Evaluating Mdm Maturity In Human Capital Data: Case Study of Jasa Marga

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Abstract

Effective Master Data Management (MDM) is essential for organizations to ensure data consistency, accuracy, and accessibility, particularly within intricate operational settings. This study assesses the maturity level of MDM for human capital data at PT Jasa Marga (Persero) Tbk, Indonesia's leading state-owned toll road developer and operator. Human capital data is currently managed through two primary applications: SAP for the main company and the JM-Click Human Capital Information System (HCIS) for its subsidiaries. This separation has led to data silos and inconsistencies, diminishing the reliability and accessibility of critical human capital data. Utilizing the Master Data Management Maturity Model (MD3M) by Spruit and Pietzka, this research investigates five main topics and 13 focus areas within the organization. Data collection involved questionnaires and interviews with key experts. Results indicate that PT Jasa Marga has implemented 76.92% of necessary MDM capabilities, with Data Protection and Usage & Ownership scoring the highest maturity level of 5. However, Data Quality is at level 2, indicating a need for major enhancements in data maintenance and consistency across subsidiary data models. This study provides actionable recommendations for improving data quality, aligning data models, and integrating advanced technologies, stressing the importance of continuous MDM improvements to better support the organization's strategic objectives and operational demands.
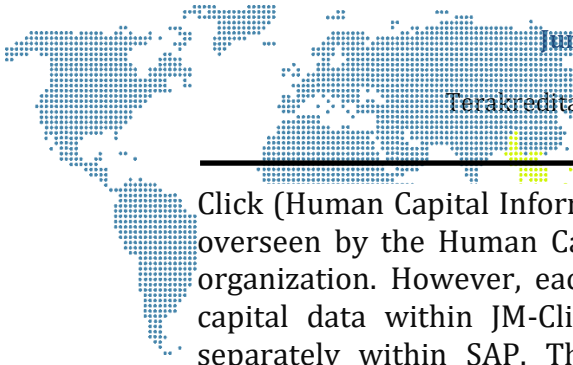
Keywords: *Master Data Management, Maturity Model, MD3M, Human Capital Data, Data Quality.*

1. INTRODUCTION

Master data is indeed crucial for organizations in today's data-driven business environment. Companies rely on multiple systems to manage their operations, and extracting measurable master data from these systems is essential for informed decision-making and efficient operations [1]. Master data encompasses essential information shared across an organization's systems, such as customer details, product information, and location data [2]. Effective MDM addresses data-related challenges, allowing organizations to enhance overall performance by maintaining reliable, high-quality data [3].

PT Jasa Marga (Persero) Tbk, a state-owned enterprise in Indonesia (BUMN), primarily engages in the construction, operation, and maintenance of toll roads. According to its 2023 annual report, the company holds concession rights for 1,736 km of toll roads, actively operates for 1,264 km, and commands a 50% market share in Indonesia's toll road operations. With 7,949 employees across the Jasa Marga Group, efficient management of human capital data is vital for optimizing operational performance and supporting strategic decisions [4].

Human capital data within Jasa Marga includes records related to performance, capacity, assessment, payroll, and training, managed primarily through two applications: SAP for PT Jasa Marga's parent company and HCIS JM-

Click (Human Capital Information System) for its subsidiaries. These applications, overseen by the Human Capital Services (HCS) unit, handle HR data across the organization. However, each subsidiary independently manages its own human capital data within JM-Click, while the parent company's data is maintained separately within SAP. This fragmented approach has led to data silos and inconsistencies, compromising the reliability and accessibility of essential human capital data. If these issues remain unresolved, Jasa Marga could experience delays in decision-making, reduced operational productivity, and increased risk of errors due to inconsistent and incomplete data. Such inefficiencies would hinder strategic planning and may lead to costly setbacks in the organization's overall performance. Recognizing these challenges, Jasa Marga has initiated a Master Data Management (MDM) solution to combine data from both SAP and JM-Click, aiming to establish a unified Human Capital MDM system. To ensure the effectiveness of this initiative, assessing the current MDM maturity level is crucial, which will provide insights into existing gaps and inform targeted improvements.

