

Prioritizing Data Quality Improvement Areas in Master Data Management Using the Analytic Hierarchy Process

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Abstract—Master Data Management (MDM) requires effective data quality management to ensure that master data supports organizational operations and decision-making. However, organizations may face difficulties in determining which data quality improvement areas should receive priority because multiple factors influence data quality. This study aims to prioritize data quality improvement areas in MDM using the Analytic Hierarchy Process (AHP). Seven improvement areas were identified from the literature: Accuracy, Completeness, Consistency, Timeliness, Governance, Stewardship, and Accessibility. Pairwise comparisons were obtained from experts representing the oil and gas, telecommunications, and cloud services sectors. The expert judgments were aggregated using the geometric mean, and the priority weights were derived from the principal eigenvector of the aggregated pairwise comparison matrix. The consistency of the judgments was assessed using the Consistency Ratio (CR). The results show that Governance received the highest priority in the aggregated evaluation, with a weight of 0.342, followed by Consistency, Accuracy, Accessibility, Timeliness, Stewardship, and Completeness. These findings indicate that governance-related mechanisms should receive particular attention when organizations prioritize MDM data quality improvement, while the relative importance of other improvement areas may depend on organizational and operational contexts. The resulting prioritization provides a structured basis for organizations to determine the areas that should receive greater attention in MDM data quality improvement initiatives.

Keywords—Master data management; data quality; analytic hierarchy process; data governance; decision-making

I. INTRODUCTION

Master Data Management (MDM) has a significant role in maintaining a consistent and trusted representation of core business data for fundamental business entities such as customers, suppliers, and products [1]. As organizations increasingly adopt digital transformation initiatives and rely on data-driven decision-making, the importance of high-quality master data continues to grow [2]. Poor data quality can lead to inconsistent reporting, operational inefficiencies, and reduced trust in enterprise information systems [3].

Although MDM frameworks have been widely adopted, achieving and maintaining high data quality remains a persistent challenge [4]. Previous studies have identified several important data quality dimensions. Among them are accuracy, completeness, consistency, timeliness, governance, and stewardship. These are the critical components of effective

MDM [5,6]. However, the relative importance of these dimensions varies across organizational contexts, creating uncertainty regarding which areas should be prioritized for improvement. Without a clear prioritization framework, MDM initiatives may become misaligned, resource-intensive, and less effective [7].

Existing studies have largely concentrated on defining data quality characteristics and describing MDM frameworks, while comparatively less attention has been given to quantitatively ranking the improvement areas that organizations should address first [2,8,9]. While some studies categorize data quality into technical and organizational aspects [3,10], others emphasize governance and stewardship models without offering a quantitative approach to determine their relative importance [9,11]. Decision-support methods such as the Analytic Hierarchy Process (AHP) have been widely applied in domains requiring prioritization, including ERP evaluation and data analytics [7,8]. However, the use of AHP in prioritizing data quality improvement areas within MDM is still very limited. This study addresses this gap by collecting expert judgment from multiple industries into a unified prioritization model, enabling a more context-aware evaluation of data quality improvement in MDM.

Prior research in data governance highlights that unclear decision rights, ambiguous accountability structures, and misaligned governance mechanisms significantly reduce the effectiveness of data initiatives [12]. Empirical evidence from service organizations further indicates that the absence of coordinated governance structures leads to inconsistent data management practices and limits the sustainability of data quality improvement efforts [13].

Moreover, governance-related mechanisms have been shown to directly influence organizational performance and trust in data-driven environments, showing the need for structured coordination rather than isolated technical solutions [14]. These findings suggest that the challenge in MDM is not only about the identification of relevant data quality dimensions, but also the lack of a structured and evidence-based prioritization approach that enables organizations to plan data quality improvement efforts effectively.

This study therefore focuses on determining which data quality improvement areas should receive greater priority within MDM environments. Specifically, it addresses the following research questions:

What data quality improvement areas are most relevant for MDM based on recent literature?

How can these areas be prioritized using the Analytic Hierarchy Process (AHP) to support effective data quality improvement?

To address these questions, this study conducts a structured approach by identifying relevant data quality dimensions from the published literature and evaluating their relative importance using AHP based on expert judgments. The resulting model provides a quantitative basis for prioritizing data quality improvement initiatives in MDM.

This study is structured into six sections. Section II reviews related studies on data quality and MDM. Section III explains the research methodology, including the AHP model and data collection process. Section IV presents the results and analysis. Section V interprets the findings and discusses their theoretical and practical implications. Finally, Section VI gives the conclusion and outlines directions for future research.

II. LITERATURE REVIEW

A. Master Data Management (MDM) and the Importance of Data Quality

Master Data Management (MDM) brings together organizational processes, governance mechanisms, and supporting technologies to maintain consistent and trustworthy representations of core business entities across enterprise systems [1]. High-quality master data serves as a trusted single source of truth, supporting decision-making, regulatory compliance, and analytical initiatives [2]. Conversely, poor data quality can lead to duplicate records, inconsistent reporting, operational inefficiencies, and increased financial and operational risks [3].

