Data Quality Management Maturity Measurement of Government-Owned Property Transaction in BMKG

Septian Bagus Wibisono[1], Achmad Nizar Hidayanto[2], and Widijanto Satyo Nugroho[3]
[1–3]Faculty of Computer Science, University of Indonesia
Depok 16424, Indonesia
Email: [1]septian.bagus@ui.ac.id, [2]nizar@cs.ui.ac.id,
[3]wnugroho@cs.ui.ac.id

***Abstract*—Government-Owned Property (GOP) management, including the bookkeeping of GOP transaction, is part of GOP Officer responsibility to ensure the quality of transaction data. This responsibility also applies to GOP Officer in Indonesian Agency for Meteorological, Climatological and Geophysics Badan Meteorologi, Klimatologi, dan Geofisika (BMKG). GOP data as the source for the Central Government Financial Report is expected to be well-maintained. It must be presented as accurate as possible, although there are still inaccurate data presented in the latest BMKG GOP Report. This qualitative research using document study and some interview sessions aims to measure how well the Data Quality Management (DQM) maturity of GOP transaction in BMKG using Loshin's Data Quality Maturity model. Thus, the result of maturity assessment is analyzed to recommend and implement DQM activities from the Data Management Body of Knowledge (DMBOK). The purpose is to improve GOP DQM. The research shows that the level of DQM maturity is at a repeatable level to defined level. Moreover, 52 maturity characteristics need to be followed through with DQM activities.**

***Index Terms*—Data Quality Management Maturity, Government-Owned Property (GOP), Indonesian Agency for Meteorological, Climatological, and Geophysics**

I. Introduction

NOWADAYS, data have been considered as the main capital in an organization as well as financial and human capital. Organizations need to pay particular attention to data capital, as data give added value to the organization [1]. The statement is in line with the results of a survey conducted by Ref. [2] in 179 large companies. They concluded that business with Data-Driven Decision (DDD) making produced the highest productivity about 5–6% higher than expected. Reference [3] showed that the implementation of data governance affected the data quality especially on the aspects of completeness, consistency, accuracy, relevancy, and timeliness.

Ensuring data quality is an important step to improve business results. The business analysis based on bad data will result in business losses. The data quality also influences the level of users satisfaction and stakeholders [4]. Maintaining high data quality level is essential for the organization, whether it is to improve the productivity of its employees or to give better services to the customers. To achieve a good data quality level, key stakeholders have to understand the importance. The organizations need to have a data steward and apply appropriate technology as well [5]. Data Quality Management (DQM) is a concept and practice to improve data and information quality including the quality of organization's policies and guidelines, the measurement, analysis, cleansing and correction, data process improvement, and data quality education [6].

The government of Indonesia has also been aware of the importance of maintaining their data including the data of their property as part of policies-making in various fields. Their concerns are shown by several Central Government Regulations and the Minister of Finance Regulation. Those are expected to serve as guidelines for Ministries/Agencies/Local Governments in managing their assets. Indonesian Meteorology, Climatology, and Geophysics Agency Badan Meteorologi, Klimatologi, dan Geofisika (BMKG) as one of the non-ministerial government agencies has been implementing the governmental act in meteorology, climatology, air quality, and geophysics. These duties include managing their state property as stated in 2008 Indonesian President Act Number 61 about Agency of Meteorology, Climatology, and Geophysic. According to 2014 Indonesian Goverment Act Number 27 about Goverment-Owned Property Management. There are several activities to maintain the property such as plan-

Received: Feb. 15, 2018; received in revised form: Jun. 20, 2018; accepted: Jun. 20, 2018; available online: Oct. 25, 2018.

ning and budgeting, procurement, utilization, securities and maintenance, appraisal, liquidation, destruction, removal, administration, supervision, and control.

GOP administration as stated in 2007 Minister of Finance Act Number 120/PMK.06/2007 about Government-Owned Property Administration covering the activities of bookkeeping aims to embody proper administration and support the management of GOP. In practice, the bookkeeping activity of GOP is an activity of inputing all transactions related to state assets to 'Persediaan' and Government-Owned Property Accounting Management Information System (SIMAK-BMN).

The registration of GOP transactions includes compiling those data every month at BMKG Head Office. It provides integrated data as a source of decision making-process about asset management. Furthermore, GOP data are required by technical deputies as supported data in meteorological, climatological, air quality, and geophysical maintenance activities. The BMKG Planning Bureau also requires GOP data for budgeting procurement activities.

The Ministry of Finance has issued regulations about the importance of accuracy and reliability of GOP data as a source of Central Government Financial Report. In practice, there are indications that BMKG GOP data is less accurate. There is an imbalance in BMKG financial statements on two accounts that should be complementary on the debit and credit side. This condition is not suitable for the rules of balance sheet [7]. On the other hand, based on reports of GOP consolidation activities, there are still GOP locations which do not match the records in the database. GOP report also indicates the assets that should be reclassified by existing regulations, but it still records the by previous classification.

Based on these problems, the researchers measure how far the maturity level of DQM in BMKG, especially for GOP data transactions. Previous research as done by Refs. [8–10] emphasized the maturity of data quality based on the information system and and did not consider the effect from poor data quality. BMKG GOP data are derived from the SIMAK-BMN application which is developed by the Ministry of Finance. Therefore, the proper maturation model is needed to consider the side effect of poor data quality. Data quality maturity model by David Loshin is chosen because it emphasizes the impact of poor quality data such as the impact on finance, organizational trust, productivity, and investment risk [11, 12]. BMKG faces these impacts when their financial statements show differences in some balance sheet accounts and make their credibility reduced. GOP data which are not reflected in real condition also affect the decision-making related to the financial [13], procurement, and investment in assets.