Earlier Master Data Management (MDM) models, such as those by Oracle, DataFlux, and Kumar, each focused on specific aspects of MDM: Oracle emphasized technical integration, DataFlux concentrated on data governance, and Kumar focused on process workflows. While valuable, these models lacked a holistic framework capable of comprehensively addressing MDM across diverse organizational contexts. In contrast, the Master Data Management Maturity Model (MD3M) by Spruit and Pietzka, developed in 2015, integrates these elements into a balanced, comprehensive approach. MD3M assesses five critical dimensions strategy, governance, technology, metrics, and business impact across 13 focus areas, providing essential insights into MDM maturity [5]. We selected MD3M for its adaptability and ability to provide actionable recommendations, making it highly effective in complex data environments that require cohesive and robust MDM practice for evaluating MDM maturity across various organizational contexts [6].

This study specifically aims to evaluate the MDM maturity level of human capital data at Jasa Marga, utilizing the MD3M model to identify the current state and required enhancements. Through a methodology that combines quantitative data collection and observational insights, this study assesses the efficiency and effectiveness of Jasa Marga's MDM practices, establishing a foundational evidence base. The ultimate objective is to improve MDM for human capital, ensuring data consistency, accuracy, and accessibility across the organization, which is essential for optimizing human resource management and supporting strategic business processes at PT Jasa Marga.

2. RESEARCH METHODOLOGY
2.1. Organization's Profile
PT Jasa Marga (Persero) Tbk is the first and largest toll road developer and operator in Indonesia, with a market share of 50% for commercial toll roads that have been operating (± 1,264 km). As a State-Owned Enterprise, the Indonesian government owns 70% of Jasa Marga's shares. Since 2007, Jasa Marga has become

a public company through an Initial Public Offering (IPO) and has listed its shares on the Indonesia Stock Exchange.

The main business of Jasa Marga is the Construction, operation, and maintenance of toll roads. Jasa Marga is a toll road operation service (providing operating services to the Jasa Marga business group and other toll road investors), toll road maintenance services, and property (managing rest areas and other properties in toll road corridors).

2.2. Human Capital Data

Human capital data contain essential information about a company, especially about its employees. Managing human capital data is challenging because it needs to comply with local standards and be centrally integrated to support corporate human capital functions [7]. The role of subject matter experts (SMEs) in managing master data management of human capital data is important.

Jasa Marga's Human Capital data contains employee data such as performance data, capacity data, assessment data, employee self-development data, payroll data, training data, talent data, personal data, and many more. This was the main research objective of this study.

2.3. Master Data

According to Otto and Huner (2009), master data is records that can explain information about entities or relevant business domains to the organization such as customer, counterparty, suppliers, and employee [8]. Master data can be identified as organization's data in which each domain represents information needed to business functions, unit, and also between operational system and decision support system (DSS) [9]. Master data store transactional and analytical critical business information and define business-oriented attributes used in other applications. The master data undergoes a series of processes involving cleansing, standardization, and integration from various systems within the organization [8].

2.4. Master Data Management

Master data management (MDM) is a collection of best practices in data management that manage key stakeholder, participant, and business client in an integrated business application, information management method, and data management tools to implement policy, procedure, services, and infrastructure to support recording process, integration, and continuous usage of an accurate, timely, consistent, and complete master data. MDM programs are designed to support organization's business needs by providing access to a consistent view of unique master data entities across the entire operational application infrastructure [10].

2.5. Master Data Management Maturity Model

Master data management maturity model refers to the measurement of an organization's capability for continuous improvement in master data management activities. Previous research has produced various models for assessing master

data maturity. This study attempts to examine several models proposed by Oracle, DataFlux, Kumar, Spruit and Pietzka.