Despite the use of MDM frameworks, maintaining high-quality data remains a significant challenge. Organizations must integrate data from multiple sources, enforce governance policies, and manage complex business rules, all of which increase the difficulty of sustaining data quality over time [4]. These challenges highlight the need to systematically identify and prioritize key improvement areas within MDM to ensure effective data quality management.

B. Data Quality Dimensions as the Foundation for Improvement Areas

Data quality is commonly defined as the degree to which data meets user requirements for specific tasks and decision-making processes [4]. Prior studies have categorized data quality dimensions into several groups, including intrinsic, contextual, and system-dependent attributes. Data quality can be characterized by intrinsic dimensions, including accuracy, completeness, and consistency, and contextual dimensions, such as timeliness and relevance.

Although these dimensions are well established, the literature provides limited guidance on their relative importance in the context of MDM. Different studies show different aspects depending on context. For example, analytical reliability is often associated with accuracy and completeness [5,6], whereas long-term data quality sustainability is linked to

governance-related aspects such as ownership, stewardship, and accountability [3,15]. This variation suggests that data quality dimensions are not equally important across contexts, confirming the need for a structured prioritization approach.

Based on these findings, this study adopts key data quality dimensions as improvement areas and evaluates their relative importance using a quantitative decision-making approach.

III. METHODOLOGY

A. Identification of Data Quality Improvement Areas

A structured literature identification and screening process was conducted to identify data quality improvement areas relevant to MDM. The literature search was conducted using Scopus, IEEE Xplore, and ScienceDirect with the search terms “(“master data management” OR “MDM”) AND (“data quality” OR “information quality”) AND (accuracy OR completeness OR consistency OR timeliness OR governance OR stewardship OR accessibility OR dimension OR dimensions).” The search covered publications from 2019 to 2024. Studies were included when they were peer-reviewed journal or conference papers published in English that explicitly discussed one or more data or information quality dimensions in the context of MDM, enterprise data governance, or related information systems, while studies were excluded when they were not published in English, were not peer-reviewed (e.g., blog posts, white papers, or non-peer-reviewed theses), or mentioned data quality only in passing without substantively discussing specific dimensions. After removing duplicates and screening the retrieved studies based on title, abstract, and full text, 10 studies were retained for the final analysis. The occurrence of each improvement area across the selected studies was then counted to identify the improvement areas used as criteria in the AHP model.

Based on the reviewed literature, seven improvement areas—Accuracy, Completeness, Consistency, Timeliness, Governance, Stewardship, and Accessibility—were selected as criteria for the AHP evaluation.

B. Expert Evaluation

Expert judgment was used to assess the relevance of the selected improvement areas and to provide the pairwise comparisons required for the Analytic Hierarchy Process (AHP). The use of expert evaluation is widely recognized in data governance and information quality research, as many data quality aspects are context-dependent and not fully measurable using quantitative indicators [3,10,15].

1) *Expert selection criteria:* The experts participating in this study were selected based on established practices in AHP and data governance research [7,16]. The selection criteria were:

A minimum of three years of professional experience in MDM, data governance, enterprise data architecture, or information quality management.

Direct involvement in data governance, stewardship, or MDM implementation.

Employment in data-intensive and regulated industries.

The selected experts represent telecommunications, oil and gas, and cloud service sectors. These industries are characterized by high data volume, strict regulatory requirements, and mature data governance practices [3,4]. The inclusion of multiple industries enables the study to capture perspectives from different data-intensive contexts. However, because each industry is represented by a single expert, the findings should be interpreted as context-specific expert judgments rather than representative sector-level consensus.

A total of three experts participated in this study, with one expert representing each selected industry sector. The relatively small expert panel limits the generalizability of the findings and motivates future research involving a larger and more diverse expert sample.

C. Data Collection Procedure

Data collection was conducted through an on-site session, and the experts filled in a paper-based pairwise comparison questionnaire. This approach was intended to ensure clarity of the instructions, allow immediate clarification when necessary, and reduce the risk of misinterpretation.

Experts evaluated each pair of improvement areas using the fundamental AHP comparison scale proposed by Saaty [16]. A score of 1 represented equal importance between two areas, whereas higher scores indicated increasing preference for one area over the other.

Each expert's justification was then transcribed into a digital matrix for further analysis and processing. Since AHP requires the combination of the experts' input, individual pairwise comparison matrices were aggregated using the geometric mean method. The geometric mean was used to combine the experts' pairwise judgments because the AHP comparisons are expressed on a ratio scale [4,7,16].

D. Analytic Hierarchy Process (AHP)

The study employed the Analytic Hierarchy Process (AHP) to convert the experts' pairwise judgments into relative priority scores. AHP was selected because it provides a structured mechanism for comparing multiple criteria and assessing the internal consistency of the resulting judgments [4,6,7].

1) *AHP model structure*: The hierarchy was constructed as follows:

- Goal: Prioritizing Data Quality Improvement Areas in MDM
- Criteria: Seven improvement areas identified from the reviewed literature—Accuracy, Completeness, Consistency, Timeliness, Governance, Stewardship, and Accessibility.

This structure follows the commonly used AHP modeling practices in the information quality assessment [4,16].

