data and metadata required being complete; (2) accuracy, which refers to confirmation from the organization regarding the accuracy of the data collection; (3) consistency, which can be seen from the comparison of reference data with data to be published; (4) data integrity includes ideas related to completeness, accuracy, and consistency. In data, integrity usually refers to referential integrity or internal consistency within the data set such that there are no holes or missing pieces; (5) uniqueness, which states that there is no entity that exists more than in the dataset; (6) validity, refers to the data value with the specified value domain. In addition, an added format adherence dimension refers to data that is stored, exchanged, or presented in a consistent format by adding metadata related to one of them, namely the predefined data type [14].

3. Research Design

A study design can be interpreted as a research plan, structure, and strategy for obtaining answers to research questions with optimal control variables [15]. The study design determines the type of analysis performed to achieve the desired results. Clarify what data you need, how to collect and analyze the data, and how to answer your research question.

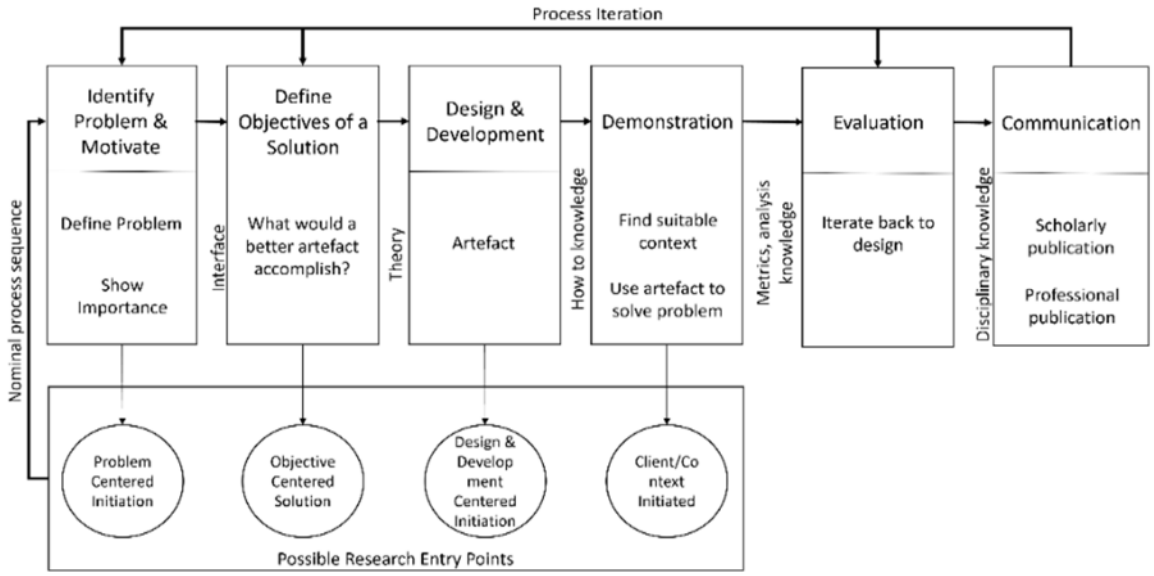


Figure 1 DSRM Framework [16]

The study design adopted Design Science Research Methodology (DSRM) [16] which provides six steps as shown in Figure 1. The artefacts you create are blueprints for service-oriented systems.

3.1. Identify Problem and Motivate

A literature review was conducted to draw research questions for this study. Several sources including articles published in journals, and case studies on government open data management especially those implemented in DJPK were examined. Research questions related to the practical problems discussed are listed in Table 1.

Table 1 Research Questions and Motivations

No	Research Questions	Motivations
1	How to improve data quality on the platform by implementing data governance?	Data management platforms need to pay more attention to the quality of published data. One effort to improve data quality is to implement data governance. Data governance defines all the activities that will be added to the data management platform development.
2	How to quantify the effect of data governance on the platform in terms of the quality of published data?	Measurements need to be taken as proof of improving the quality of data published on an open government data management platform.

3.2. Define Objectives of a Solution

The research objectives are explained through the provision of success metrics as evaluation metrics. Table 2 details the objectives of the proposed solutions.