After the maturity level determined, an analysis is conducted to provide recommendations to improve the quality of data management strategies based on DQM activities in Data Management Body of Knowledge (DMBOK) which are considered as the best-theory approaches to data quality improvement [14]. Data quality activities in DMBOK are selected due to their continuous activities to ensure the desired level of data quality of the organization in each DQM cycle.

II. Literature Review

A. Data Quality Management (DQM)

DMBOK mentions that DQM is a vital support process in organizational change management. Data quality is closely related to the quality of information. Low data quality causes inaccurate information and leads to business performance degradation [6]. DQM has an impact in decision support system as well as the value of the decision [15]. Therefore, poor DQM impacts poor operational activities and strategic decision-making.

A governmental organization needs to implement data quality management initiatives since this methodology has proven to improve business decision-making. It also improves the organizational data integrity, controls business cost, reduces the risk of fraudulent activities, and maintains customer relationship [16].

There is a limitation to improve data quality if correction is done at the error data and does not seek the cause of the error. These limitation leads to a continuous correction process. Therefore, a framework for DQM is required to improve data quality more effectively and efficiently [17, 18].

B. Data Quality Maturity Model

A performance management approach to data quality is used to illustrate how DQM is related to all activities in an organization depending on the information. Since the information is based on data and to improve data quality, organization needs to understand how far the maturity that fits the needs can provide a criterion to analyze their capability [11, 19]. One way to evaluate and solve this problem is to assess the level of maturity associated with the quality of the data. Then, it determines the target level of maturity that meets the requirements of the organization the best.

A tool called Data Quality Maturity model can be used to categorize the level of maturity of an organization in handling design, implementation, production, problem-solving, and others [11]. The same approach applies to the Data Quality Maturity model which

measures and visualizes how DQM aligns with all information activities in an organization. Table I shows some previous research which measured data quality.

C. Data Quality Maturity Model by David Loshin

Loshin has a model that can be used to measure the maturity of a quality data management. It is called as Data Quality Maturity model. This model is an adaptation of the maturity model developed by the Software Engineering Institute in Carnegie Mellon University. The framework is used to measure the maturity of DQM based on eight components. Those are:

1) Data Quality Expectations. This domain measures the expectations related to the quality of data that are explicit or implicit in various directives and policies of the organization. Determination of data quality expectations includes relevant measures in the dimensions of data quality, metrics to evaluate compatibility in each dimension, and processes for evaluating compatibility in each dimension.
2) Dimensions of Data Quality. This domain emphasizes the classification of data quality expectancy components and provides steps to evaluate compatibility with the measurement of the expected quality of the data.
3) Policies. Various types and sources of data cause complexity in data management. The created policies to manage data management include data certification, privacy, data flow, and reliable data sources for the organization.
4) Procedures. Data quality procedures describe the operational aspects of a system to validate the existence and effectiveness of data management activities.
5) Governance. DQM should incorporate participatory, collaborative, and oversight management of all individuals within the organization. To realize it, it requires a data of governance structure that manages oversight and a set of data stewardship processes across all individual organizations.
6) Standards. Data standardization simplifies and adapts to external and internal information exchange standards. Standardization related to data quality is data definition, data meaning, and data exchange.
7) Technology. The implementation of a data quality framework involves the participation of individuals in organizations that are expected to use technology with the intention of adhering to data quality protocols and processes. It also supports data quality service levels through a reference set of data and validates/verifies the compatibility of data values with the expectation.
8) Performance Management. Specific processes for governance, stewardship, identification of data quality expectations, and determining the suitability of data quality expectations require performance management schemes to monitor overall organizational data quality.

The characteristics contained in the eight components can be seen in Tables A1–A2 (see Appendix). These eight components can be used as a measurement tool to determine how far the management of data quality within an organization is. The measurement produces values which are mapped according to their maturity level. There are five levels of maturity starting from the initial level which data practices and policies are still ad hoc to the highest that processes and practices assessed in a sustainable, upgraded, and optimized manner. The levels of maturity are as follows.

1) Initial. The process used for data quality assurance is mostly ad hoc with the most effort to respond to data quality issues.
2) Repeatable. There is some management in the organization and simple information-sharing activities. There are some process disciplines, mostly it is adopted from good practice and tries to imitate the practice in the same situation.
3) Defined. At this level, the team that handles data quality begins to document things like data governance policies, processes to define expectations of data quality, technology components, data quality, and report of validation processes.
4) Managed. DQM includes business impact analysis, defines expectations of data quality, and measures compliance with those expectations.
5) Optimized. Performance measurement across the organization can be used to identify opportunities for systemically improving data quality.

D. Data Management Body of Knowledge (DMBOK) in Data Quality Management (DQM) Activities

DMBOK has defined 12 activities that can be used to improve the quality of data adjusting to business objectives. Those activities include:

1) Develop and promote data quality awareness
2) Define data quality requirements
3) Profile, analyze, and assess data quality
4) Define data quality metrics
5) Define data quality business rules
6) Test and validate data quality requirements
7) Set and evaluate data quality service levels
8) Continuously measure and monitor data quality
9) Manage data quality issues
10) Clean and correct data quality defects

TABLE I
PREVIOUS RESEARCH ON DQM.