2) *Weight calculation*: The three expert matrices were first combined into a single group matrix using the geometric mean of the corresponding pairwise judgments. The priority vector was subsequently obtained by extracting the principal

eigenvector of this group matrix and scaling its elements so that their total equaled one. The resulting values were interpreted as the relative priorities of the seven improvement areas in the AHP model.

3) *Consistency ratio*: To assess the consistency of the expert judgments, several calculations were made. The Consistency Index (CI) is calculated using Eq. (1).

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (1)$$

The Consistency Ratio (CR) was then calculated using Eq. (2).

$$CR = \frac{CI}{RI} \quad (2)$$

RI is the Random Index table provided by Saaty [16]. A CR value that is lower than 0.10 indicates acceptable consistency. In contrast, if the CR exceeds 0.10, the corresponding pairwise comparisons should be reviewed and revised if necessary.

IV. RESULTS

This section presents the identified data quality improvement areas in Master Data Management (MDM) and their relative importance based on expert evaluation using the Analytic Hierarchy Process (AHP).

A. Synthesis of Data Quality Improvement Areas

Seven data quality improvement areas were identified from established literature and consistently reported across prior studies. These areas represent a combination of technical, contextual, and organizational dimensions of data quality.

Technical dimensions—including Accuracy, Completeness, Consistency, and Timeliness—are widely recognized as fundamental components of information quality frameworks. These dimensions are essential for ensuring reliable and usable data within enterprise systems. In addition, organizational dimensions such as Governance and Stewardship are emphasized as critical factors for sustaining long-term data quality, particularly in highly regulated and data-intensive environments. Accessibility is also identified as an important system-related dimension, reflecting the need for efficient data retrieval and usability within modern enterprise platforms [5,16].

The existence of these dimensions across multiple studies indicates that the nature of data quality in MDM is multi-dimensional, requiring a balance between technical accuracy, organizational control, and system usability.

Based on the reviewed literature, the frequency of occurrence of each data quality improvement area is summarized in the following table.

The frequency distribution presented in Table I indicates that Governance appears as the most frequently discussed improvement area across the reviewed studies, followed by Accuracy and Consistency. This suggests that governance-related mechanisms and core data reliability dimensions are consistently emphasized in the literature as critical components of data quality in MDM.

TABLE I. THE FREQUENCY OF THE OCCURRENCE OF THE SEVEN DATA QUALITY IMPROVEMENT AREAS

Improvement Areas	Frequency
Accuracy	8
Completeness	7
Consistency	8
Timeliness	6
Governance	9
Stewardship	7
Accessibility	6

In contrast, dimensions such as Timeliness and Accessibility show relatively lower frequencies, indicating that while they remain relevant, they are less consistently highlighted across different studies. Stewardship and Completeness occupy a middle position, reflecting their contextual importance depending on organizational needs and data usage scenarios.

Although Governance and Stewardship are both classified as organizational improvement areas, they represent distinct roles within MDM. Governance refers to the policies, decision rights, standards, controls, and organizational mechanisms established to direct and oversee data management. Stewardship refers to the operational responsibility and accountability for maintaining, monitoring, and resolving data quality issues within assigned data domains. Thus, Governance establishes the rules and decision structures for managing data, whereas Stewardship focuses on the execution of data ownership and data quality responsibilities.

B. AHP-Based Prioritization of Improvement Areas

The seven improvement areas are used as criteria to construct the AHP model. Expert judgments were collected through structured pairwise comparison questionnaires using Saaty's 1-9 scale [16]. The evaluations were conducted in a supervised setting to ensure clarity and consistency in the assessment process.

The experts participating in this study were selected based on their experience in MDM, data governance, or enterprise information quality. Experts are also required to have a diverse background across industries and have a mature and regulated data ecosystem [3,4]. The selected industry sectors were telecommunications, oil and gas, and cloud services.

The improvement areas are abbreviated as follows: Accuracy (A1), Completeness (C1), Consistency (C2), Timeliness (T), Governance (G), Stewardship (S), and Accessibility (A2).

1) *Expert matrices and interpretation:* Each expert provided a 7x7 pairwise comparison matrix. The individual expert matrices are presented in Tables II-IV.

Table II presents the pairwise comparison matrix provided by the oil and gas expert. The results indicate a strong preference for Accuracy (A1) over Timeliness (T) and Accessibility (A2). For instance, the values $A1-T = 7.00$ and $A1-A2 = 7.00$ demonstrate that accurate data is considered

significantly more critical than fast or easily accessible data. This reflects the perspective represented by the participating Oil and Gas expert, where incorrect or unreliable data may lead to severe operational disruptions, safety incidents, financial losses, and regulatory risks. In such environments, ensuring the correctness and reliability of master data becomes more important than rapid access or update frequency.

