The Role of Data Quality Dimensions in Enhancing Life Cycle Costing and Data-Driven Decision Making for Public Sector Asset Management

Mohd Suharizal Mahamad Subri[1], Mohamad Adzizulrohim Abd Malek[2], Afiqah Ngah Nasaruddin[3], Madihah Md Fadil[4]

Public Works Department of Malaysia, JKR Malaysia, KUALA LUMPUR, Malaysia

DOI: https://doi.org/10.47772/IJRISS.2026.100600128

Received: 28 May 2026; Accepted: 02 June 2026; Published: 18 June 2026

ABSTRACT

The transition toward data-driven decision-making has become increasingly important for modern Asset Management (AM) within the public sector, particularly in supporting effective Life Cycle Costing (LCC) and long-term asset investment decisions. Despite significant government initiatives to strengthen asset management practices in Malaysia, the implementation of LCC remains constrained by challenges associated with the quality and availability of asset information. This study aims to identify and prioritize the Data Quality Dimensions (DQD) that are most critical for supporting LCC and data-driven decision-making within Malaysian public sector asset management. A mixed-methods approach was adopted comprising a quantitative survey of experienced asset management practitioners and qualitative validation through five institutional building case studies. Data were analysed using the Relative Importance Index (RII) to determine the relative significance of Data Quality Dimensions and operational data quality challenges. The findings reveal that all Data Quality Dimensions are important for effective asset management; however, Accuracy, Reliability, and Availability emerged as the most critical dimensions for supporting LCC applications. The study further identified data recording problems, fragmented information systems, and limited access to historical asset information as key barriers affecting data quality and lifecycle-based decision-making. The institutional case studies validated these findings by demonstrating how deficiencies in data quality directly influence the reliability of lifecycle cost analyses and asset management decisions. This study contributes to the growing body of knowledge on asset information management by extending the application of the Wang and Strong Data Quality Framework to the context of public sector asset management and Life Cycle Costing. The proposed D-LCC Governance Framework provides practical guidance for improving data quality, strengthening information governance, and enhancing data-driven decision-making capabilities within public sector organizations.

Keywords: Asset Management; Data Quality Dimensions; Life Cycle Costing; Data-Driven Decision Making; Public Sector Asset Management; Asset Information Management; Data Governance.

[1] M.S. Mahamad Subri (✉)
Public Works Department, Kuala Lumpur, Malaysia
email: msuharizal@jkr.gov.my

[2] M.A. Abd Malek
Public Works Department, Kuala Lumpur, Malaysia
email: adzizul@jkr.gov.my

[3] A. Ngah Nasaruddin
Public Works Department, Kuala Lumpur, Malaysia
email: afiqah.ngahn@jkr.gov.my

[4] Md. Fadil Madihah
UTMSPACE, Kuala Lumpur, Malaysia
email: madihah@utmspace.edu.my

INTRODUCTION

Asset Management and the Global Imperative for Data-Driven Decision Making

Asset Management (AM) has evolved from a maintenance-oriented discipline into a strategic management approach focused on realizing value from assets throughout their lifecycle. According to the International Organization for Standardization (ISO, 2024), asset management encompasses coordinated organizational activities that enable assets to deliver value while balancing performance, cost, and risk considerations. This evolution has become increasingly important as organizations face challenges associated with ageing infrastructure, fiscal constraints, increasing service expectations, and sustainability requirements.

The advancement of digital technologies has accelerated the transition toward data-driven decision making (DDDM) in asset management. Rather than relying solely on experience-based judgement, organizations are increasingly utilizing asset information and analytical tools to support maintenance planning, resource allocation, risk management, and investment decisions. Effective DDDM enables asset owners to improve operational efficiency, optimize lifecycle performance, predict asset failures, and enhance long-term value creation (Hastings, 2021; ISO, 2024).