No.	Source	Dimensions Evaluated	Summary of Research
1	Reference [18]	Consistency, completeness, exceptions	The research explained how the implementation of business rule approaches developed a data validation tool called GuardianIQ. It transformed the description of the data quality rules into lines of code that objectively measured, and reported quality levels based on user expectations.
2	Reference [20]	Accuracy, consistency, completeness, timeliness	The research focused on the impact of data quality dimensions to improve business processes to support and facilitate managerial leadership in business process improvement.
3	Reference [21]	Completeness, accuracy, traceability, currency, term, compliance, understandability	This research aimed to create a framework of indicators that measured the quality of data in Open Data Government. It was based on a series of quality dimensions at the level of measurement in detail.
4	Reference [22]	Completeness, unambiguity, correctness	Taxonomy for data quality issues, especially ontology-based frameworks improved the quality of online financial data. This framework was expected to support financial decision-making and in other domains where data were scattered across multiple overlapped but complementary sources.
5	Reference [23]	Accuracy, completeness, consistency, relevance, timeliness	This research proposed a framework for enterprise DQM. The scope of the framework was inferred from IT and data management conditions such as COBIT and ITIL. The proposed framework helped to determine what activities needed to be done to improve the quality of corporate data and how those relationships were interrelated. The framework helped to combine enterprise data management with the business goals of an organization.
6	Reference [24]	Consistency, completeness, correctness	This research shows an approach to data quality orientation that facilitated and enhanced the quality of managerial decision-making in the context of redesigned business processes. Data quality was considered as a factor in business process success. It was conceptualized using a rule-based approach.
7	Reference [25]	Accuracy	The research proposed an integrated framework that organizations could adopt a part of the financial and management control process to provide a mechanism to calculate data problems. It determined potential solutions and monitored costs and benefits. It also improved and maintained data quality.

11) Design and implement operational DQM procedures
12) Monitor operational DQM procedures and performance

Activities that are best practices in DQM based on DMBOK are used to response BMKG challenges in improving the maturity level of their DQM. DMBOK approach is a continuous approach so that the process of data quality improvement, planning, dissemination, supervision, and the action can be repeatedly done when data issue arises.

III. RESEARCH METHOD

A. Research Stages

This research started by determining the problem to the final step. The researchers map the challenges in DQM with data quality improvement activities according to DMBOK. The research stages are in Fig. 1.

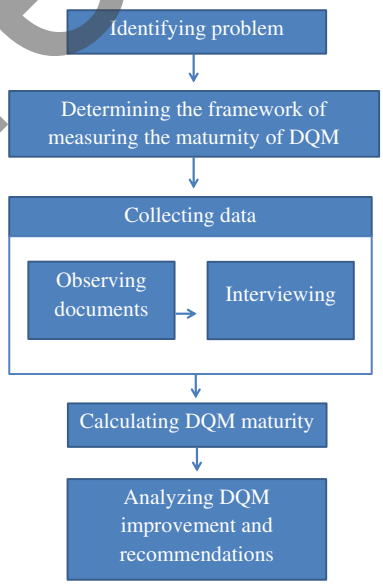

Fig. 1. Research stages.

B. Problems Identification and Define Framework

Accurate and reliable data quality expectation has been stated in the 2016 Minister of Finance Act Number 69/PMK.06/2016 about Guidance Goverment-Owned Property Reconsiliation in Forming Central Governmental Financial Report. It aims that the Central Government Financial Report is presented accurately. The current Audited 2016 BMKG Financial Report shows that there are imbalanced accounts, especially outgoing transfers, and inbound transfers. Another evidence is the misclassification of GOP that is not in line with the codification of GOP. Real life GOPs locations which are not presented in the application also contribute to the inaccuracy of data.

These realities cause the BMKG financial statements and the state property statement to be inaccurate. Therefore, it is necessary to measure the maturity of DQM and recommend activities to improve the

maturity.

To determine the framework, the researchers conduct a study of literature on previous research. Based on several researches in Table I, the researchers define the framework proposed by David Loshin as the model. It emphasizes on the impact of data quality to analyze the data in BMKG.

C. Collecting Data

The characteristic in every component of Loshin's Data Quality Maturity model is used as a checklist to assess the compliance with the state of DQM. Checklists are formed to resemble a matrix to simplify the assessment process. The presentation of the assessment data includes a characteristic of ID code adjusting to the level of maturity. The codes are expectation component (H), dimension (D), policy (K), procedure (P), governance (G), standardization (S), technology (T), and performance management (M). For maturity code, initial (I), repeatable (R), defined (D), managed (M), and optimized (O). The characteristic ID is a combination of characteristic code, the code of maturity level, and the serial number of characteristics in each component per level of maturity in the theory of David Loshin [11].

Due to a large number of checklists, the first step in data collection and compatibility assessment is done by observing the documents. The documents are regulations related to the management of GOP such as Central Government Regulation, Presidential Regulation, Minister of Finance Regulation, and BMKG Regulation, financial statements, GOP statement, and other reports related GOP managed by BMKG. Several documents cannot evaluate some of the checklists. Some of them need an evaluation from people who ever do the activities on the checklist or see the activities.

Moreover, the interview section is conducted with open questions. It aims to explore more information from interviewees. Then, the interviewees focus on elaborating on the situation. It is not just "yes" or "no" answers for every point in the checklist. The interviewees are two GOP Officers in BMKG head office. They have experienced the management of GOP for nine years. There are 197 BMKG offices in Indonesia, and every office has at least one GOP Officer. However, the head office, where all transactions are collected and all BMKG GOP regulations are made, has ten officers. The result of the interviews completes the checklist.

D. Calculating Data Quality Maturity

Calculation of the maturity level of each component is done by summing the value of each level of maturity. Each component has a maximum maturity level (1). It is derived from the average value of the overall characteristics of erach component. If the characteristics are by BMKG practice, it is 1. Otherwise, it is 0. For example, in expectation component (H) with initial level (I), there are three characteristics (HI1, HI2, HI3). HI1 and HI3 are appropriate with circumstances in BMKG, then each value is 1. Meanwhile, HI2 is not fit, so the value is 0. Then, the expected component value for the initial level is as follows:

$$\text{Initial level} = \frac{(1+0+1)}{3} = 0.6. \quad (1)$$

The number of characteristics (3) is in the expectation component (H) with the initial level (I). The calculations are also applied to other levels of maturity in the expectation component. The values at each level are summed to get the value of maturity in a component. The maximum value of a component is 5.