TABLE II. PAIRWISE COMPARISON MATRIX FROM THE OIL AND GAS EXPERT

	A1	C1	C2	T	G	S	A2
A1	1.000	5.000	5.000	7.000	1.000	1.000	7.000
C1	0.200	1.000	0.333	5.000	0.200	0.200	5.000
C2	0.200	3.000	1.000	3.000	0.200	0.200	3.000
T	0.143	0.200	0.333	1.000	0.143	0.143	1.000
G	1.000	5.000	5.000	7.000	1.000	1.000	9.000
S	1.000	5.000	5.000	7.000	1.000	1.000	9.000
A2	0.143	0.200	0.333	1.000	0.111	0.111	1.000

The matrix also shows that Governance (G) and Stewardship (S) receive consistently strong evaluations across multiple comparisons. Governance is strongly preferred over Timeliness ($G-T = 7.00$) and Accessibility ($G-A2 = 9.00$), indicating that structured control mechanisms, policy enforcement, and regulatory compliance are considered fundamental components of data quality management. Similarly, Stewardship demonstrates strong importance relative to operational dimensions, suggesting that accountability and ownership are necessary to maintain long-term data reliability and consistency.

Furthermore, Governance (G) and Stewardship (S) are evaluated as equally important, indicating that both policy enforcement and data accountability play complementary roles in ensuring data quality. This finding aligns with prior studies emphasizing governance structures and data ownership as key factors in maintaining high data quality in highly regulated environments [3].

Overall, the prioritization pattern suggests that the oil and gas expert's judgments indicate a stronger emphasis on reliability, control, and regulatory alignment than on operational speed or convenience. This reflects the industry's dependence on accurate and well-governed master data to support critical operational and safety-related decision-making processes.

Table III presents the pairwise comparison matrix provided by the telecommunications expert. Compared to the oil and gas sector, the telecommunications context represented by the participating expert demonstrates a stronger emphasis on operational responsiveness, consistency, and governance-related mechanisms. This is reflected in several strong comparisons, such as Timeliness over Completeness ($T-C1 = 7.00$), Timeliness over Stewardship ($T-S = 7.00$), and Governance over Stewardship ($G-S = 5.00$). These results indicate the importance of maintaining responsive, synchronized, and well-regulated data environments across interconnected systems.

TABLE III. PAIRWISE COMPARISON MATRIX FROM THE
TELECOMMUNICATIONS EXPERT

	A1	C1	C2	T	G	S	A2
A1	1.000	3.000	0.333	0.200	0.333	3.000	0.333
C1	0.333	1.000	0.200	0.143	0.200	0.333	0.200
C2	3.000	5.000	1.000	0.333	0.333	3.000	0.333
T	5.000	7.000	3.000	1.000	1.000	7.000	1.000
G	3.000	5.000	3.000	1.000	1.000	5.000	3.000
S	0.333	3.000	0.333	0.143	0.200	1.000	0.200
A2	3.000	5.000	3.000	1.000	0.333	5.000	1.000

The telecommunications context represented by the participating expert places greater emphasis on synchronized master data across distributed platforms, including billing, provisioning, customer relationship management, and network operations systems. In such environments, inconsistencies in customer identifiers, service configurations, or transactional records may spread rapidly across multiple systems and disrupt operational processes. As a result, consistency in data definitions, integration standards, and governance mechanisms becomes essential to ensure seamless interoperability, accurate customer information, and reliable service delivery.

The matrix also demonstrates that Governance (G) receives consistently strong evaluations relative to several dimensions. Governance is strongly preferred over Completeness (G-C1 = 5.00) and Accuracy (G-A1 = 3.00), indicating that regulatory alignment, standardized policies, and centralized control mechanisms are considered critical for sustaining reliable telecommunications operations. Similarly, Consistency (C2) demonstrates relatively strong importance compared to Completeness (C2-C1 = 5.00), reflecting the operational need to maintain synchronized and unified master records across heterogeneous enterprise systems.

In contrast, Stewardship (S) receives relatively lower evaluations across multiple comparisons, suggesting that centralized governance structures and operational responsiveness are perceived as more influential than individual ownership responsibilities within telecommunications environments. This prioritization pattern aligns with existing literature on MDM in the telecommunications context represented by the participating expert, which emphasizes standardized data structures, regulatory compliance, and system integration as key enablers of high-quality master data management [4,10].

Table IV presents the pairwise comparison matrix obtained from the cloud services expert. The results demonstrate a strong emphasis on Governance (G), Accessibility (A2), and Consistency (C2) as the primary improvement dimensions within the cloud services context represented by the participating expert. Several comparisons indicate strong relative preferences, including Accessibility over Completeness (A2-C1 = 7.00), Governance over Accuracy (G-A1 = 5.00), Governance over Timeliness (G-T = 5.00), and Consistency over Completeness (C2-C1 = 7.00). These findings highlight the importance of scalable governance mechanisms, standardized data structures, and reliable data accessibility within distributed cloud infrastructures.

TABLE IV. PAIRWISE COMPARISON MATRIX FROM THE CLOUD PROVIDER
EXPERT

	A1	C1	C2	T	G	S	A2
A1	1.000	5.000	0.333	0.333	0.200	5.000	0.200
C1	0.200	1.000	0.143	0.200	0.143	0.333	0.143
C2	3.000	7.000	1.000	3.000	0.333	5.000	0.333
T	3.000	5.000	0.333	1.000	0.200	5.000	1.000
G	5.000	7.000	3.000	5.000	1.000	7.000	1.000
S	0.200	3.000	0.200	0.200	0.143	1.000	0.143
A2	5.000	7.000	3.000	1.000	1.000	7.000	1.000

Cloud service operations depend heavily on continuous data availability, scalable infrastructure, and rapid access across geographically distributed platforms. In this environment, delays, inconsistencies, or governance failures may directly affect system reliability, customer experience, and service continuity. Consequently, Accessibility (A2) becomes a critical operational requirement to support real-time provisioning, dynamic resource management, and responsive digital services.