Table 2 Research Questions and Motivations

No	Objectives of a Solution	Success Metrics
1	Improving data quality by developing an SOA-based platform incorporates data governance requirements and responsibilities in the implementation of data governance.	There is an improvement in the quality of the data published on the platform through implementing data governance activities.
2	Get the results of performance trials by calculating the seven data quality dimensions.	The results of the performance trials are expected to increase the quality of published data by fulfilling the seven dimensions of data quality.

3.3. Design and Development

In the third step, designing and developing SoA-based artefacts is carried out. To produce artefacts that are in accordance with research objectives, the functionality that must be achieved by the artefact architecture is determined. In more detail, the activities carried out are: (1) modelling business processes using BPMN; (2) decomposition of open government data management business processes in Directorate General of Fiscal Balance; (3) creating class diagram; (4) creating use case; (5) creating SOA reference architecture; (6) software coding to create an open governance data management platform from a pre-designed SOA design. Clear data management business processes are needed to make a good platform design. It is obtained from the data governance in the Directorate General of Fiscal Balance.

3.4. Demonstration

The resulting artefacts are then demonstrated to solve the problems presented in the research questions. Demonstrations are carried out through experiments,

simulations, case studies, evidence, and other relevant activities. To make it happen, sufficient practical knowledge is needed so precise measurements can be made according to success metrics. At the demonstration stage, testing was carried out on several datasets available at the Directorate General of Fiscal Balance by conducting simulations by several users to fulfil existing data management business processes and produce good data quality outputs.

3.5. Evaluation

The fifth activity of DSRM is a rating that measures how well the artifact solves the problem. To evaluate the improvement of data quality, the data quality value calculation formula is shown in Equation 1 and Equation 2.

$$ValidDQI_{(r)} = \frac{(TestExecutions_{(r)} - ExceptionsFound_{(r)})}{TestExecutions_{(r)}} \quad \text{Equation 1}$$

$$InvalidDQI_{(r)} = \frac{(ExceptionsFound_{(r)})}{TestExecutions_{(r)}} \quad \text{Equation 2}$$

R represents the rule being tested. For example, the results of testing 10,000 business rules (r) found 560 exceptions. Based on this example, the Valid Data Quality Indicator (DQI) result will be 9440/10000 = 94.4%, and the Invalid DQI result will be 560/10000 = 5.6%. Each valid DQI and invalid DQI will be calculated for each data quality dimension.

3.6. Communication

Communicating study results is the last step in DSRM. Presentation of study results in the form of scientific papers and similar publications among experts is usually chosen as a medium of communication. The initial part of our study has been presented at international conferences and published in IEEExplore and Scopus-indexed proceedings [19].

4. Result

After defines the problems and research objectives to be resolved, the result section describe how the platform designed and developed.

4.1. Design and Development

To explore and ensure practical operational requirements, we are enhancing the capabilities of the platform according to SoA principles. Unified Modeling Language (UML) was chosen to model the service concerning the problems posed during the initial research phase.

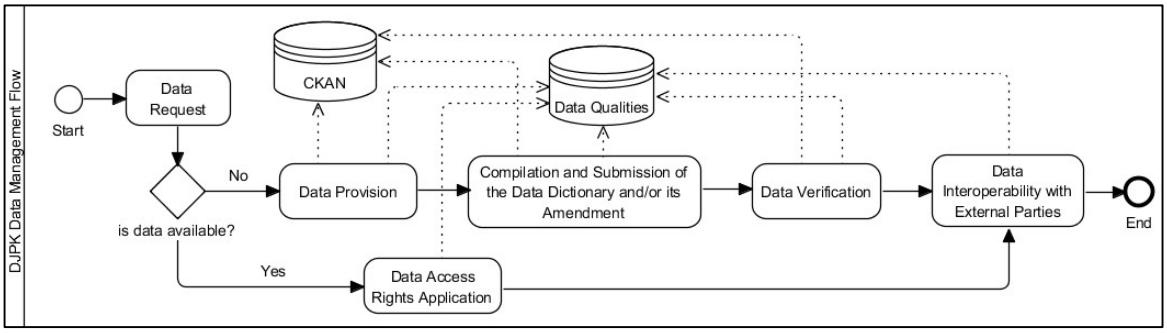


Figure 2 Data Management Business Process

4.1.1. Business Process Modeling

The first design created is a business process model (BPM) to visualize business analysis and workflows in an organization. In general, open government data management BPM at DJPK is shown in Figure 2.