In the Oracle model, there are five main focuses profiling data sources, definition of data strategy, definition of a data consolidation plan, maintaining data, and utilization of data. The maturity levels are divided into four stages starting from marginal, stable, best practice to transformational [11]. On the other hand, Data Flux has six component layers consisting of architecture, governance management, identification, integration, and business process management. Data Flux divides maturity levels into five stages: initial, reactive, managed, proactive, and strategic performance [12].

The model proposed by Kumar consists of five maturity levels: ignorant, initial, isolated, organized, unified, and optimized, with each level having its own description of achievements, but without specific focus topics [13]. The MD3M model proposed by Spruitz and Pietzka in 2015 was formed by comparing previous models, namely Oracle 2011, DataFlux 2010, and Kumar (IMN) 2010, to create a new model consisting of five focus areas and five maturity levels, which will be discussed Table I. Table I [6] shows a comparison of key topics from each model.

Table 1. Comparison of Maturity Models

Key Topics				
Subject	**Oracle**	**DataFlux**	**Kumar**	**MD3M (Spruitz & Pietzka)**
Definition of Master Data	√	√	√	√
Master Data Model	√	√	√	√
Data Landscape	√	√		√
Assessment of Data Quality	√	√	√	√
Impact on Business		√	√	√
Awareness of Quality Gaps	√	√	√	√
Improvement	√	√	√	√
Data Usage	√	√		√
Data Ownership	√	√		√
Data Access	√	√		√
Data Protection		√		√
Storage	√	√	√	√
Data Lifecycle	√	√	√	√

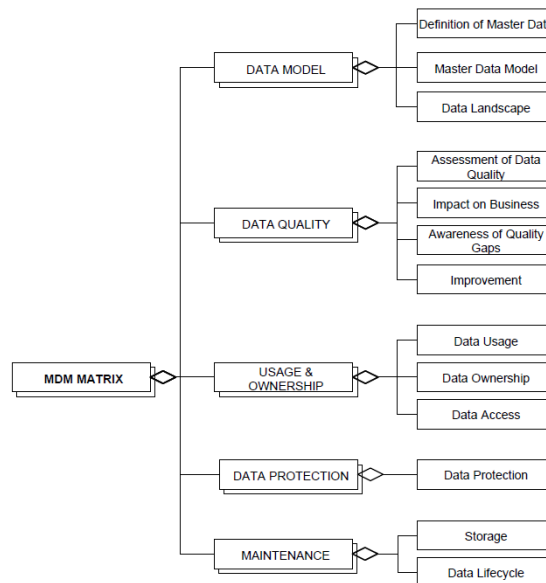## 2.6. Master Data Management Maturity Model (MD3M)

According to Becker [14], A maturity model is a tool that aims to solve problems in determining the current condition of a company related to the company's capabilities and as a means of determining relevant improvements. Spruit and Pietzka [5] created the Master Data Management Maturity Model (MD3M), a maturity model that can be used to measure the maturity of Master Data Management implementation in an organization. This model is based on the COBIT model. This model has five levels as shown in table 2.
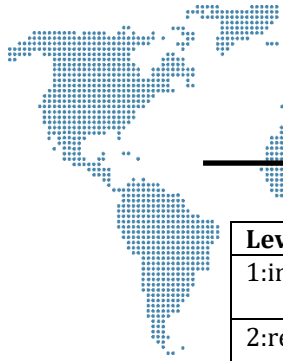
Table 2. Descriptions of MD3M Maturity Level [5]

Level	Description
1:initial	A first awareness for issues regarding the topic of MDM has been raised on an operational level. Initial steps are initialized.
2:repeatable	Measures from individuals are conducted to solve individual problems. No connection to other units or projects. Still operational.
3:defined process	First collaborations take place on a tactical level. Awareness was created for the existence of other initiatives.
4:managed and measurable	Best practices are in place for handling of MDM. There are defined processes on a tactical level.
5:optimized	Optimized handling of MDM. The organization's efficiency has been improved. Tactical approach on the topic.

To assess the maturity of the master data management of an enterprise, Spruit and Pietzka created MDM maturity model is a means of assessing the whole process of master data management including the data point of view, and focusing on the whole operational process. The key topics and the focus areas are developed with a bottom-up approach [5]. As shown in Figure 1, the model has 5 main topics and 13 focus areas.