Within the public sector, the importance of data-driven decision making is particularly significant due to the scale and complexity of infrastructure portfolios managed by government agencies. Public organizations are responsible for ensuring that assets such as buildings, roads, utilities, healthcare facilities, and educational institutions continue to deliver reliable services while operating within limited financial resources. Consequently, the ability to make informed decisions based on accurate and reliable asset information has become a fundamental requirement for effective asset management practices.

Despite the increasing adoption of digital systems and information technologies, the effectiveness of data-driven decision making remains highly dependent on the quality of the underlying data. Poor-quality data can result in inaccurate forecasts, ineffective maintenance strategies, inefficient resource allocation, and increased operational risks. Wang and Strong (1996) argued that data quality should be assessed based on its fitness for use, emphasizing that the value of information depends on its ability to support organizational decision-making requirements. Similarly, recent studies in the Malaysian public sector have identified data quality as a critical success factor influencing the effectiveness of immovable asset management and organizational decision-making processes (Subri et al., 2025a; Subri et al., 2025b).

As public sector organizations continue their digital transformation journey, improving data quality has become a strategic priority for enabling effective asset information management and supporting evidence-based decision making. Consequently, understanding the dimensions and characteristics of data quality is essential for organizations seeking to maximize the benefits of asset management systems, digital technologies, and lifecycle-based decision-making approaches.

The Malaysian Public Sector Context: Bridging Policy Aspirations and Operational Realities

Over the past decade, the Malaysian Government has undertaken significant efforts to strengthen public sector asset management through the introduction of strategic policies, regulatory frameworks, and institutional reforms. The National Asset and Facilities Management Policy (Dasar Pengurusan Aset Kerajaan, DPAK) and the Government Comprehensive Asset Management Manual (Manual Pengurusan Aset Menyeluruh, MPAM) were introduced to promote a systematic and lifecycle-oriented approach to managing public immovable assets. These initiatives emphasize the importance of optimizing asset performance, minimizing lifecycle costs, and supporting informed decision-making throughout the asset lifecycle (Ruslan et al., 2022).

In support of these objectives, various digital initiatives have been introduced to enhance the management of government assets. Centralized asset information systems have been developed to improve asset visibility, facilitate information sharing, and support strategic planning and maintenance activities. Furthermore, public agencies, particularly the Public Works Department Malaysia (JKR), have actively promoted the adoption of Life Cycle Costing (LCC) to encourage value-based decision-making and ensure that asset investment decisions consider both capital expenditure and long-term operational costs (Ayob et al., 2021).

Despite these advancements, the practical implementation of data-driven asset management remains a significant challenge. Previous studies have reported that many public sector organizations continue to face difficulties in maintaining accurate, complete, accessible, and reliable asset information required for effective decision-making (Subri et al., 2025a; Subri et al., 2025b). While asset-related data are generated throughout planning, construction, operation, maintenance, and disposal stages, these data are frequently dispersed across multiple systems, departments, and stakeholders, resulting in fragmented information environments. Consequently, organizations often encounter difficulties in consolidating and utilizing asset information to support strategic asset management functions.

The challenges are particularly evident in the implementation of Life Cycle Costing. Effective LCC analysis requires comprehensive historical data relating to asset condition, maintenance interventions, operational expenditures, performance trends, and replacement activities over extended periods. However, the availability of such information remains limited within many public sector organizations due to inconsistencies in data collection practices, incomplete asset records, and inadequate information governance mechanisms (Maisham et al., 2021). As a result, LCC analyses are frequently constrained by data limitations, reducing their effectiveness as a decision-support tool for asset investment, maintenance planning, and resource allocation.

Recent studies focusing on Malaysian public sector immovable asset management have further demonstrated that People, Process, and Technology (PPT) factors significantly influence the quality of asset information and subsequently affect organizational decision-making capabilities (Subri et al., 2025c). Similarly, weaknesses in data governance, information management practices, and digital readiness have been identified as key barriers to achieving effective digital transformation within public sector asset management environments (Subri et al., 2025b).