The matrix also demonstrates that Governance (G) receives consistently strong evaluations across multiple comparisons. Governance is strongly preferred over Accuracy (G-A1 = 5.00), Completeness (G-C1 = 7.00), Timeliness (G-T = 5.00), and Stewardship (G-S = 7.00), indicating that policy enforcement, compliance management, security control, and standardized governance procedures are viewed as fundamental components of reliable cloud operations. At the same time, the strong weighting of Consistency (C2) reflects the operational need to maintain synchronized and interoperable master data across distributed cloud-based applications and services.

In contrast, Stewardship (S) receives relatively lower evaluations across most pairwise comparisons, suggesting that centralized governance mechanisms and platform-level operational controls are perceived as more influential than individual ownership responsibilities in maintaining data quality within cloud ecosystems.

These findings align with existing literature on cloud data governance and data quality management, which highlights the importance of accessibility, policy enforcement, scalability, and standardized data management frameworks in distributed cloud infrastructures [5,16].

Individual consistency was assessed for each expert before aggregating the pairwise comparison matrices. The Oil and Gas expert obtained a maximum eigenvalue (λ_{max}) of 7.4474, resulting in a Consistency Index (CI) of 0.0746 and a Consistency Ratio (CR) of 0.0565. The Telecommunications expert obtained a λ_{max} of 7.4810, with a CI of 0.0802 and a CR of 0.0607. The Cloud Provider expert obtained a λ_{max} of 7.7659, with a CI of 0.1276 and a CR of 0.0967. All three CR values are below the 0.10 threshold, indicating acceptable internal consistency in the individual pairwise comparison judgments. Because each industry was represented by one expert, these matrices represent individual expert judgments rather than aggregated sector-level judgments.

2) *Aggregated pairwise comparison matrix*: Individual pairwise comparison matrices from the three experts (Tables II-IV) were aggregated using the geometric mean, the standard method for consolidating ratio-scale judgments in group AHP [16]. The resulting group-level 7×7 matrix is presented in Table V. In this matrix, each cell shows the relative importance of the row criterion over the column criterion: a value greater than 1 indicates that the row criterion is judged more important, whereas a value below 1 indicates that the column criterion is more important.

TABLE V. AGGREGATED PAIRWISE COMPARISON MATRIX USING GEOMETRIC MEAN

	A1	C1	C2	T	G	S	A2
A1	1.000	4.217	0.822	0.776	0.405	2.466	0.776
C1	0.237	1.000	0.212	0.523	0.179	0.281	0.523
C2	1.216	4.718	1.000	1.442	0.281	1.442	0.693
T	1.289	1.913	0.693	1.000	0.306	1.710	1.000
G	2.466	5.593	3.557	3.271	1.000	3.271	3.000
S	0.405	3.557	0.693	0.585	0.306	1.000	0.636
A2	1.289	1.913	1.442	1.000	0.333	1.573	1.000

Table V shows a clear cross-industry prioritization pattern among the identified data quality improvement areas. Governance (G) receives the highest relative priority in the aggregated evaluation, demonstrating strong relative importance over several dimensions, including Completeness (G-C1 = 5.593), Consistency (G-C2 = 3.557), Timeliness (G-T = 3.271), and Accessibility (G-A2 = 3.000). These findings indicate that governance-related mechanisms—such as policy enforcement, accountability structures, compliance management, and standardized decision-making procedures—are considered fundamental for sustaining high-quality master data within MDM initiatives.

The matrix also demonstrates that Accuracy (A1), Consistency (C2), and Accessibility (A2) maintain moderate but relatively balanced importance across the aggregated evaluation. Consistency shows a relatively strong preference over Completeness (C2-C1 = 4.718), reflecting the operational need for standardized, synchronized, and interoperable master data across enterprise systems. Accuracy similarly maintains a balanced influence, indicating that organizations continue to prioritize trustworthy and dependable information to support operational reliability and strategic decision-making. Accessibility further reflects the growing importance of efficient data retrieval and usability within increasingly digital and distributed environments.

Timeliness (T) demonstrates moderate influence in Table V: it is judged more important than Completeness (T-C1 = 1.913) and Stewardship (T-S = 1.710), but less important than Governance (T-G = 0.306) and Consistency (T-C2 = 0.693). Although timely updates remain operationally important, the results suggest that organizations give priority to governance, reliability, and consistency to maintain sustainable data quality over time. Similarly, Stewardship (S) receives lower relative priority than Governance in the aggregated evaluation, indicating that operational data ownership and accountability

were assigned comparatively lower priority within the expert judgments.

As shown in Table V, Completeness (C1) receives lower relative importance than the other criteria, with its pairwise comparison values ranging from 0.179 to 0.523 against the other improvement areas. This result indicates that, within the expert judgments represented in the aggregated matrix, Completeness received lower relative priority in comparison with the other improvement areas. The result should not be interpreted as indicating that incomplete master data is generally acceptable. Rather, the relative importance of Completeness may vary depending on the intended use of the data, operational requirements, and regulatory obligations.