As shown in Figure 2, the data management process begins with a data request by the user. If available, the custodian is granted access, if not, the data is provided using the data sheet as the source. After the data submission process by data producers, dictionaries and metadata are entered, followed by data validation. This validation process involves performing data cleansing to ensure that the published data attain high-quality standards. The last step involves sharing the data with data users through the provision of an API that fulfils their specific data requests.

4.1.2. Decompose Process Business

The following design stage decomposes the business processes described in the BPMN. This decomposition aims to obtain the capabilities of each business process or business service capabilities as shown in Table 3. The defined IT services result from the business process decomposition described in Figure 2. These collection of IT services managed in a catalog. It should be emphasized that we have reported initial service catalogs in a previous study [19]. The IT services presented in Table 3 are additional services that have not been identified in previous studies.

Table 3 Additional IT Services

IT Services	Operation
Data Request Management	Datarequest_update()
DsMetadata Management	Dsmetadata_create(), Dsmetadata_search()
Rule of Business Details	Detailsrob_create(), Detailsrob_update(), Detailsrob_search()
Data Cleansing	Post_completeness(), Post_duplicates(), Post_conformity(), Post_validity(), Post_accuracy(), Post_consistency(), Post_integrity()
Quality Score Management	Quality_score(), Qualityscore_search()
Data Type Management	Typedata_create(), Typedata_update(), Typedata_delete(), Typedata_search(), Typedata_list().

4.1.3. Service Interaction and Participants

This section will show detailed modeling of service interfaces described by class diagrams to get a clearer picture of the representation in Rest creation. Rest relies on Uniform Resource Identifiers (URI) to detect and interact with unique resources [17]. There are several operations provided by Rest which include: (1) GET to fetch resources; (2) POST to send many data to the server from a specific resource; (3) DELETE to delete or retrieve resources; (4) PATCH to send data to the server from the resource to change data that previously existed. The modeling carried out will include all service candidates that have been identified previously. Figure 3 is an example of a class diagram showing the list of operations and parameters from the Metadata Management candidates. The operations listed in figure 3 are required to create, modify and view details of the metadata created by custodians. Parameters are marked with an up arrow, and the response given from the operation that has been executed is marked with a down arrow.

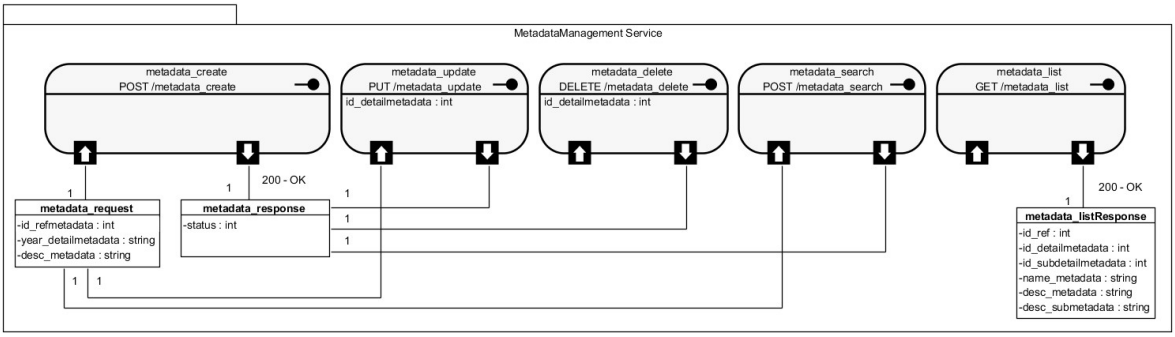


Figure 3 Metadata Class Diagram

Furthermore, service participant modelling is carried out for each business process in an open government data management platform to see participant involvement in each business process. Use case diagram used to map participant and any service in the system.