These findings suggest that the challenges faced by public sector organizations are no longer solely related to the availability of information systems or policy frameworks. Rather, the ability to generate, maintain, and utilize high-quality asset information has emerged as a critical determinant of successful asset management implementation. Consequently, a deeper understanding of data quality dimensions and their contribution to Life Cycle Costing and data-driven decision-making is required to bridge the gap between policy aspirations and operational realities within Malaysian public sector asset management.

The Nexus between Life Cycle Costing and Data Quality

Life Cycle Costing (LCC) is widely recognized as one of the most important decision-support tools in contemporary asset management. Unlike traditional cost estimation approaches that focus primarily on initial acquisition or construction costs, LCC evaluates the total cost of ownership of an asset throughout its entire lifecycle, including planning, acquisition, operation, maintenance, renewal, and disposal phases (RICS, 2016). Consequently, LCC enables asset owners and decision-makers to make more informed investment decisions by considering the long-term financial implications of asset-related activities rather than focusing solely on short-term expenditures.

The effectiveness of LCC, however, is highly dependent on the quality of the underlying asset information. Accurate lifecycle cost projections require comprehensive historical and operational data, including asset condition records, maintenance histories, failure frequencies, operational expenditures, replacement costs, and asset performance information collected over extended periods. Unlike conventional budgeting approaches that may rely on current market prices or estimated costs, LCC requires longitudinal datasets that accurately represent asset behaviour throughout its service life (Ayob et al., 2021).

As organizations increasingly adopt data-driven decision-making approaches, the reliability of LCC outcomes becomes directly influenced by the quality of available data. Poor-quality data can significantly distort lifecycle cost projections and lead to inappropriate investment decisions. For example, incomplete maintenance records may underestimate future maintenance requirements, inaccurate asset condition information may lead to premature replacement decisions, while inaccessible historical data may limit the ability to predict asset deterioration patterns accurately. Consequently, deficiencies in data quality can compromise the credibility and effectiveness of LCC analyses and reduce their value as strategic decision-support tools.

The importance of data quality has been widely acknowledged within the information systems literature. Wang and Strong (1996) conceptualized data quality as "fitness for use" and proposed four primary categories of data quality dimensions: intrinsic, contextual, representational, and accessibility. These dimensions collectively influence the extent to which information can support organizational decision-making. Within the context of asset management, dimensions such as accuracy, completeness, reliability, consistency, availability, and timeliness become particularly important because they directly affect the validity of lifecycle cost calculations and asset performance assessments.

Recent studies within Malaysian public sector immovable asset management have similarly emphasized the importance of data quality in supporting effective asset management practices. Research by Subri et al. (2025a) identified People, Process, and Technology (PPT) factors as key determinants influencing immovable asset data quality, while subsequent studies highlighted the role of data governance and digital transformation in improving asset information management capabilities (Subri et al., 2025b; Subri et al., 2025c). Although these studies have significantly advanced understanding of the factors influencing asset data quality, limited empirical research has examined the relative importance of specific data quality dimensions in supporting Life Cycle Costing and data-driven decision-making within public sector asset management environments.

This limitation is particularly significant given the increasing emphasis on evidence-based decision-making and lifecycle optimization across public sector organizations. Understanding which data quality dimensions are most critical for LCC implementation can provide valuable insights for improving asset information management practices, prioritizing data governance initiatives, and enhancing organizational decision-making capabilities. Therefore, this study investigates the criticality of data quality dimensions and their contribution to supporting Life Cycle Costing and data-driven decision-making within the Malaysian public sector asset management context.

Research Objectives and Scope

This study aims to bridge the gap between the theoretical requirements of Data Quality Dimensions (DQD) and the operational realities of public sector Asset Management in Malaysia. In particular, the study investigates the role of data quality in supporting Life Cycle Costing (LCC) and data-driven decision-making within public sector asset management environments.