Figure 1. The key topics and focus area MD3M [5]

2.7. Previous Work About MD3M

Spruit and Pietzka developed a Master Data Management (MDM) maturity model known as MD3M, which serves as a comprehensive tool for assessing the maturity of master data management within organizations. Their study aimed to evaluate the maturity level of the master data of enterprises and identify the key reasons and incentives for effective master data management. This model also facilitates benchmarking by providing a means for organizations to compare their data management practices against standardized maturity levels [5].

Gumelar et al. (2018) applied the MD3M model to the MDM maturity assessment of the Indonesian Ministry of Education and Culture (KemenDikBud). The findings revealed that the maturity level of master data management within the organization was level 0, with only 26 out of 62 defined capabilities (approximately 41.93%) implemented. This assessment highlights significant areas for improvement in the ministry's data management practices [15].

Similarly, Iqbal et al. (2019) conducted an MDM maturity assessment at PT XYZ, a leading provider of infrastructure networks for banks in Indonesia, and a pioneer in the electronic transaction market. Utilizing the MD3M model by Spruit and Pietzka, this study discovered that PT XYZ also scored a maturity level of 0. However, they implemented 54 of 65 capabilities, which corresponds to 83% of the total capabilities. This demonstrates PT XYZ's proactive efforts in managing master data, albeit primarily at the individual or unit level, indicating initial steps towards organization-wide data management improvement [16].

Vilminko and Pekkola (2017) examined the challenges of implementing Master Data Management (MDM) in a public sector organization using the MD3M model. The study focused on issues like data ownership, governance, and communication across departments. Through 32 months of ethnographic research, including interviews and document analysis, the authors found challenges in engaging business units, defining clear data ownership, and ensuring consistent communication. The study also highlighted difficulties in defining master data sets and the need for common terminology. These challenges align with those at PT Jasa Marga, where fragmented data governance and misalignment between technical and organizational practices are key issues. The study emphasizes that successful MDM requires both strong technical solutions and clear organizational roles, alignment, and executive support [17].

3. RESULTS AND DISCUSSION
3.1. Research Approach

This research uses a quantitative type. According to Budihardjo (2012), quantitative research basically requires measurement of research variables. The construction in a study must be built based on a relevant theory and concept and then formulated and operationalized so that it can be measured through an instrument (for example: a questionnaire) that uses a certain scale or level [18].

This study uses the MD3M model which focuses on 5 important areas (key topics) that are in accordance with the needs of master data in the company. Key topics and focus areas are developed with a bottom-up approach to be able to cover all aspects of master data management that are relevant to the organization [5]. There are five key topics and thirteen focus areas in total.

3.2. Questionnaire

The questionnaire comprises two distinct sections of inquiries. The first section evaluates influential factors, while the second section focuses on assessing specific capabilities. The initial section includes four questions, each of which

impacts the evaluation of the capabilities addressed in the subsequent section, as detailed in Table 3 below.

Table 3. Influential factors question and ist impact

Question	Impact
Does your company belong to a group and your company needs to interact regularly with their internal members of the group and exchange data?	if the answer is 'yes', then the answer of 'Definition of Master Data' point 'E', must be incorporated into the measurements.
Is your company a non-profit organization, and/or a governmental or military organization?	if the answer is 'no', then the answer of 'Impact on Business' point 'D' and 'E', must be incorporated into the measurements
Does your company exceed a number of employees of approximately 250?	if the answer is 'yes', then the answer of 'Assessment of Data Quality' point 'C', must be incorporated into the measurements
Do the employees need to work with many different systems for executing their daily work and have to follow different processes when doing this?	if the answer is 'yes', then the answer of 'Data Landscape' point 'E', must be incorporated into the measurements

Table 3 explains the influencing question factors and their impact. Each question has an impact on the measurement. The first question will affect the ability to define master data in standard interfaces for data exchange between Companies belonging to the same group. The second question will influence the ability of the impact on the business in the non-monetary perspective data impact and classify the impact on the monetary and reputation aspects.