4.1.4. Platform Architecture

As reported in our previous study [19], the proposed solution is described in a multi-layer architecture, however, there are adjustments to the service layer by removing data access rights management and adding quality score and metadata management services. In summary, the architecture consists of 5 layers, namely: operational system, service component, service, business process, and customer. The operational systems layer contains information technology assets to support the various processes defined at the business process layer. A variety of utility services and supporting systems to support task services [18], which are key IT services according to business processes, are delivered at the service component layer. This includes SSO, notifications, and CKAN. IT services resulting from the business process decomposition fill layers of services based on various business processes related to the business process layer. Finally, the customer layer contains the interface used by users to access the developed platform.

4.2. Demonstration

A prototype is used to demonstrate the proposed platform. Prototypes are developed based on designs that have been made before. In general, the overall operations for each service are mentioned in Table 3 and already assembled. Due to the focus of this research, which is improving data quality, in the following, we present some examples of operational displays for improving data quality developed in a prototype of an open government data management platform. For example, Table 4 shows the results of the coding done on the post-duplicate operation; the service shows the service operation is executed; the method shows the method used in the operation; and the parameter indicates the parameters needed to send the operation to the server. The response shows the result of the operation that has been executed.

Table 4 Result of Software Coding Post Duplicate Operations

Service name	post_duplicate
Method	POST
Parameter	{ "package_name": "tesis-habibie-tes-01", "token_ckan": token_ckan_api, "id_datastore": 393,

Service name	post_duplicate
	"confirm": **false** }

Response	{
	"data_result": [],
	"data_quality": {
	"DataQuality": "Completeness",
	"id_datastore": 393,
	"status": "pre",
	"Total Missing": 0,
	"Total Data": 547
	}
	}

Additionally, several features can be used to enhance user interaction when operating an open data management platform, including data provision, a process for compiling and submitting a data dictionary and amendments to it, and a business for data verification.