E. Recommendation Analysis Improved Data Quality Management

Based on the characteristic, the matrix shows the characteristics of points that have not been met by BMKG. These characteristics are mapped into the activities that need to be done according to the DQM in DMBOK rules. It expects the DQM performed by BMKG can get better in the future. For a better presentation of DQM in DMBOK mapping activity, the code is given for each activity starting from the code to develop and promote data quality awareness (DQM1) to monitor operational SOP and DQM performance (DQM12).

IV. Results and Discussion

The results of the assessment are presented in Tables A3–A5 (see Appendix). The justification for condition is based on documents observation and interview. Reference number for every evidence for the document is presented in Table A6 (see Appendix). Meanwhile, the interview-based evidence is given a code W1 for the first interviewee and W2 for the second interviewee.

The maturity position of the DQM and the target of maturity are based on the position above the assessment of the current condition. The results of the assessment and target of maturity are presented in Table II. The maturity condition of GOP DQM in BMKG in each component of maturity is as follows.

1) Expectation. Based on the calculation, the expectation component has the highest maturity value. This assessment is supported by GOP of BMKG DQM condition. This component identifies the

TABLE II
THE RESULTS OF ASSESSMENT AND TARGET OF MATURITY.

No.	Component	Present condition	Target
1	Expectation	3.4	4
2	Dimension	2.2	3
3	Policy	2.9	3
4	Procedure	3.1	4
5	Governance	2.0	3
6	Standardization	3.3	4
7	Technology	3.3	4
8	Performance Management	2.2	3

expectation of data quality regarding data problems anticipation and reporting. The lacks of this component lies in the absence of methods for measuring business impact when data errors occur and the absence of benchmarks in the measurement of data quality. Measuring data error impact on business process is a necessary action to do especially in data interchange matter [26].

2) Dimension. Dimensional component assessment shows that the management of GOP data quality already uses the dimension of data quality in general. However, there is no determination of data quality dimension in the form of regulation. The absence of rules by governing data quality dimensions leads to no reports of data quality. The absence is seen in the various ways of data quality assessment in each GOP Officer in head office.
3) Policy. The condition of existing policy components in BMKG and coordination do the policy-making process. The regulated policies include restrictions on access rights to data and historical data changes. Things that have not applied in BMKG are the SLA regarding the data quality, and there is still unsuitable standard notification for data transaction. Other policies that need to be considered are the handling of data problems and the certification process regarding the sources of data quality.
4) Procedure. The condition of GOP DQM for procedural components is done with coordination at the technical service unit level and head office level. It also includes coordination of data correction as and coordination related to data source in searching data. The search does not include syntax and data structures since it is the authority of the Ministry of Finance. Moreover, the validation and auditing have been done by involving several other applications.
5) Governance. Governance implemented in BMKG still has not applied the data steward, and there is no organizational structure to supervise data governance. However, to overcome the problem, it has been communicated to GOP Officers in technical service unit to head office. The GOP Officers have realized that the data problem is not only the problem of IT. Regarding appreciation of the GOP data management business, the Ministry of Finance has also held awards as a form of appreciation of the ministry/institution that has proper GOP management.
6) Standardization. The condition of standardization component can be seen in the existing of standard and definition of managed data and business terminology. The existence of reference data also supports it. GOP transaction data can be identified by referring to any information. The guidelines for data exchange are well organized and executed. On the other hand, metadata management does not exist, and the master data are still managed with transaction data.
7) Technology. Technology components in DQM are illustrated by the availability of applications to find, match, and connect data. GOP Officers have also realized that the problem of data will impact the other parts. It also provides dashboard and reporting applications to support impact analysis caused by data errors.
8) Performance Management. Performance management conditions in BMKG GOP DQM has the absence of regional characterization as the impact of poor data quality, and the absence of profiling that can be used to identify data errors. Moreover, there is no framework to analyze the impact or detect data errors. Continous profiling is needed since the size of GOP data is big. Profiling process is performed while data are created or updated. Profiling also determines the common properties or heterogeneity of data, so that inconsistent data can be found easily [27]. Moreover, there is no framework to analyze the impact or detect data errors. BMKG and the Ministry of Finance must continue to update and give more rules as a foundation for improving the management of functional data quality.

V. RECOMMENDATION

The result of the assessment based on the compatibility with the condition of DQM also yields characteristics that have not fulfilled. The fulfillment of DQM characteristics is anticipated by the application of DQM activities on DMBOK. Table III shows the mapping of characteristic that has not met the DQM activity in DMBOK.

The most critical issue is DQM3, BMKG must promote the awareness of data quality to every employee

Cite this article as: S. B. Wibisono, A. N. Hidayanto, and W. S. Nugroho, "Data Quality Management Maturity Measurement of Government-Owned Property Transaction in BMKG", CommIT (Communication & Information Technology) Journal 12(2), 59–72, 2018.

TABLE III
CHARACTERISTICS MAPPING WITH DMBOK ACTIVITY.