The second set of questions asks about the capabilities of the organization for each key topic. The completed set of questions are referenced to Spruit and Pietzka's Technical Report [19]. These questions are based on five key factors consisting of thirteen focus areas which have been discussed in the previous point and each of them has five optional levels which must be selected according to the conditions existing in the organization so that the total number of questions asked is 65 questions.

The responses from the questionnaire were mapped into a matrix to determine the maturity level. This matrix reflects the questionnaire results: a "yes" response indicates that the focus area has been implemented, while a "no" response signifies that the focus area has not been implemented.

3.3. Data Collection And Validation

The questionnaire was filled out by 3 subject matter experts (SME) consisting of the data governance coordinator, IT operational staff, and business data stewards and discussed together through a discussion group interview. In addition, the author validated the answers given by the SME by looking at the documents and related supporting systems in the company.

3.5. Result

In this segment, we interpreted the findings from the questionnaire organized in a matrix format, which was completed by subject matter experts (SMEs) through collaborative discussions. Table 4 presents the responses to the first set of questions regarding influential factors.

Table 4. Influential Factors Answer

Question	Answer
Does your company belong to a group and your company needs to interact regularly with other internal members of the group and exchange data?	Yes
Is your company a non-profit organization, and/or a governmental or military organization?	No
Does your company exceed the number of employees of approximately 250?	Yes
Do the employees need to work with many different systems for executing their daily work and have to follow different processes when doing this?	Yes

As indicated in Table 4, responses from the Data Governance Coordinator reveal that PT Jasa Marga is part of a larger group that requires consistent interaction and data sharing with its internal entities. The enterprise operates as a for-profit entity under state ownership (BUMN) and is expected to have nearly 7,949 employees by December 2023. A diverse array of information systems contributes to the 'Data Landscape' capability, marked as point E.

Table 5. MD3M Measurement Level Matrix Result

Key Topics	L1	L2	L3	L4	L5
Data Model					
Definition of Master Data	I	I	I	I	M
Master Data Model	I	I	I	I	I
Data Landscape	I	I	I	M	M
Data Quality					
Assessment of Data Quality	I	I	M	I	M
Impact on Business	I	I	I	I	M
Awareness of Quality Gaps	I	I	I	M	M
Improvement	I	I	M	I	M
Usage and Ownership					
Data Usage	I	I	I	I	I
Data Ownership	I	I	I	I	I
Data Access	I	I	I	I	I
Data Protection					
Data Security	I	I	I	I	I
Data Maintenance					
Storage	I	I	M	M	M
Data Lifecycle	I	I	M	I	M

Note: L1 = Initial, L2= Repeatable, L3= Defined Process, L4= Managed & Measurable, L5= Optimized

Table 5 displays the maturity level assessment for the master data management of Human Capital (HC), according to the MD3M criteria. This

assessment was mapped out with 'M' signifying 'missing' for unimplemented aspects and 'I' indicating 'implemented' for successfully applied aspects across the MD3M focus areas. The maturity levels, labeled L1 through L5, correspond to the progression of implementation, with data quality currently at level 2, signifying that all foundational key focus areas are fully operational at the initial level, as shown in Table 6. The areas of Usage & Ownership' and 'Data Protection have achieved the highest maturity at level 5.

Table 6. Maturity levels of mdm human capital at PT Jasa Marga

Key Topics	Maturity Levels
Data Model	3
Data Quality	2
Usage & Ownership	5
Data Protection	5
Data Maintenance	2

Table 6 details the maturity level for each MD3M key topic extracted from the results in Table 5. This is calculated by evaluating the fully implemented focus areas starting at the foundational level.