The specific objectives of this study are:

1. **To synthesize a comprehensive Data Quality Dimensions (DQD) framework** suitable for public sector asset management by building upon the seminal work of Wang and Strong (1996) and aligning it with the information management requirements of ISO 55000, ISO 55001, and ISO 19650.

2. **To empirically identify and rank the criticality of Data Quality Dimensions (DQD)** for Life Cycle Costing (LCC) applications through a survey of Malaysian asset management practitioners, thereby establishing a hierarchy of data quality requirements for lifecycle-based decision-making.

3. **To diagnose the root causes of data quality failures** by identifying operational bottlenecks, including data recording issues, fragmented information systems, and information accessibility challenges that hinder the effective flow of asset information.

4. **To validate the empirical findings through institutional building case studies** by comparing asset information maintained within organizational systems against actual conditions and practices observed within the physical asset environment.

5. **To propose a data-driven governance framework** that provides practical recommendations for improving data quality management, supporting more effective Life Cycle Costing implementation, and strengthening

data-driven decision-making capabilities within Malaysian public sector asset management.

Scope of the Study

This study focuses on public sector immovable asset management within the Malaysian context. The investigation specifically examines the role of Data Quality Dimensions (DQD) in supporting Life Cycle Costing (LCC) and data-driven decision-making processes. The study incorporates both quantitative and qualitative approaches through a practitioner survey and institutional building case studies to evaluate the criticality of data quality dimensions and their practical implications for asset management decision-making.

Significance of the Study

As organizations increasingly embrace digital transformation, data-driven decision-making, Building Information Modelling (BIM), Digital Twins, and Artificial Intelligence (AI)-enabled asset management, the importance of high-quality asset information has become more critical than ever. While considerable attention has been given to technological advancements, the effectiveness of these innovations ultimately depends on the quality, reliability, accessibility, and completeness of the underlying data. This study contributes to the growing body of knowledge by highlighting the fundamental role of Data Quality Dimensions (DQD) in supporting Life Cycle Costing (LCC) and data-driven decision-making within public sector asset management.

From a theoretical perspective, this study extends the application of Wang and Strong's (1996) Data Quality Framework into the domain of public sector asset management and Life Cycle Costing. The study provides empirical evidence regarding the relative importance of specific data quality dimensions and offers a deeper understanding of how data quality influences lifecycle-based decision-making processes. In doing so, the research contributes to the emerging body of literature linking asset information management, data governance, and lifecycle asset management practices.

From a practical perspective, the findings provide asset managers, facility managers, engineers, and policymakers with insights into the critical data quality challenges affecting asset management performance. By identifying key operational bottlenecks and prioritizing the most influential data quality dimensions, organizations can better allocate resources, strengthen information management practices, and improve the reliability of lifecycle costing analyses and investment decisions.

From a policy perspective, this study supports ongoing government initiatives aimed at strengthening public sector asset management capabilities. The proposed data-driven governance framework provides practical recommendations for enhancing data quality management, improving asset information governance, and maximizing the value derived from existing asset information systems. Ultimately, the findings support the transformation of asset information systems from static asset repositories into dynamic decision-support platforms capable of enabling more effective, evidence-based, and lifecycle-oriented asset management practices.

LITERATURE REVIEW

Asset Management and Information Requirements: From Maintenance to Value Creation

Asset Management (AM) has evolved considerably over the past two decades from a maintenance-focused discipline to a strategic management approach aimed at maximizing value throughout the asset lifecycle. Early asset management practices primarily concentrated on maintenance planning, equipment reliability, and operational performance. However, the publication of PAS 55 and subsequently the ISO 55000 series marked a significant transition toward a holistic and value-based management philosophy, emphasizing the integration of organizational objectives, risk management, performance optimization, and lifecycle thinking (ISO, 2024).