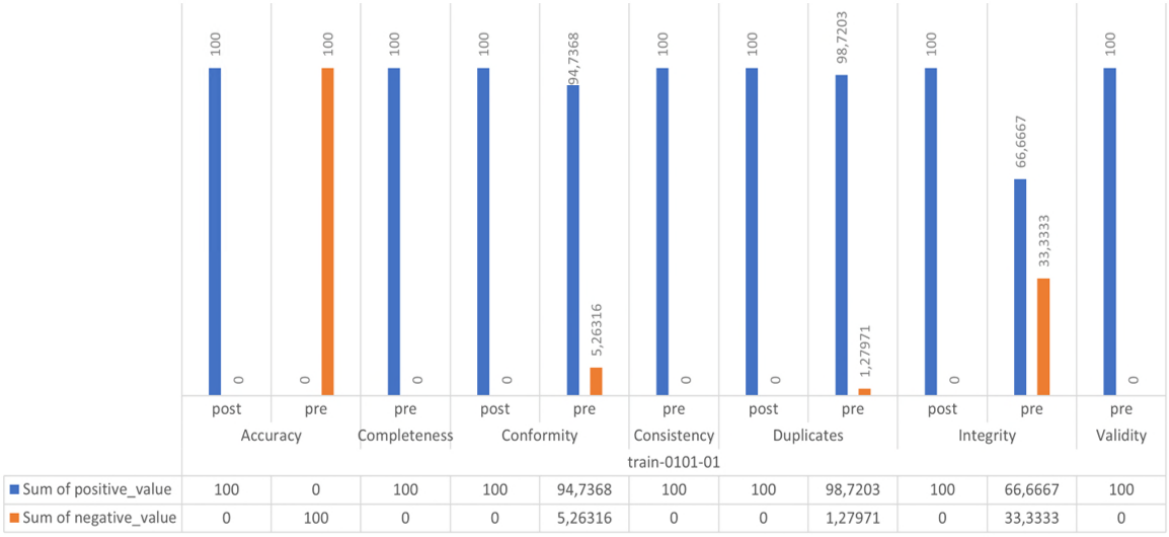
5. Discussion

After the demonstration, the next stage is to evaluate the design that has been made at the design and development stage and improve the data quality of the data that will be published. The evaluation is carried out by testing the monthly realization data of regional government revenue and expenditure budgets. The data used is local government monthly transaction data. The training data used is 30 data consisting of 3 local governments for ten months. Evaluation is carried out using valid and invalid DQI calculations in equations (5) and (6). Table 5 shows the results of the data quality assessment of the data to be published using XYZ Regional Government data.

Table 5 Result of Data Quality Assessment XYZ Regency

Dimensions	Calculation	Metrics	Status Indicator
Completeness (All columns in each row must be filled in)	Counted population: 547 Unpopulated count: 0 Number of records: 547	Valid DQI: 547/547 * 100 = 100% populated. Invalid DQI: 0/547 * 100 = 0% unpopulated.	Accepted
Uniqueness (There should be no rows that have the same value)	Counted duplicates: 7 Number of records: 547	Valid DQI: 540/547 * 100 = 98.720% identified differently in each row of data. Invalid DQI: 7 / 547 * 100 = 1.2797% of the 547 rows identified.	Not Accepted
Consistency (Local government codes and local government names are compared with available reference data)	Calculated local government code or local government name is not the same: 0 Calculated local government code or local government name is the same: 1 Total local government contained in row data: 1	Valid DQI: 1/1*100 = 100% of records equal data references. Invalid DQI: 0/1*100=0% of records do not equal data references.	Accepted
Accuracy (APBD data is checked by custodians, and uploads a pdf of APBD data the competent authority has approved)	Accuracy check proof has been uploaded: 0 Custodians who checked: 0 Total Prerequisites: 2	Valid DQI: 0/2 * 100 = 0% meets the prerequisites. Invalid calculations: 2/2 * 100 = 100% does not meet the prerequisites.	Not Accepted

Dimensions	Calculation	Metrics	Status Indicator
Conformity (The data producer defines the data type for each column)	Number of columns according to data type: 18 The number of columns does not match the data type: 1 Total columns: 19	Valid DQI: 18/19 * 100 = 94.7368% according to the defined data type. Invalid DQI: 1/19 * 100 = 5.26316% does not match the defined data type.	Accepted
Validity (The results of the absorption percentage of LRA XYZ regency in January is on the threshold of the upper max and lower min set)	In accordance with the upper limit validation: 1 In accordance with lower limit validation: 1	Valid DQI: 2/2 *100 = 100% meets validation. Invalid DQI: 0/2 *100 = 0% does not meet validation.	Accepted
Integrity (Data LRA. XYZ regency in January has obtained values from the dimensions of accuracy, completeness, and consistency)	Accuracy Value: 0 Completeness Value: 100 Consistency Value: 100 Total dimension values: 300	Valid DQI: 200 / 300 * 100 = 66.6667% integrity. Invalid DQI: 100/300 * 100= 33.3333% not integrated.	Accepted



	Accuracy post	Accuracy pre	Completeness pre	Completeness post	Conformity pre	Conformity post	Consistency pre	Duplicates post	Duplicates pre	Integrity post	Integrity pre	Validity pre
Sum of positive_value	100	0	100	100	94,7368	100	100	98,7203	100	100	66,6667	100
Sum of negative_value	0	100	0	0	5,26316	0	0	1,27971	0	0	33,3333	0

Figure 4 Statistics on Increasing Data Quality Value of Realization of the Monthly APBD of XYZ Regency

From the values shown in Table 5, it can be seen that there are still complex data in data quality of validity, integrity, accuracy, conformity (even though conformity is acceptable, it can still be optimized), and uniqueness. For accuracy, this is because there has yet to be manual checking from custodians regarding the data to be published and whether it is by the reports sent every month. If accuracy is not valued, it affects integrity which gets value from the three data values, one of which is accuracy. Due to data duplication, the validity has problems because after being identified, there are duplicated data which makes the percentages more significant than they should be and exceeds the upper max or lower min limits previously set. In the calculation results, the spending budget percentage is 3.511849, which is still in the max and min range of spending, but when it is matched with manual checking, it is not the same.