Overall, the aggregated results in Table V indicate that data quality improvement in MDM is primarily driven by governance-oriented and reliability-focused considerations rather than purely operational efficiency factors. The aggregated results indicate that Governance has the highest relative priority, while the sector-specific judgments reveal meaningful variation in the importance assigned to the other improvement areas.

3) *Priority weights*: Following the aggregation of the expert judgments, the priority weights for the seven improvement areas were derived from the principal eigenvector of the aggregated pairwise comparison matrix. The principal eigenvector was normalized so that the sum of the priority weights equaled one. The resulting weights represent the relative priority of each improvement area within the AHP model. Because the priority vector is normalized, the weights sum to one up to rounding. The resulting weights and the ranking of the seven improvement areas are presented in Table VI.

TABLE VI. IMPROVEMENT AREAS RANKED FROM HIGHEST TO LOWEST

Rank	Improvement Areas	Weight
1	Governance (G)	0.342
2	Consistency (C2)	0.137
3	Accuracy (A1)	0.136
4	Accessibility (A2)	0.132
5	Timeliness (T)	0.119
6	Stewardship (S)	0.090
7	Completeness (C1)	0.044

As shown in Table VI, Governance (0.342) receives the highest priority, followed by Consistency (0.137), Accuracy (0.136), Accessibility (0.132), Timeliness (0.119), Stewardship (0.090), and Completeness (0.044). Governance therefore represents the highest-ranked improvement area in the aggregated expert evaluation. However, the relatively small differences among Consistency, Accuracy, and Accessibility indicate that their relative ordering should be interpreted with caution rather than as a substantial separation in importance.

Meanwhile, Table VI shows that Consistency (0.137), Accuracy (0.136), and Accessibility (0.132) form a second level of relatively balanced importance; the gap between the

highest and the lowest of these three is only 0.004, so their relative order should be interpreted with caution. This indicates that experts see technical reliability, data correctness, and ease of access as complementary contributors to effective MDM implementation. The relatively similar weights among these dimensions suggest that organizations must ensure that master data are accurate and consistent while remaining readily accessible to authorized users in order to support operational efficiency and informed decision-making [4,10].

Timeliness also remains an important factor; with a weight of 0.119 (rank 5 in Table VI), it receives slightly lower priority compared to the other operational dimensions. This finding suggests that organizations may prioritize governance, reliability, and consistency over update frequency, particularly in environments where compliance requirements and data validation processes are more critical than rapid data refresh cycles.

Table VI shows that Stewardship (0.090) and Completeness (0.044) receive the lowest weights in the aggregated evaluation. The relatively lower weight of Stewardship suggests that, although accountability and ownership remain important, it was assigned lower relative priority than the other improvement areas in the expert evaluation. Completeness also receives a relatively low priority in the aggregated model. This result should not be interpreted as indicating that completeness is unimportant or that incomplete master data is generally acceptable. Instead, the result indicates that Completeness was assigned lower relative priority within the contexts represented by the participating experts. Its practical importance remains dependent on the intended use of the data, operational requirements, and regulatory obligations.

Overall, the prioritization results demonstrate a layered structure of MDM data quality determinants, with Governance receiving the highest relative priority, while Consistency, Accuracy, Accessibility, and Timeliness receive substantial but comparatively lower priorities.

4) *Consistency ratio*: A key requirement in AHP is to ensure that expert judgments are sufficiently consistent. While some degree of inconsistency is expected in human decision-making, excessive inconsistency can compromise the reliability of pairwise comparisons and the resulting priority weights. Therefore, AHP incorporates a consistency measure, known as the Consistency Ratio (CR), to quantify the degree of logical consistency in the judgments [10].

The procedure begins with computing the principal eigenvalue ($\lambda_{\max}$), which reflects the degree of deviation from perfect consistency. Using the aggregated matrix in Table V, the eigenvalue was obtained as $\lambda_{\max} = 7.290$. Since perfect consistency would result in $\lambda_{\max} = 7$, this value indicates a small level of inconsistency.

The Consistency Index (CI) is then calculated as:

$$CI = \frac{\lambda_{\max} - n}{n - 1} = \frac{7.290 - 7}{6} = 0.0483$$

The consistency value is compared against the Random Index (RI), which is derived from standard AHP benchmarks. For a matrix of size $n = 7$, the RI value is 1.32 [16].

The resulting Consistency Ratio is:

$$CR = \frac{CI}{RI} = \frac{0.0483}{1.32} = 0.0366$$

A commonly accepted threshold for consistency in AHP is $CR \leq 0.10$. The obtained CR value of 0.0366 is well below this threshold, indicating that the aggregated expert judgments demonstrate a high level of consistency and that the resulting pairwise comparison judgments demonstrate an acceptable level of internal consistency.

Using the aggregated pairwise comparison matrix in Table V, the maximum eigenvalue was obtained as 7.290. The resulting Consistency Index (CI) was 0.0483, and with an RI value of 1.32 for a seven-criterion matrix, the Consistency Ratio (CR) was 0.0366. Since the CR is below the 0.10 threshold, the aggregated pairwise comparison judgments demonstrate an acceptable level of internal consistency. However, this consistency assessment indicates the logical consistency of the expert judgments and does not by itself establish the predictive validity or empirical effectiveness of the resulting priority weights.