Component	Level	ID	Condition	DMBOK Activity
Expectation	Defined	HD1	There is no documented data of quality dimension	DQM2
		HD4	The methods for assessing business impact is not available	DQM5
	Managed	HM4	There is no scheduling of data quality assessment	DQM8
	Optimized	HO1	There is no data quality benchmark	DQM4
		HO2	It is not associated with individual performance targets	DQM11
		HO3	The level of industry proficiency has not been used	DQM5
Dimensions	Initial	DI3	There is no categorization of data quality problems	DQM3
	Defined	DD3	The report on data quality measurement is not available	DQM3
	Managed	DM1	There is no grouping of data quality dimensions to business impact	DQM5
		DM2	There is no report of data quality	DQM4
		DM3	There is no data steward	DQM1
	Optimized	DO1	There is no SLA related to data quality	DQM7
		DO2	There is no SLA related to data quality	DQM7
		DO3	There is no definition of data quality dimensions	DQM2
Policy	Defined	KD2	There is no certification process regarding data quality	DQM6
		KD4	There is no SLA about data quality	DQM7
	Managed	KM3	DQM is missing	DQM5
		KM4	The policy has not driven performance management	DQM11
		KM5	There is no SLA about data quality	DQM7
	Optimized	KO1	There is no automatic notification if there is any inappropriate data	DQM10
		KO2	It has not implemented a system with independent data governance	DQM5
Procedure	Repeatable	PR2	Search does not include syntax and structure	DQM3
		PR3	Problem source analysis has not used data quality rules	DQM9
	Managed	PM1	Data quality monitoring is not proactive	DQM1
		PM3	The weakness of data is unknown from the beginning	DQM1
	Optimized	PO2	There is no publication of data quality measurements from participants	DQM8
		PO3	DQM is closed	DQM12
Governance	Initial	GI3	There is no official data steward	DQM5
	Repeatable	GR2	There is no working group	DQM1
		GR3	There is no working principle of data quality	DQM2
	Defined	GD1	There is no organizational structure oversees data governance	DQM1
		GD2	There is no documentation of working principles and data governance	DQM5
		GD3	There is no standard data stewardship view	DQM8
		GD4	There are no SOPs in governing data governance	DQM11
	Managed	GM1	There are no committees in dealing with data governance yet	DQM1
		GM2	It has not handled data governance	DQM1
		GM3	There is no SLA	DQM7
		GM4	There is no data governance framework	DQM11
		GM5	There is no report of data governance	DQM11
Standardization	Repeatable	SR5	There is no metadata management	DQM3
	Defined	SD1	There is no metadata management	DQM3
		SD2	Standard structures and data formats have not been defined and documented	DQM3
	Managed	SM4	There is no standard data supervisory board	DQM1
	Optimized	SO1	The master data concept is performed in one environment with transaction data	DQM5
		SO4	The standardization process is still manually updated	DQM3
Technology	Repeatable	TR1	There is no tool to measure the objectivity of data quality	DQM8
	Defined	TD4	There is no standard technology	DQM2
	Optimized	TO1	Non-technical users cannot modify technical rules because Ministry of Finance governs the rules	DQM12
Performance Management	Repeatable	MR1	There is no regional characterization of the impact of poor data quality	DQM3
		MR2	There is no profiling data	DQM3
	Defined	MD1	There is no framework to analyze the impact	DQM3
		MD2	There is no data quality service component	DQM7
	Managed	MM1	There is no data quality metrics	DQM4
		MM2	There are no determined data quality dimensions	DQM2

using GOP data directly or indirectly. Informing them of the impact on data issues and giving socialization about the data quality issue are not only a technology matter. Next critical issue is DQM1. BMKG must identify the business usage of GOP data set to list potential anomalies. These anomalies must be analyzed with subject matter expert to determine if it is categorized as data flaw or not. They can evaluate the potential impact on business caused by that anomaly. DQM5 is another concern for BMKG. After the expectation of data quality is determined, the next stage is to set business rules related transactions. It is inputted into the system including giving notification to data steward if there is a transaction that has the potential to reduce the quality of data.

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VI. Conclusion

This research shows the maturity level of each component of DQM maturity from Loshin's DQM model. It consists of expectation (3.4), dimension (2.2), policy (2.9), procedure (3.1), governance (2.0), standardization (3.3), technology (3.3), and performance management (2,2). Thus, the average maturity level of 2.8. In other words, maturity is still at the level of repeatable to defined. Repeatable level shows that BMKG has essential organizational management and information sharing. BMKG also can recognize good practice and try to implement it in their process. However, it has limited documentation of processes, plans, standards, and practices.

The characteristic assessment also leaves 54 characteristics that still need to be a concern for BMKG to achieve the highest level of maturity. These characteristics are mapped into DQM in DMBOK activities as a recommendation for improving the maturity of GOP DQM. The most critical issue is DQM3, DQM1, and DQM5. There are many concerns in how BMKG delivers awareness according to data quality, and how it must identify which transaction that may cause a flaw in data and how to avoid it. BMKG may need to consider to start determining SLA for data quality to specify the organizational expectation for response and remediation. With SLA of data quality, BMKG can monitor the compliance of data to the organizational expectation, and how well the employee performs the procedure associated with data errors.

Research shows that Loshin's Data Quality Maturity model can be used as a measurement of maturity in DQM. Therefore, it is expected that further research can be done in the ministry or other government institutions, especially in the Ministry of Finance as the builder in GOP management and as an agency that develops applications of SIMAK-BMN and Inventory. Moreover, further research can raise the subject of information system aspects in assessing the maturity of DQM.

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APPENDIX

The Appendices can be seen in the next page.

Cite this article as: S. B. Wibisono, A. N. Hidayanto, and W. S. Nugroho, "Data Quality Management Maturity Measurement of Government-Owned Property Transaction in BMKG", CommIT (Communication & Information Technology) Journal 12(2), 59–72, 2018.

TABLE A1
CHARACTERISTICS OF EXPECTATION, DIMENSIONS, POLICIES, AND PROCEDURES.