Then the improvement stage for the anomaly was carried out to improve data quality; in this case, it was used as an example, namely XYZ Regency data, and the results were obtained as shown in Figure 4. Its shows an increase from duplication at the anomaly identification stage to nothing when it has passed the

anomaly cleansing stage. As a concern, the validity data quality dimension is also different from the stage before eliminating duplication. The percentage of the previous expenditure budget was 3.511849 to 2.04304, and after manually checking the expected results for the percentage of the expenditure budget were 2.04304. The dimension of conformity data quality has also increased from the previous valid DQI value of 94.7368 to 100. On other quality dimensions, completeness is worth 100, which indicates there are no empty columns in the data, and consistency is also worth 100, which indicates that the data is consistent after being compared with existing reference data (in this case, using local government name and reference data code). Furthermore, the dimension of data quality and accuracy has also increased from the previous valid DQI value of 0 to 100 by manually checking from custodians by uploading pdf documents which are used as a comparison of the data to be published. Due to an increase in the accuracy of the data quality dimension, the integration dimension has also increased from the previous valid DQI value of 66.6667 to 100.

6. Conclusions

This research has resulted in an open government data management platform based on SOA that can accommodate data governance. One of the aims of fulfilling data governance needs is to improve data quality from the strategies, policies, and initiatives contained therein.

Based on the evaluation results, there is an increase in data on the dimensions of validity, integrity, accuracy, conformity, and uniqueness. In testing the validity of the data quality dimension, it obtained a valid DQI of 100. Still, the value of the percentage of the expenditure budget was different due to duplication of data, which previously had a value of 3.511849 to 2.04304. After removing duplication of data, the valid DQI value of the uniqueness dimension increased from 98.7203 to 100. After that, the results of the validity data quality dimension also matched the results of manual calculations by custodians. The dimension of conformity data quality has also increased from the previous Valid DQI value of 94.7368 to 100. No blank data indicates that the trial data is complete on the completeness data quality dimension.

Furthermore, the dimension of data quality and accuracy has also increased from the previous valid DQI value of 0 to 100 by manually checking from custodians by uploading pdf documents which are used as a comparison of the data to be published. On the consistency data quality dimension, the Valid DQI is 100, which indicates that the data is consistent when compared with existing reference data. Meanwhile, for the dimension of data quality integrity, there was an increase from the previous Valid DQI value of 66.6667 to 100 obtained from the data quality dimension values of completeness, accuracy, and consistency, respectively, namely 100, 100, and 100, the integrity dimension value was 100.

Bibliography

[1] R. Enriquez-Reyes, S. Cadena-Vela, A. Fuster-Guillo, J.-N. Mazon, L. D. Ibanez, and E. Simperl, “Systematic Mapping of Open Data Studies: Classification and Trends From a Technological Perspective,” IEEE Access, vol. 9, pp. 12968–12988, 2021, doi: 10.1109/ACCESS.2021.3052025.

[2] J. Attard, F. Orlandi, S. Scerri, and S. Auer, “A systematic review of open government data initiatives,” Government Information Quarterly, vol. 32, no. 4, pp. 399–418, Oct. 2015, doi: 10.1016/j.giq.2015.07.006.

[3] A. Bachtiar, Suhardi, and W. Muhamad, “Literature Review of Open Government Data,” in 2020 International Conference on Information Technology Systems and

Innovation (ICITSI), Bandung - Padang, Indonesia: IEEE, Oct. 2020, pp. 329–334. doi: 10.1109/ICITSI50517.2020.9264960.

[4] A. Nikiforova and N. Kozmina, “Stakeholder-centred Identification of Data Quality Issues: Knowledge that Can Save Your Business,” in 2021 Second International Conference on Intelligent Data Science Technologies and Applications (IDSTA), Tartu, Estonia: IEEE, Nov. 2021, pp. 66–73. doi: 10.1109/IDSTA53674.2021.9660802.