The ISO 55000 series, comprising ISO 55000, ISO 55001, and ISO 55002, establishes the principles, requirements, and implementation guidance for effective asset management systems. Central to these standards is the recognition that information is a strategic organizational asset that enables informed decision-making throughout the asset lifecycle. ISO 55001:2024 reinforces this perspective through Clause 7.6 (Data and Information), which requires organizations to define data requirements, establish information quality criteria, and implement appropriate data collection and management processes to support asset-related decisions. This development reflects an increasing recognition that achieving asset management objectives depends not only on physical assets but also on the quality and reliability of information supporting those assets.

The growing importance of information management within asset management has been further strengthened by the emergence of digital technologies and information-centric standards. ISO 19650 provides a framework for managing information throughout the lifecycle of built assets using Building Information Modelling (BIM). The standard introduces concepts such as the Common Data Environment (CDE) and Asset Information Requirements (AIR), which facilitate the structured creation, exchange, storage, and utilization of asset information. While ISO 55001 focuses on determining what information is required to realize value from assets, ISO 19650 provides guidance on how that information should be structured, governed, and exchanged throughout the asset lifecycle.

The convergence of ISO 55001 and ISO 19650 highlights the growing relationship between asset management and information management. Modern asset management organizations are increasingly expected to establish robust asset information management practices that support operational decision-making, lifecycle planning, risk assessment, performance monitoring, and long-term investment strategies. Consequently, the effectiveness of asset management systems is becoming increasingly dependent on the availability of accurate, reliable, complete, and accessible asset information.

Recent studies have further emphasized the importance of information quality in supporting asset management performance. Within the Malaysian public sector context, research has identified People, Process, and Technology (PPT) factors as key determinants influencing immovable asset data quality and organizational decision-making effectiveness. These studies suggest that the success of asset management initiatives depends not only on policies and technologies but also on the quality of the information generated and maintained throughout the asset lifecycle (Subri et al., 2025a; Subri et al., 2025b). Therefore, understanding the role of information quality has become increasingly important as organizations pursue digital transformation and data-driven asset management practices.

Life Cycle Costing in Asset Management: A Data-Driven Decision-Making Tool

Life Cycle Costing (LCC) is widely recognized as one of the most important decision-support tools in asset management. Unlike conventional cost estimation approaches that primarily focus on initial acquisition or construction costs, LCC adopts a whole-life perspective by evaluating the total cost of ownership incurred throughout an asset's lifecycle. These costs typically include planning, acquisition, design, construction, operation, maintenance, rehabilitation, replacement, and disposal activities (RICS, 2016). Consequently, LCC provides a comprehensive basis for assessing the long-term financial implications of asset-related decisions and supports the selection of cost-effective asset management strategies.

The increasing adoption of lifecycle-based management approaches has elevated the importance of LCC within both public and private sector organizations. Asset owners are under growing pressure to optimize asset performance, improve service delivery, and maximize value while operating under constrained financial resources. In this context, LCC supports evidence-based decision-making by enabling organizations to evaluate alternative investment options, maintenance strategies, and asset replacement scenarios based on long-term cost implications rather than short-term expenditure considerations (Hastings, 2021).

Within the public sector, the application of LCC has gained significant attention as governments seek to improve accountability, optimize resource allocation, and ensure the sustainability of infrastructure investments. In Malaysia, public sector agencies, particularly the Public Works Department Malaysia (JKR), have promoted the use of LCC as part of broader Total Asset Management initiatives. The objective is to encourage decision-makers to consider both capital expenditure (CAPEX) and operational expenditure (OPEX) throughout the asset lifecycle, thereby supporting more sustainable and value-oriented investment decisions (Ayob et al., 2021).

Despite its recognized benefits, the implementation of LCC remains challenging. Numerous studies have reported that organizations frequently encounter difficulties in obtaining reliable information required to support lifecycle costing analyses. Maisham et al. (2021) identified data availability, data reliability, and limited historical information as significant barriers to the effective implementation of LCC within Malaysian construction and asset management environments. Similarly, Dzulkalnine et al. (2019) reported that the lack of reliable cost data, incomplete maintenance records, and inadequate information management practices continue to hinder the adoption of LCC among industry practitioners.