Level	Component							
	ID	Expectation	ID	Dimensions	ID	Policy	ID	Procedure
Initial	HI1	Data quality activities are reactive	DI1	There is no ability to measure data quality	KI1	The policy is still informal	PI1	The found failures are handled in a careful way
	HI2	There is no ability to identify data quality expectations	DI2	The problem of data quality has not been a concern	KI2	The policy is not documented	PI2	Data values are corrected without coordination of business processes
	HI3	There is no data quality expectation documentation	DI3	Data quality problems have not been categorized	KI3	Data repair actions are done by many staff and without coordination	PI3	The source of the problem is not identified
							PI4	The same error is repeatedly corrected
Repeatable	HR1	There is the limited anticipation of data problems	DR1	It knows the general dimensions in measuring the data quality values	KR1	Organizations are trying to consolidate data in a single source	PR1	It is capable of searching for errors due to incomplete data
	HR2	Expectations related to specific data quality dimensions and data values have been delivered	DR2	It can measure the suitability of data values with data quality rules	KR2	Privacy policy and restrictions have been determined	PR2	It can trace errors due to syntax or structure errors
	HR3	Simple data errors have been identified and reported			KR3	The basic policy for dealing with data problems is fixed	PR3	The problem-sourced analysis is possible using simple data quality rules and data validation
Defined	HD1	Data quality dimensions have been identified and documented	DD1	Expectations about the data quality dimensions associated with data values, formats, and data descriptions have been submitted	KD1	Guidelines for achieving management objectives are readily available within the business unit	PD1	The procedures are established and documented for examining data and determining the accuracy and validity
	HD2	Expectations related to the quality of data associated with data values, formats, and data description have been submitted with data quality rules	DD2	It can validate values, models, and data exchange using predefined data quality rules	KD2	There is a certification process regarding the data quality sources	PD2	DQM is deployed at the unit level and organizational level
	HD3	It can validate data by using data quality rules	DD3	There are already simple reports of data quality measurements	KD3	Data quality practitioners apply best practices	PD3	Data validation is done automatically and only the deficiencies are checked manually
	HD4	The methods for assessing business impacts are already underway			KD4	SLA data quality sets for managing compliance with policies	PD4	The procedure for alternative data already exists
Managed	HM1	Validation of data has been checked and monitored	DM1	The dimensions of data quality are mapped into business impact clusters	KM1	Policies are created and coordinated throughout the organization	PM1	Data quality rules are proactively monitored
	HM2	It is familiar with business impact analysis resulting from flawed data	DM2	There are reports in the form of data quality matrices	KM2	There is management on the historical alteration of data	PM2	Data controls are designed to combine into different business applications
	HM3	The results of the impact analysis have been considered priority for the management of compatibility expectations	DM3	Data Steward is notified when there is inappropriate data	KM3	DQM is based on regulation	PM3	The weakness of the data is known at the beginning of the information flow
	HM4	Assessment of data quality is scheduled on a regular basis			KM4	Data quality policies drive performance management	PM4	Well-defined processes govern data cleansing
					KM5	Data quality SLAs are used to manage policy compliance	PM5	There is a validation of data exchange
							PM6	Data Validation has been audited
Optimized	HO1	The data quality bench has been determined	DO1	SLA for data quality has been determined	KO1	There is automatic notification of inappropriate data	PO1	Data control is implemented throughout the organization
	HO2	Compliance with data quality expectations has been attributed to individual performance targets	DO2	SLA on data quality is always monitored	KO2	Systems with self-governance have been implemented	PO2	Each participant publishes data quality measurements
	HO3	The level of industry proficiency used in anticipating and establishing has increased business objectives	DO3	New data quality dimensions can integrate into system development			PO3	DQM practices are transparent
	HO4	Data validation controls integrated with business processes						

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TABLE A2
CHARACTERISTICS OF COMPONENTS OF GOVERNANCE, STANDARDIZATION, TECHNOLOGY, AND PERFORMANCE MANAGEMENT.

Level	Component							
	ID	Governance	ID	Standardization	ID	Technology	ID	Performance Management
Initial	GI1	Little or no communication is related to DQM at all	SI1	There is no data standard	TI1	Ad hoc job is routinely done	MI1	The impact is indicated and only recognized after the error event
	GI2	Data quality problems are considered an IT problem	SI2	Similar data are displayed in various variants	TI2	Mentality avoids problems because it is not developed in the work unit		
	GI3	There is no data steward	SI3	There is no data definition				
	GI4	Data correction responsibility is ad hoc						
Repeatable	GR1	Best practices are collected and shared across organizations	SR1	Data definitions generally use business terminology	TR1	Tools for measuring quality objectivity are available	MR1	There is a regional characterization of the impact of poor data quality
	GR2	Key individuals are from organizations in working groups to design and recommend data governance programs and policies	SR2	There is the existence of reference data	TR2	Data standardization, data parsing, and data repair are available	MR2	Profiling data is used to identify data errors in the process
	GR3	The principles of data quality are developed	SR3	Data elements identify specific information	TR3	Available apps find, match, and connect data		
			SR4	There is a certification process of the data source				
			SR5	Standard metadata is managed throughout organization				
			SR6	Guidelines for data exchange are defined				
Defined	GD1	There is already an organizational structure for monitoring of data governance	SD1	There are organizational data standards and metadata management	TD1	Standard procedures for using data checking and quality improvement applications are available	MD1	A framework for impact analysis is available
	GD2	Principles of work and data governance have been documented	SD2	Standard structures and formats are defined for all data elements	TD2	Validation based on business rules has already been implemented	MD2	Data quality service components are available and can detect early data errors
	GD3	The standard view of data steward in organization and stewardship program already exists	SD3	The data exchange scheme is defined	TD3	Technological components for data validation, checking, and data quality reporting are available		
	GD4	Operational procedures for data governance have been defined			TD4	Component technology is standard for all lines of organization in terms of service and implementation		
Managed	GM1	There are data governance committees from various representatives in the organization	SM1	There is the existence of certification for data sources	TM1	Automatic data correction based on governance policies and business rules has been implemented	MM1	The data quality metrics are displayed in the management report
	GM2	The governance committee meets regularly	SM2	Master reference data are already specified	TM2	Impact analysis is supported by dashboard and reporting applications	MM2	Audit is based on compliance with rules related to data quality dimensions
	GM3	Operational governance is based on SLA	SM3	The exchange standards are managed through standard data control processes				
	GM4	Teams within each division or group use the same governance framework	SM4	The supervisory board of data standards oversees the maintenance of internal standards and compliance with external standards				
	GM5	The reporting and remediation framework is collaborated in applying statistical process controls to maintain at specified limits						
Optimized	GO1	Data quality performance measures are reviewed for improvement opportunities	SO1	The concept of master data is managed in a master data environment	TO1	Non-technical users can dynamically define and modify data quality rules and data dimensions	MO1	Overall organizational performance can be improved through policy modifications through rules
	GO2	Staff are rewarded for meeting data governance performance goals	SO2	Taxonomy for data standards is defined and validated				
			SO3	Compliance with standards is integrated in a policy-oriented technical structure				
			SO4	The data standardization process is done automatically				

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TABLE A3
THE LEVEL OF MATURITY OF EXPECTATIONS, DIMENSIONS, AND POLICIES.