Table 7. Percentage of total MD3M capability maturity level

Level	Implemented		Missing		Total
	Total	%	Total	%	
Initial	13	100%	0	0%	13
Repeatable	13	100%	0	0%	13
Defined Process	9	69%	4	31%	13
Managed & Measurable	10	77%	3	23%	13
Optimized	5	31%	8	69%	13
Total	**50**	**76,92%**	**15**	**23,08%**	**65**

Table 7 shows the number of capabilities that have been implemented and not implemented based on the maturity level. For each topic, we summarized the overall capabilities, that is, the 65 capabilities that the implemented capability for each level. This level is achieved by implementing all capabilities of each topic.

Table 8. Percentage of total by key topics

Key Topic	Implemented		Missing		Total
	Total	%	Total	%	
Data Model	12	80%	3	20%	15
Data Quality	13	65%	7	35%	20
Usage & Ownership	15	100%	0	0%	15
Data Protection	5	100%	0	0%	5
Data Maintenance	5	50%	5	50%	10
Total	**50**	**76,92%**	**15**	**23,08%**	**65**

Details of implementation and non-implementation based on key topics are shown in Table 8. The master data model in the company has been identified, it has

a good data structure, activities are routinely carried out, and strategic collaboration has been implemented. Meanwhile, best-practice activities on certain topics are still not perfectly implemented.

The Overall assessment of the maturity level of the master data management system was 2. Table 7 and table 8 show that the total percentage of implemented capabilities was approximately 76,92% implemented. From these 65 capabilities, the Master Data Human Capital at Jasa Marga implements 50 capabilities. This means that Jasa Marga already has an awareness of the management of the master data.

3.6. Discussion And Recommendation

In the context of Master Data Management (MDM), data ownership and data protection are essential components of a robust data governance framework, with achieving level 5 maturity in these areas indicating optimized practices that ensure data remains accurate, accessible, and secure. This level reflects well-defined data ownership, assigning clear responsibilities to individuals or departments for managing data elements, while enforcing strict access controls to protect sensitive information, ensuring only authorized personnel can manipulate or view data.

Following discussions with the IT Coordinator board, the decision was made to initially concentrate on level 2 topics, specifically Data Quality and Data Maintenance, as these areas are fundamental for establishing a solid MDM foundation prior to advancing to more complex models like data modeling, which has already reached level 3 but is currently not prioritized.

3.7. Data Maintenance

In the context of PT Jasa Marga, which is currently at Level 2 in implementing data maintenance practices, the company's data maintenance practices exhibit a reliance on manual checks by IT and business teams to ensure data integrity. This approach is inefficient and can hinder scalability as data volumes increase.

1) Storage

Currently, data storage practices involve routine checks by IT and business teams to ensure data integrity and timeliness for system-driven data transfer activities. However, these checks are predominantly manual, indicating reliance on processes that may not scale efficiently as data volumes grow. To advance from this level, it is recommended that PT Jasa Marga invest in automated data validation tools that integrate seamlessly with the existing storage systems. This would not only speeds up the data checking process but also reduces the likelihood of human error. Furthermore, exploring more sophisticated data storage solutions, such as cloud storage or hybrid systems, could offer greater scalability and resilience, ensuring that data are accessible, yet secure against potential breaches or data loss.

2) Data *Lifecycle*

The lack of established operational models and procedures for data lifecycle management suggests an ad hoc approach to how data are handled, from creation

to deletion. To improve this, PT Jasa Marga should develop a formal data lifecycle management policy that defines clear stages of data handling, including creation, storage, usage, archiving, and destruction. Each stage should have explicit protocols that align with the compliance standards and business needs. Automating lifecycle management through software solutions could ensure consistent application of these policies across all datasets, enhancing efficiency, and reducing the burden on staff.

3) Recommendations

To improve data maintenance, organizations like PT Jasa Marga (currently at Level 2) should move away from relying on manual checks and invest in automated tools. This will make the process of ensuring data quality quicker, more accurate, and easier to manage as data grows. By automating data checks and integrating them with existing systems, organizations can reduce the chances of mistakes and save time. Additionally, adopting cloud or hybrid storage solutions can provide better scalability and security, making sure data is accessible yet protected from potential threats.