C. Leave-One-Expert-Out Sensitivity Analysis

To assess the robustness of the aggregated priority structure, a leave-one-expert-out sensitivity analysis was conducted. The analysis recalculated the geometric-mean pairwise comparison matrix and the corresponding priority weights after excluding one expert at a time (Table VII).

TABLE VII. LEAVE-ONE-EXPERT-OUT RESULT

Excluded Expert	Governance Weight	Top Criteria
Oil and Gas	0.299	Governance
Telecommunications	0.354	Governance
Cloud Provider	0.330	Governance

When the Oil and Gas expert was excluded, Governance remained the highest-priority improvement area with a weight of 0.299. When the Telecommunications expert was excluded, Governance remained the highest-priority area with a weight of 0.354. Similarly, when the Cloud Provider expert was excluded, Governance remained the highest-priority area with a weight of 0.330.

These results suggest that the high priority assigned to Governance is relatively robust to the exclusion of any single expert. However, the relative ordering of the remaining improvement areas varies across the sensitivity analyses, indicating that the ranking of criteria with relatively close weights should be interpreted with caution. The sensitivity analysis therefore supports the robustness of Governance as the highest-priority improvement area while highlighting contextual variation in the priorities assigned to the other improvement areas.

V. DISCUSSION

The findings of this study provide an integrated view of Master Data Management (MDM) data quality challenges by combining evidence from the reviewed literature with expert-driven prioritization using the Analytic Hierarchy Process (AHP). The resulting ranking reflects the relative priorities assigned by the participating experts from highly regulated and data-intensive industry contexts.

A. Interpretation of Priority Structure

Governance as the highest-ranked improvement area highlights the relative importance of organizational control mechanisms, including policy enforcement, accountability structures, and decision rights, within the evaluated MDM improvement framework. Governance emerges as the highest-priority improvement area in the aggregated multi-industry model, with a weight of 0.342. The sector-specific judgments, however, reveal meaningful contextual variation. Governance receives a high relative priority in the Telecommunications and Cloud Provider assessments, while the Oil and Gas assessment assigns similarly high importance to Governance, Stewardship, and Accuracy. These differences suggest that governance is an important cross-industry priority, but the relative importance of individual improvement areas may vary according to industry context.

Consistency (0.137), Accuracy (0.136), and Accessibility (0.132) form a closely ranked group of operational and technical improvement areas. The small differences among these weights indicate that their relative ordering should be interpreted with caution rather than as a substantial separation in importance. The relatively balanced weights among these dimensions indicate that organizations consider synchronized data structures, trustworthy information, and efficient data accessibility as complementary requirements for effective enterprise data management. Consistency remains particularly important in distributed and interconnected environments, such as telecommunications and cloud computing, where multiple applications rely on synchronized master records [4,15]. Accuracy continues to serve as a foundational attribute across data quality frameworks because organizations depend on reliable information for operational and strategic decision-making [9,10]. Accessibility further reflects the growing importance of usability, operational responsiveness, and efficient data retrieval within modern digital platforms [5].

Timeliness (0.119) receives a slightly lower ranking, suggesting sector-specific prioritization patterns. Although timely data updates remain operationally important, the results indicate that experts place greater emphasis on governance, reliability, and consistency to maintain sustainable data quality over time. This finding suggests that organizations may prioritize validated and reliable information over update speed, particularly in highly regulated or operationally sensitive environments.

Stewardship (0.090) receives comparatively lower priority in the aggregated evaluation. This result indicates that, within the expert judgments represented in this study, operational responsibility and accountability for data quality were assigned lower relative priority than Governance and the other improvement areas. This finding does not imply that

stewardship is subordinate to governance; rather, the two represent distinct organizational roles with different responsibilities within MDM.

Completeness (0.044) receives the lowest priority in the aggregated evaluation. This result does not imply that completeness is unimportant or that incomplete master data is generally acceptable. Rather, within the expert judgments and contexts examined in this study, Completeness was assigned a lower relative priority than the other improvement areas. The practical importance of completeness remains dependent on the intended use of the data, operational requirements, and regulatory obligations.

The prioritization structure indicates that governance-oriented and reliability-focused considerations receive greater relative priority in the aggregated expert evaluation than purely operational efficiency considerations. The consistency of this pattern across telecommunications, cloud services, and oil and gas sectors further reinforces the strategic role of governance in sustaining enterprise data quality initiatives.

B. Theoretical Contribution

This study makes three primary contributions to MDM and data quality literature.

First, it bridges descriptive data quality frameworks with quantitative prioritization. Prior studies on Master Data Management (MDM) predominantly identify data quality dimensions and challenges in a descriptive manner, with limited emphasis on structured prioritization. This study addresses this gap by providing an evidence-driven ranking of improvement areas using a systematic multi-criteria decision-making approach.