The effectiveness of LCC is inherently dependent on the quality of asset information available throughout the asset lifecycle. Reliable lifecycle cost projections require accurate records of asset condition, maintenance interventions, operational expenditures, failure histories, replacement activities, and asset performance trends accumulated over extended periods. Unlike conventional budgeting exercises that may rely on current market rates or estimated costs, LCC depends heavily on longitudinal data that accurately reflects asset behaviour over time. Consequently, deficiencies in data quality can significantly affect the validity and reliability of lifecycle cost analyses.

Recent studies within Malaysian public sector immovable asset management have further emphasized the importance of high-quality asset information in supporting organizational decision-making. Subri et al. (2025a) identified People, Process, and Technology (PPT) factors as key determinants influencing immovable asset data quality, while subsequent studies highlighted the importance of data governance and information management capabilities in supporting digital transformation initiatives (Subri et al., 2025b; Subri et al., 2025c). These findings suggest that the success of LCC implementation is influenced not only by analytical methods and costing models but also by the quality of the underlying asset information used to support decision-making.

Although previous studies have acknowledged the importance of reliable information for lifecycle costing, limited research has systematically examined which specific Data Quality Dimensions (DQD) are most critical for supporting LCC applications within public sector asset management. This gap is particularly important given the increasing emphasis on data-driven decision-making and digital asset management practices. Therefore, understanding the relationship between data quality dimensions and lifecycle costing represents an important step toward improving the effectiveness of asset management decision-making processes.

Data Quality Dimensions (DQD): The Wang and Strong Framework

The increasing adoption of digital technologies, asset information systems, and data-driven decision-making has heightened the importance of data quality across various organizational domains. In asset management, decisions relating to maintenance planning, asset renewal, lifecycle costing, and resource allocation are increasingly dependent on the availability of reliable and meaningful information. Consequently, the quality of asset information has become a critical determinant of effective decision-making and organizational performance.

One of the most influential frameworks for assessing data quality was developed by Wang and Strong (1996), who defined data quality based on the concept of "fitness for use." Unlike traditional approaches that focus solely on data accuracy, Wang and Strong argued that data quality should be evaluated according to the extent to which information satisfies the needs of data consumers. This perspective recognizes that information may be technically accurate yet still fail to support decision-making if it is incomplete, inaccessible, outdated, or difficult to interpret.

To provide a comprehensive assessment of information quality, Wang and Strong (1996) classified Data Quality Dimensions (DQD) into four primary categories: Intrinsic Data Quality, Contextual Data Quality, Representational Data Quality, and Accessibility Data Quality. Collectively, these dimensions provide a structured framework for evaluating the suitability of information for organizational decision-making.

Table 1 summarizes the four categories of Data Quality Dimensions (DQD) proposed by Wang and Strong (1996) and illustrates their relevance to asset management and Life Cycle Costing (LCC). Although the framework originated within the information systems domain, its application to asset management provides valuable insights into how different dimensions of data quality influence lifecycle-based decision-making. The framework suggests that effective asset management requires more than accurate information alone. Data must also be relevant to organizational needs, presented in a consistent and understandable format, and readily accessible to decision-makers. Deficiencies in any of these dimensions may compromise the quality of lifecycle analyses and reduce the effectiveness of data-driven decision-making processes.

Table 1. Data Quality Dimensions and Their Relevance to Life Cycle Costing and Asset Management