It's also important for organizations to establish a clear data lifecycle management plan, outlining the different stages of data handling, from creation to deletion. Automating these stages will help keep things consistent and efficient. These changes will improve data quality, lighten the load on staff, and allow the organization to respond more effectively to changing business needs.

3.8. Data Quality

The data Quality remains at the repeatable stage (level 2). it is essential to establish clear definitions and metrics for data quality, ensuring that criteria for accuracy, completeness, and reliability are well-defined and consistently applied across the organization. Implementing regular data quality assessments will help identify and address issues, while establishing a systematic approach for data cleansing and auditing will enhance the integrity of the data. Additionally, raising awareness of data quality among employees through training sessions and workshops can foster a culture of accountability and attention to detail. Integrating data quality checks into business processes and linking data quality improvements to key performance indicators (KPIs) will further emphasize its importance and ensure continuous enhancement of data quality standards within the organization.

1) Assessment of Data Quality

Currently assessed at level 2 (repeatable), it is essential to conduct regular data quality assessments. This assessment should measure key aspects such as accuracy, completeness, and reliability of the data. By defining clear criteria and standards, the organization can identify weaknesses in data management and develop strategies for improvement. This assessment not only provides a clear picture of the current state of data quality but also helps establish a solid foundation for ongoing enhancements.

2) Improvement

Despite being at level 2, there are significant opportunities for improvement in data quality practices. The first step is to implement regular data cleansing and auditing processes to ensure better data integrity. Additionally, it is crucial to raise employee awareness regarding the importance of data quality through training sessions and workshops. By engaging teams in data quality management, the organization can foster accountability and build a culture that values precision in information management.

3) Recommendations

To improve data quality, organizations like PT Jasa Marga should make data quality checks part of their daily operations. This can be done by creating a clear data quality policy that focuses on preventing issues and regularly monitoring data. It's also important to define clear standards for things like data accuracy and reliability, ensuring everyone in the organization follows the same guidelines. Tying data quality improvements to key performance indicators (KPIs) will help show that these efforts matter and align them with the organization's goals.

Additionally, organizations should invest in training their employees about the importance of data quality. Offering workshops and training sessions can help create a culture where people take ownership of data accuracy. Regularly cleaning and auditing data will also help keep it accurate and trustworthy. By taking these steps, organizations will not only improve the quality of their data but also make better decisions and improve overall performance.

4. CONCLUSION

This study evaluates the Master Data Management (MDM) maturity of human capital data at PT Jasa Marga (Persero) Tbk, utilizing the MD3M model developed by Spruit and Pietzka. The analysis reveals that PT Jasa Marga has implemented 76.92% of the required MDM capabilities, with significant strengths in Data Protection and Usage & Ownership, which achieved the highest maturity level of 5. However, the assessment also highlights that Data Quality remains at level 2, indicating that substantial improvements are needed in this area. Additionally, data maintenance practices and the alignment of data models across subsidiaries require urgent attention.

While PT Jasa Marga has made progress in establishing a strong MDM foundation, there is still considerable work to be done to fully optimize its data management practices. Addressing these areas will be essential for improving decision-making, operational efficiency, and alignment with strategic goals. A culture that values data accuracy and reliability will be key to supporting PT Jasa Marga's long-term success.

For future work, it is recommended that PT Jasa Marga develops a comprehensive action plan to advance its MDM maturity. This plan should focus on regular data quality assessments, automating data maintenance processes, and integrating advanced technologies to enhance data management capabilities. Furthermore, expanding the research to include multiple organizations across

different sectors—such as government, private enterprises, and other large institutions—could offer broader insights into common challenges and best practices in MDM. Longitudinal studies could also be conducted to track the progress of MDM maturity over time and assess its impact on organizational performance. Engaging stakeholders across all levels will be crucial to fostering a culture of data stewardship and ensuring the success of MDM initiatives. By prioritizing these areas, PT Jasa Marga, as well as other organizations facing similar challenges, can build a robust MDM framework that not only meets current business needs but is also resilient to future challenges in an increasingly data-driven world.

ACKNOWLEDGMENT

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