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 Geophysics. According to 2014 Indonesian Government Act Number 27 about Government-Owned Property Management. There are several activities to maintain the property such as plan-
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”, CommiIT (Communication & Information Technology) Journal 12(2), 59–72, 2018.

... 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 inputting 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 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 maturating 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. 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. |
| 3   | Reference [21] | Completeness, accuracy, traceability, currency, term, compliance, understandability | 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. |
| 4   | Reference [22] | Completeness, unambiguity, correctness | 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 interconnected. The framework helped to combine enterprise data management with the business goals of an organization. |
| 5   | Reference [23] | Accuracy, completeness, consistency, relevance, timeliness | 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. |
| 6   | Reference [24] | Consistency, completeness, correctness | 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. |
| 7   | Reference [25] | Accuracy | 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. |

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.

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 Governor-Owned Property Reconciliation 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
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 each 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
The absence of rules by governing data quality is considered are the handling of data problems and dimensional 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. Continuous 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. 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.

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**TABLE II**

| 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      |
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 group 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 |
| | Optimized | KO1 | There is no automatic notification if there is any inappropriate data | DQM10 |
| Procedure | Repeatable | PR2 | Search does not include syntax and structure | DQM3 |
| | 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 measurement 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 | DQM5 |
| | | GD2 | There is no documentation of working principles and data governance | DQM5 |
| | | GD3 | There is no standard data stewardship view | DQM8 |
| | | GB5 | There are no SOPs in governing data governance | DQM11 |
| | Managed | GM1 | There are 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 | DQM7 |
| | 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 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.
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 | DH1 | There is no ability to measure data quality | K1 | 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 | D1 | The problem of data quality has not been a concern | K2 | The policy is not documented | PI2 | Data values are corrected without coordination of business processes |
| | HI3 | There is no data quality expectation documentation | D3 | Data quality problems have not been categorized | K3 | Data repair actions are done by many staff and without coordination | PI3 | The source of the problem is not identified |
| 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 | DR3 | There are already simple reports of data quality measurements | 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 and 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 assurance | 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 |
| | HM5 | Data quality SLAs are used to manage policy compliance | KM5 | Data quality SLAs are used to manage policy compliance | PM5 | There is a validation of data exchange |
| 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 | KO3 | Systems with self-governance have been implemented | PO3 | DQM practices are transparent |
| | HO4 | Data validation controls integrated with business processes |
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| 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 |
| Repeatability | 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 report are available |
| | 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 organizations |
| | | 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 |
| | GD2 Principles of work and data governance have been documented | SD2 | Standard structures and formats are defined for all data elements |
| | GD3 The standard view of data steward in organization and stewardship program already exists | SD3 | The data exchange scheme is defined |
| | GD4 Operational procedures for data governance have been defined | SD4 | The data management processes are available |
| | | SD5 | The supervisory board of data standards oversees the data dimensions and compliance with external standards |
| 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 already been implemented |
| | GM2 The governance committees meets regularly | SM2 | Master reference data are already specified |
| | GM3 Operational governance is based on SLA | SM3 | The exchange standards are already specified |
| | 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 |
| | 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 |
| | | SO5 | The data standardization process is done automatically |

TABLE A2
CHARACTERISTICS OF COMPONENTS OF GOVERNANCE, STANDARDIZATION, TECHNOLOGY, AND PERFORMANCE MANAGEMENT.
### TABLE A3