Level	Expectation			Dimensions			Policy		
	ID	Condition	K[a]	ID	Condition	K[a]	ID	Condition	K[a]
Initial	HI1	There is a policy (W1)	1	DI1	It can measure data quality (W1)	1	KI1	Policies have been done through PP and PMK (1, 2)	1
	HI2	It has been already identified (W2)	1	DI2	It is a concern (3)	1	KI2	The policy has been documented (2)	1
	HI3	It has been already submitted (4)	1	DI3	There is nothing (W2)	0	KI3	Data repair is performed by coordination (W1)	1
	Value		1	Value		0.6	Value		1
Repeatable	HR1	It is anticipated with DC and DRC (5)	1	DR1	The general dimension is known (6, 7)	1	KR1	Data consolidation in one data source is done with SIPBB implementation (8)	1
	HR2	It has been already submitted (8)	1	DR2	It can measure data quality (W1)	1	KR2	Privacy and data access restrictions have been made (9, 10)	1
	HR3	It has been already submitted (11)	1				KR3	The basic policy already exists (12)	1
	Value		1	Value		1	Value		1
Defined	HD1	There is no documentation yet (W1)	0	DD1	It has been submitted (3, 7)	1	KD1	Guidelines for achieving management objectives already exist (6)	1
	HD2	There is documentation (13)	1	DD2	It can validate (W1)	1	KD2	There is no certification process regarding data quality (W1)	0
	HD3	There is validation (2, 10, 14)	1	DD3	There is no report (W1)	0	KD3	Best practice is already implemented (W2)	1
	HD4	It is not available (W2)	0				KD4	There is no SLA about data quality (W2)	0
	Value		0.5	Value		0.6	Value		0.5
Managed	HM1	Validation is checked and monitored (8)	1	DM1	It is not grouped (W2)	0	KM1	Policies are coordinated (W2)	1
	HM2	The impact analyst is accustomed (W2)	1	DM2	There is no report (W2)	0	KM2	Historical data conversion has been done (11)	1
	HM3	The results of the analysis have been considered (W2)	1	DM3	There is no official data steward (W1)	0	KM3	There is no DQM (W2)	0
	HM4	There is no schedule (W2)	0				KM4	Performance management has not driven by policy (W2)	0
							KM5	There is no SLA about data quality (W2)	0
	Value		0.7	Value		0	Value		0.4
Optimized	HO1	There is nothing (W1)	0	DO1	There is no SLA related to data quality (W2)	0	KO1	There is no auto notification (W2)	0
	HO2	It is not associated with performance targets (W2)	0	DO2	There is no SLA related to data quality (W2)	0	KO2	It has not implemented a system with independent data governance (W2)	0
	HO3	Level of proficiency is not used (W2)	0	DO3	There is no defining dimension (W2)	0			
	HO4	There are integrated validation controls (2)	1						
	Value		0.2	Value		0	Value		0
Total			3.4			2.2			2.9

[a]Compatibility

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TABLE A4
THE LEVEL OF MATURITY OF PROCEDURES, GOVERNANCE, AND STANDARDIZATION.

Level	Procedure			Governance			Standardization		
	ID	Condition	K[a]	ID	Condition	K[a]	ID	Condition	K[a]
Initial	PI1	There is coordinated failure handling (W1)	1	GI1	There is communication (W1)	1	SI1	Standard data are already specified (13)	1
	PI2	Data value is corrected with coordination (W1)	1	GI2	It is not only IT problems (W2)	1	SI2	Data are displayed at the UAKPB to UAPB level (9)	1
	PI3	The source of the problem can be identified (W2)	1	GI3	There is no official data stewardship (W2)	0	SI3	There is already data definition (13)	1
	PI4	It has data error correction (W1)	1	GI4	Responsibility is provided with coordination (W1)	1			
	Value		1	Value		0.7	Value		1
Repeatable	PR1	Data searching has been done (W2)	1	GR1	There is already knowledge sharing (W2)	1	SR1	The definition of data is by business terminology (1)	1
	PR2	Search does not include syntax and structure (W2)	0	GR2	There is nothing (W2)	0	SR2	Reference data already exist (7)	1
	PR3	Analysis does not use rule (W2)	0	GR3	There is no working principle in data quality (W2)	0	SR3	Data elements show specific information (13)	1
							SR4	The data source is from a valid proof of acquisition (W1)	1
							SR5	There is no metadata management (W2)	0
							SR6	Data exchange is already through SIPBB application (8)	1
	Value		0.3	Value		0.3	Value		0.8
Defined	PD1	It is done (15)	1	GD1	There is no organizational structure (W2)	0	SD1	There is no metadata management (W2)	0
	PD2	DQM is at UAKPB (10)	1	GD2	There is no documentation (W2)	0	SD2	Standard structures and data formats have not been defined and documented (W1)	0
	PD3	It is partial data validation (16)	1	GD3	There is no standard view of data stewardship (W2)	0	SD3	There is already a data exchange scheme (7, 16)	1
	PD4	There are alternative data with DRC (5)	1	GD4	There is no SOP governing data governance (W2)	0			
	Value		1	Value		0	Value		0.3
Managed	PM1	Monitoring is not proactive (W1)	0	GM1	There is no handle on data governance (W2)	0	SM1	The data source is from a valid proof of acquisition (W1)	1
	PM2	Data quality control also does SAIBA (7)	1	GM2	There is no handle on data governance (W2)	0	SM2	Reference data already exist (7)	1
	PM3	The weakness of data is unknown since the beginning (W1)	0	GM3	There is no SLA (W2)	0	SM3	Data exchange standards are maintained (7)	1
	PM4	There is a process of normalization (7)	1	GM4	There is no governance framework (W2)	0	SM4	There is no standard data supervisory board (W2)	0
	PM5	Validation of data exchanges already exists (7, 16)	1	GM5	There is no report of data governance (W2)	0			
	PM6	Data validation has been audited (2)	1						
	Value		0.6	Value		0	Value		0.7
Optimized	PO1	Data control is performed across all organizational lines (W2)	1	GO1	The quality of routine data is audited by the Inspectorate and BPK RI (11)	1	SO1	The master data concept is still performed in one environment with transaction data (W1)	0
	PO2	There are no publications (W1)	0	GO2	There are already awards like the GOP Award (4)	1	SO2	Taxonomic data standards are already set in FMD (12)	1
	PO3	The management is closed (W1)	0				SO3	Compliance with standards has been established (17)	1
							SO4	The standardization process is still manually updated (W2)	0
	Value		0.3	Value		1	Value		0.5
Total			3.2			2			3.3