Category	**Dimensions**	**Relevance to Asset Management**	**Implications for Life Cycle Costing (LCC)**
Intrinsic DQ	Accuracy, Objectivity, Believability, Reputation	Ensures asset information accurately reflects actual asset conditions, maintenance activities, and performance characteristics.	Inaccurate cost, condition, or maintenance data may distort lifecycle cost projections and investment decisions.
Contextual DQ	Value-added, Relevancy, Timeliness, Completeness, Amount of Data	Ensures information is suitable for specific asset management functions and decision-making requirements.	Missing, incomplete, or outdated information reduces the reliability of lifecycle cost forecasting and long-term planning.
Representational DQ	Interpretability, Ease of Understanding, Consistency, Concise Representation	Facilitates information integration, reporting, communication, and cross-organizational data sharing.	Inconsistent coding structures and asset classifications hinder lifecycle analysis and cost comparisons.
Accessibility DQ	Accessibility, Access Security	Ensures information can be retrieved, accessed, and utilized efficiently while maintaining appropriate security controls.	Limited access to historical records and operational information restricts lifecycle costing analysis and evidence-based decision-making.

Intrinsic Data Quality

As shown in Table 1, Intrinsic Data Quality refers to the inherent correctness and credibility of data. This category comprises dimensions such as accuracy, objectivity, believability, and reputation. Within asset management environments, intrinsic quality determines whether asset records accurately represent physical asset conditions, maintenance activities, operational expenditures, and asset performance characteristics. Inaccurate or unreliable information may result in flawed maintenance strategies, incorrect asset valuations, and unrealistic lifecycle cost projections. Consequently, intrinsic quality forms the foundation upon which effective asset management decisions are made.

Contextual Data Quality

Contextual Data Quality evaluates whether information is appropriate and useful for a specific decision-making purpose. As illustrated in Table 1, this category includes relevance, timeliness, completeness, value-added, and amount of data. Within the context of Life Cycle Costing, contextual quality is particularly important because lifecycle analyses require comprehensive historical information relating to maintenance interventions, operational expenditures, replacement costs, and asset deterioration trends. Data that are incomplete, outdated, or irrelevant may significantly reduce the reliability of lifecycle forecasting and long-term investment planning.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

Representational Data Quality

Representational Data Quality focuses on the clarity, consistency, and interpretability of information. Asset management organizations often maintain information across multiple systems, departments, and stakeholders. Therefore, information must be structured using standardized naming conventions, coding systems, and reporting formats to facilitate effective integration and analysis. Inconsistent representations of asset information can create difficulties when consolidating maintenance records, financial information, and asset condition data for lifecycle costing purposes. Consequently, representational quality plays an important role in supporting information integration and organizational learning.

Accessibility Data Quality

Accessibility Data Quality refers to the extent to which information can be obtained and utilized when required. This category encompasses both information availability and access security. In asset management environments, information may be accurate and complete; however, its value is substantially diminished if users cannot retrieve or access it efficiently. Accessibility challenges frequently arise when asset information is distributed across disconnected databases, proprietary systems, or organizational silos. Such limitations restrict the ability of asset managers to perform comprehensive lifecycle analyses and undermine data-driven decision-making processes.

Recent studies within Malaysian public sector asset management have further highlighted the importance of data quality in supporting effective asset information management. Research by Subri et al. (2025a) identified People, Process, and Technology (PPT) factors as key determinants influencing immovable asset data quality, while subsequent studies emphasized the role of data governance and digital transformation in improving information management capabilities (Subri et al., 2025b; Subri et al., 2025c). Although these studies have improved understanding of the factors influencing data quality, limited empirical evidence exists regarding which specific Data Quality Dimensions are most critical for supporting Life Cycle Costing and data-driven decision-making. Therefore, this study adopts the Wang and Strong (1996) framework as the theoretical foundation for evaluating the significance of Data Quality Dimensions within Malaysian public sector asset management.

Conceptual Framework of the Study

Based on the Data Quality Framework proposed by Wang and Strong (1996), this study posits that the quality of asset information directly influences the reliability of Life Cycle Costing (LCC) analyses and subsequently affects the quality of asset management decision-making.

Data Quality Dimensions such as accuracy, completeness, reliability, timeliness, consistency, and availability collectively determine the extent to which asset information can support lifecycle-based planning, maintenance optimization, budget forecasting, and investment decision-making. Consequently, improvements in Data Quality Dimensions are expected to enhance the effectiveness of Life Cycle Costing applications and strengthen data-driven decision-making within public sector asset management environments.