[5] D. International, DAMA-DMBOK: data management body of knowledge, 2nd edition. Basking Ridge, New Jersey: Technics Publications, 2017.

[6] S. Thammaboosadee and N. Dumthanasarn, “Proposed Amendments of Public Information Act Towards Data Governance Framework for Open Government Data: Context of Thailand,” in 2018 3rd Technology Innovation Management and Engineering Science International Conference (TIMES-iCON), Bangkok, Thailand: IEEE, Dec. 2018, pp. 1–5. doi: 10.1109/TIMES-iCON.2018.8621651.

[7] Emilsson, Cecilia, Chauvet, Lucia, González-Zapata, Felipe, and Rivera Perez, Arturo, “The interdependency of data governance and open government data: lessons from COVID-19,” Aug. 2020, doi: 10.5281/ZENODO.3978270.

[8] H. Al Omari, S. Barham, and A. Qusef, “Data Strategy and Its Impact on Open Government Data Quality,” in 2021 International Conference on Information Technology (ICIT), Amman, Jordan: IEEE, Jul. 2021, pp. 648–653. doi: 10.1109/ICIT52682.2021.9491766.

[9] M. Lnenicka and A. Nikiforova, “Transparency-by-design: What is the role of open data portals?,” Telematics and Informatics, vol. 61, p. 101605, Aug. 2021, doi: 10.1016/j.tele.2021.101605.

[10] J. Macedo, N. Cacho, and F. Lopes, “A Comparative Study of Tools for Smart Cities Open Data Publication and Management,” in 2017 IEEE First Summer School on Smart Cities (S3C), Natal: IEEE, Aug. 2017, pp. 79–84. doi: 10.1109/S3C.2017.8501408.

[11] C. Bonina and B. Eaton, “Cultivating open government data platform ecosystems through governance: Lessons from Buenos Aires, Mexico City and Montevideo,” Government Information Quarterly, vol. 37, no. 3, p. 101479, Jul. 2020, doi: 10.1016/j.giq.2020.101479.

[12] E. Sanchez-Nielsen, A. Morales, O. Mendo, and F. Chavez-Gutierrez, “SuDaMa: Su stainable Open Government Da ta Ma nagement Framework for Long-Term Publishing and Consumption,” IEEE Access, vol. 9, pp. 151841–151863, 2021, doi: 10.1109/ACCESS.2021.3127472.

[13] M. I. Jaya, F. Sidi, I. Ishak, L. S. Affendey, and M. A. Jabar, “A Review of Data Quality Research in Achieving High Data Quality Within Organization,” Jun. 2017, doi: 10.5281/ZENODO.5374545.

[14] D. Loshin, “Data Quality and MDM,” in Master Data Management, Elsevier, 2009, pp. 87–103. doi: 10.1016/B978-0-12-374225-4.00005-9.

[15] F. N. Kerlinger and H. B. Lee, Foundations of behavioral research, 4th ed. Fort Worth, TX: Harcourt College Publishers, 2000.

[16] K. Peffers, T. Tuunanen, M. A. Rothenberger, and S. Chatterjee, “A Design Science Research Methodology for Information Systems Research,” Journal of Management Information Systems, vol. 24, no. 3, pp. 45–77, Dec. 2007, doi: 10.2753/MIS0742-1222240302.

[17] R. T. Fielding and R. N. Taylor, “Architectural Styles and the Design of Network-Based Software Architectures.” 2000.

[18] . Edison, V. Tulenan, and F. L. Gaol, “SOA Refference Architecture Blueprint,” Jurnal Sistem Informasi, vol. 5, no. 2, p. 81, Jul. 2012, doi: 10.21609/jsi.v5i2.266.

[19] K. Habibie, Suhardi, and W. Muhamad, “Designing Open Government Data Management Platform Through the Implementation of Data Governance Based on SOA,” in 2022 International Conference on Information Technology Systems and Innovation (ICITSI), Bandung, Indonesia: IEEE, Nov. 2022, pp. 37–42. doi: 10.1109/ICITSI56531.2022.9971091.