[a]Compatibility

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TABLE A5
THE MATURITY LEVEL OF TECHNOLOGY AND PERFORMANCE MANAGEMENT.

Level	Technology			Performance management		
	ID	Condition	K[a]	ID	Condition	K[a]
Initial	TI1	It routinely performs ad-hoc jobs such as recording the acquisition of GOP (W1)	1	MI1	Data errors are monitored by SIPBB delivery control (8)	1
	TI2	The division of roles and responsibilities is clear (W1)	1			
	Value		1	Value		1
Repeatable	TR1	There is no tool to measure the objectivity of data quality (W2)	0	MR1	There is no regional characterization of the impact of poor data quality (W2)	0
	TR2	Standard, parsing, and data repair methods are available (10)	1	MR2	There is no data profiling (W2)	0
	TR3	The SAIBA application can be used to search and match GOP data with Finance (7, 17)	1			
	Value		0.6	Value		0
Defined	TD1	There are already standard procedures for matching data (16)	1	MD1	There is no framework to analyze the impact (W2)	0
	TD2	Validation according to business rules has been implemented (14, 16)	1	MD2	There is no data quality service component (W2)	0
	TD3	Implementation of data validation already uses SAIBA and SIMAN applications (14, 16, 18)	1			
	TD4	There is no standard technology (W1)	0			
	Value		0.7	Value		0
Managed	TM1	Data correction is done automatically with the patch update correction shrinkage (7)	1	MM1	There is no data quality metric (W2)	0
	TM2	There is a GOP Dashboard app and reporting done every semester (8)	1	MM2	There are no data quality dimension (W2)	0
	Value		1	Value		0
Optimized	TO1	Non-technical users cannot modify technical rules because the rules governed by move (W2)	0	MO1	Regulations are regularly updated to improve performance in DQM	1
	Value		0	Value		1
Total			3.3			2

[a]Compatibility

TABLE A6
EVIDENCE LIST OF THE DOCUMENTS.

Evidence Number	Evidence description
1	2015 Chief of BMKG Act Number 58 about Government-Owned Property Administration in BMKG
2	2016 BMKG Final Report of Workshop to Improve the Quality of Forming SIMAK-BMN Reporting
3	2016 BMKG Government-Owned Property Audited Report
4	2016 BMKG Report of Application Development in Managing Goverment-Owned Property Sub Division
5	2017 BMKG Chief of Central Database letter number UM.202/095/KPD/III/2017 about Sistem Virtualization
6	2017 Documentation of greeting speech of Director of Government-Owned Property, Ministry of Finance Republic Indonesia
7	2016 General Directorate of Treasury short guidance for Accounting-Acrual Based System Application (SAIBA) for Work Unit Level
8	2008 Directorate Financial System operational guidance of SIMAK-BMN for UAKPB Level
9	2017 General Directorate of National Property documentation of BMN Awards 2017 (https://www.djkn.kemenkeu.go.id/berita/baca/13924/BMN-Awards-2017-Tingkatkan-Motivasi-Guna-Mewujudkan-Continuous-Improvement-Pengelolaan-BMN.html)
10	2017 General Directorate of National Property documentation of "GOP data validation towards single GOP database" (https://www.djkn.kemenkeu.go.id/berita/baca/13006/Validasi-Data-BMN-Menuju-Single-Database-BMN.html)
11	2013 Minister of Finance Act Number 213/PMK.05/2013 about Accounting System and Financial Reporting for Central Goverment
12	2015 Minister of Finance Decision Number 134/KM.6/2015 about Review Guidance Module of GOP Requirement Planning by Internal Government Controller Officer
13	2015 Minister of Finance Decision Number 532/KM.6/2015 about Fifth Revision of Minister of Finance Act Number 29/PMK.06/2010 about Classification and Codefication of Government-Owned Property
14	2016 Minister of Finance Act Number 69/PMK.06/2016 about Guidance Goverment-Owned Property Reconsiliation in Forming Central Governmental Financial Report
15	2016 Ministry of Finance Technical Guidance of Transaction Menu for Persediaan Application and SIMAK-BMN
16	2017 Minister of Finance Act Number 2014/PMK.05/2017 about Reconsiliation Guidelines in Forming Financial Report for National General Treasurer and Ministry/Agency
17	2014 Indonesian Government Act Number 27 about Managing Goverment-Owned Property
18	2008 Indonesian President Act Number 61 about Agency of Meteorology, Climatology, and Geophysic