Second, this study provides quantitative evidence from expert judgments regarding the relative priority of governance in MDM contexts. While governance has long been conceptually recognized as a critical factor, relatively few studies have quantified its relative importance. The findings of this study reinforce the central role of governance by identifying it as the highest-priority improvement area in the aggregated evaluation of expert judgments from multiple industry contexts.

Third, this study extends the application of the Analytic Hierarchy Process (AHP) to the domain of MDM quality improvement. Although AHP has been applied in areas such as ERP evaluation, data maturity assessment, and analytics selection [4,7], its use in prioritizing MDM data quality dimensions remains limited. This study demonstrates the methodological suitability of AHP for addressing complex, multi-dimensional data quality challenges and provides a structured approach for integrating expert judgment into decision-making.

C. Practical Implications

The findings of this study provide several actionable implications for practitioners in managing MDM data quality.

First, organizations should prioritize governance reforms by formalizing data policies and establishing clear data ownership structures. Given the highest relative priority assigned to

Governance, strengthening organizational control mechanisms should therefore be considered a priority to ensure accountability and consistent enforcement of data standards across business units.

Second, organizations should invest in consistency and validation mechanisms. The adoption of standardized data models, automated validation processes, and master data synchronization pipelines can significantly improve data consistency and accuracy, particularly in environments with distributed systems.

Third, improving system accessibility is critical to support operational efficiency and data-driven decision-making. Enhancements in data cataloging, metadata management, and role-based access control can facilitate timely and reliable access to high-quality data for authorized users.

Finally, organizations should assess completeness requirements according to the intended use of master data, operational needs, and regulatory obligations. The relatively low priority assigned to Completeness in this study should not be interpreted as a recommendation to reduce completeness efforts or accept incomplete master data. Instead, organizations should determine appropriate completeness requirements based on the risks and requirements associated with each data domain and use case.

D. Limitations and Future Research

This study is subject to several limitations that should be considered when interpreting the results.

First, the study relies on a relatively small expert panel, with one expert representing each industry. Although the expert selection criteria ensured relevant professional experience, the small and non-probabilistic sample limits the generalizability of the findings. Future research should involve a larger and more diverse panel of experts across industries and organizational roles, such as data architects, data stewards, and auditors.

Second, the findings are influenced by industry-specific contexts. The expert sample represents highly regulated and data-intensive sectors, including telecommunications, oil and gas, and cloud services. As a result, the prioritization outcomes may not fully generalize to less regulated industries, where different data quality dimensions may be emphasized.

Third, the AHP method assumes independence among criteria, which may not fully reflect real-world relationships. In practice, dimensions such as governance and stewardship are closely interrelated, while consistency and accuracy often exhibit strong correlation. Future studies may address this limitation by applying more advanced multi-criteria decision-making approaches, such as the Analytic Network Process (ANP) or fuzzy AHP, which are better suited to capturing interdependencies among criteria.

Fourth, the results are based on expert judgment, which may be influenced by the organizational maturity and experience of the participants. Future research could strengthen the robustness of the findings by incorporating objective data quality metrics or developing hybrid models that combine expert judgment with empirical performance indicators.

Despite these limitations, the study provides a structured and consistency-checked prioritization model that can support organizations in identifying and prioritizing MDM data quality improvement areas.

VI. CONCLUSION

This study demonstrates how expert-based prioritization can provide meaningful insight into the relative importance of data quality improvement areas within Master Data Management (MDM). It integrates systematic literature findings with quantitative evaluation to produce a structured and evidence-based prioritization model.

The study aimed to identify and prioritize key improvement areas influencing data quality in MDM. Seven improvement dimensions were identified—Accuracy, Completeness, Consistency, Timeliness, Governance, Stewardship, and Accessibility—and subsequently evaluated using the Analytic Hierarchy Process (AHP) to determine their relative importance.

The results indicate that Governance receives the highest relative priority in the aggregated expert evaluation, followed by Consistency, Accuracy, and Accessibility. These findings highlight the relative importance of organizational mechanisms within the evaluated MDM data quality improvement framework. While technical and operational factors remain important, the aggregated expert evaluation assigns the highest relative priority to Governance, suggesting that organizational mechanisms play an important role in supporting MDM data quality improvement.

The resulting weights can be used as relative prioritization indicators to support MDM improvement planning. In practice, these priorities should be considered together with the organization's current data quality maturity, identified gaps, regulatory requirements, operational risks, implementation costs, and organizational feasibility. Therefore, the AHP weights should be interpreted as relative priority scores rather than direct budget allocation percentages. The low consistency ratio ($CR = 0.0366$) indicates an acceptable level of internal consistency in the aggregated expert judgments. However, the CR should not be interpreted as evidence of empirical or predictive validity of the resulting prioritization.

Future research may extend this work by incorporating a larger and more diverse expert panel, applying hybrid decision-making approaches such as fuzzy AHP, or validating the prioritization results using empirical performance data from ongoing MDM initiatives. Expanding the study across different industries and organizational contexts would also enhance the generalizability of the findings.

Overall, the findings suggest that MDM data quality improvement should address both technical and organizational mechanisms, with Governance receiving the highest relative priority in the aggregated expert evaluation. Organizations that prioritize governance and align their data management practices accordingly may establish a stronger organizational foundation for consistent, accurate, and accessible master data.

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