**The Level of Maturity of Expectations, Dimensions, and Policies.**

| Level | Expectation | Dimensions | Policy |
|-------|-------------|------------|--------|
| Initial | H1 | There is a policy (W1) | DI1 | It can measure data quality (W1) | K1 | Policies have been done through PP and PMK (1, 2) |
| | H2 | It has been already identified (W2) | D12 | It is a concern (3) | K2 | The policy has been documented (2) |
| | H3 | It has been already submitted (4) | D13 | There is nothing (W2) | K3 | Data repair is performed by coordination (W1) |
| | Value | 1 | Value | 0.6 | Value | 1 |
| Repeateable | HR1 | It is anticipated with DC and DRC (5) | DR1 | The general dimension is known (6, 7) | K1 | Data consolidation in one data source is done with SIPBB implementation (8) |
| | HR2 | It has been already submitted (8) | D21 | It can measure data quality (W1) | K2 | Privacy and data access restrictions have been made (9, 10) |
| | HR3 | It has been already submitted (11) | D31 | There is nothing (W2) | K3 | The basic policy already exists (12) |
| | Value | 1 | Value | 0.6 | Value | 1 |
| Defined | HD1 | There is no documentation yet (W1) | DD1 | It has been submitted (8, 7) | K1 | Guidelines for achieving management objectives already exist (6) |
| | HD2 | There is documentation (13) | D22 | It can validate (W1) | K2 | There is no certification process regarding data quality (W1) |
| | HD3 | There is validation (2, 10, 14) | D32 | There is no report (W1) | K3 | Best practice is already implemented (W2) |
| | HD4 | It is not available (W2) | 0 | KD4 | There is no SLA about data quality (W2) |
| | Value | 0.5 | Value | 0.6 | Value | 0.5 |
| Managed | HM1 | Validation is checked and monitored (8) | DM1 | It is not grouped (W2) | KM1 | Policies are coordinated (W2) |
| | HM2 | The impact analyst is accustomed (W2) | DM2 | There is no report (W2) | KM2 | Historical data conversion has been done (11) |
| | HM3 | The results of the analysis have been considered (W2) | DM3 | There is no official data steward (W1) | KM3 | There is no DQM (W2) |
| | HM4 | There is no schedule (W2) | 0 | KM4 | Performance management has not driven by policy (W2) |
| | Value | 0.7 | Value | 0 | Value | 0.4 |
| Optimized | HO1 | There is nothing (W1) | DO1 | There is no SLA related to data quality (W2) | KO1 | There is no auto notification (W2) |
| | HO2 | It is not associated with performance targets (W2) | DO2 | There is no SLA related to data quality (W2) | KO2 | It has not implemented a system with independent data governance (W2) |
| | HO3 | Level of proficiency is not used (W2) | DO3 | There is no defining dimension (W2) | KO3 | |
| | HO4 | There are integrated validation controls (2) | 1 | KO4 | |
| | Value | 0.2 | Value | 0 | Value | 0 |

*Compatibility*
# TABLE A4

## The Level of Maturity of Procedures, Governance, and Standardization.

| Level          | Procedure | Governance | Standardization |
|----------------|-----------|------------|-----------------|
|                | ID        | Condition  | K<sup>a</sup> | ID        | Condition  | K<sup>a</sup> | ID        | Condition  | K<sup>a</sup> |
| 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      | 0.7          | Value      | 0.7          | Value      | 0.7          |
| 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 |
| Value          | 0.3       | Value      | 0.3          | Value      | 0.3          | Value      | 0.8          | 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            | 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 SEMA (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      | 0.6          | Value      | 0.7          | 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 | | | | | | |
| Value          | 0.3       | Value      | 1            | Value      | 0.3          | Value      | 0.5          | Value      | 0.5          |

<sup>a</sup> Compatibility
TABLE A5
THE MATURITY LEVEL OF TECHNOLOGY AND PERFORMANCE MANAGEMENT.

| Level        | Technology Description                                      | ID | Performance Management | K<sup>v</sup> |
|--------------|-------------------------------------------------------------|----|------------------------|---------------|
| Initial      |                                                             |    |                        |               |
| TI1          | It routinely performs ad-hoc jobs such as recording the acquisition of GOP (W1) | 1  | M1                      | 1             |
| TI2          | The division of roles and responsibilities is clear (W1)   | 1  |                         |               |
| Repeatable   |                                                             |    |                        |               |
| TR1          | There is no tool to measure the objectivity of data quality (W2) | 0  | MR1                    | 0             |
| TR2          | Standard, parsing, and data repair methods are available (10) | 1  | MR2                    | 0             |
| TR3          | The SAIBA application can be used to search and match GOP data with Finance (7, 17) | 1  |                         |               |
| Defined      |                                                             |    |                        |               |
| TD1          | There are already standard procedures for matching data (16) | 1  | MD1                    | 0             |
| TD2          | Validation according to business rules has been implemented (14, 16) | 1  | MD2                    | 0             |
| TD3          | Implementation of data validation already uses SAIBA and SIMAN applications (14, 16, 18) | 1  |                         |               |
| TD4          | There is no standard technology (W1)                        | 0  |                         |               |
| Managed      |                                                             |    |                        |               |
| TM1          | Data correction is done automatically with the patch update correction shrinkage (7) | 0.7| MM1                    | 0             |
| TM2          | There is a GOP Dashboard app and reporting done every semester (8) | 1  | MM2                    | 0             |
| Optimized    |                                                             |    |                        |               |
| TO1          | Non-technical users cannot modify technical rules because the rules governed by move (W2) | 0  | MO1                    | 1             |
| Total        |                                                             |    |                        | 2             |

<sup>v</sup>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               | 2010 BMKG Government-Owned Property Audited Report                                     |
| 4               | 2016 BMKG Report of Application Development in Managing Government-Owned Property Sub Division |
| 5               | 2017 BMKG Chief of Central Database letter number UM.202/95/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-Pengelelaan-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/13808/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 Government |
| 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 Codification of Government-Owned Property |
| 14              | 2016 Minister of Finance Act Number 69/PMK.06/2016 about Guidance Government-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 Government-Owned Property |
| 18              | 2008 Indonesian President Act Number 61 about Agency of Meteorology, Climatology, and Geophys |