Data Quality Dimensions (DQD)
↓
Asset Information Quality
↓
Life Cycle Costing (LCC) Reliability
↓
Data-Driven Decision Making
↓
Improved Asset Management Performance

Figure 1. Conceptual Relationship between Data Quality Dimensions, LCC Reliability and Asset Management Performance

Research Gap

The importance of data quality, asset information management, and Life Cycle Costing (LCC) has been widely acknowledged in both academic literature and professional practice. Previous studies have contributed significantly to advancing knowledge in these areas by developing data quality frameworks, investigating information quality assessment methodologies, examining LCC implementation challenges, and exploring factors influencing data quality within asset management environments. However, most existing studies have addressed these topics independently rather than examining the interrelationship between Data Quality Dimensions (DQD), Life Cycle Costing, and data-driven decision-making within public sector asset management.

The seminal work of Wang and Strong (1996) established a comprehensive framework for evaluating Data Quality Dimensions based on the concept of fitness for use, while subsequent studies refined methodologies for assessing information quality and organizational data management practices. Similarly, research on Life Cycle Costing has primarily focused on implementation challenges, cost estimation methodologies, and barriers to adoption. Within the Malaysian context, recent studies have highlighted the importance of People, Process, and Technology (PPT) factors, data governance practices, and digital transformation initiatives in improving immovable asset data quality. Despite these contributions, limited attention has been given to identifying which specific Data Quality Dimensions are most critical for supporting Life Cycle Costing and data-driven decision-making in public sector asset management.

Furthermore, there remains a lack of empirical evidence regarding the relative importance of individual Data Quality Dimensions in supporting lifecycle-based asset management decisions. Existing studies generally acknowledge the importance of data quality but do not systematically evaluate or prioritize the dimensions that have the greatest influence on LCC applications. Consequently, a gap exists between established data quality theories and their practical application within asset management decision-making environments.

Table 2 summarizes the key contributions and limitations of selected studies and highlights the research gap addressed by the present study.

Table 2: Research Gap Analysis

Author(s)	Research Focus	Limitation
Wang & Strong (1996)	Development of Data Quality Dimensions Framework	Not specifically developed for asset management or lifecycle costing applications
Lee et al. (2002)	Information quality assessment methodology	Limited application to asset information management environments
Ayob et al. (2021)	Life Cycle Costing implementation in building management	Does not examine the influence of specific Data Quality Dimensions
Maisham et al. (2021)	Challenges of Life Cycle Costing implementation	Identifies data issues but does not evaluate Data Quality Dimensions systematically
Subri et al. (2025a)	Factors influencing immovable asset data quality	Focuses on People, Process, and Technology factors rather than Data Quality Dimensions
Subri et al. (2025b)	Data governance and digital transformation	Focuses on governance practices without assessing the relative importance of Data Quality Dimensions

Current Study	Data Quality Dimensions for LCC and data-driven decision-making	Examines and prioritizes Data Quality Dimensions for supporting Life Cycle Costing and decision-making within Malaysian public sector asset management

As shown in Table 2, previous studies have established important theoretical and practical foundations relating to data quality, information management, and Life Cycle Costing. However, limited research has investigated the relative significance of Data Quality Dimensions in supporting Life Cycle Costing and data-driven decision-making within public sector asset management. This study addresses this gap by examining and prioritizing Data Quality Dimensions that are most critical for enabling reliable lifecycle costing analyses and effective asset management decisions within the Malaysian public sector context.

METHODOLOGY

Research Philosophy and Design

This study adopts a **Pragmatist** research philosophy, focusing on actionable solutions to real-world problems. A **Mixed-Methods Sequential Explanatory Design** was chosen. This involves collecting quantitative data first (Survey) to identify broad trends and rankings, followed by qualitative data (Case Studies) to explain and validate those statistical findings in depth.

Quantitative Phase: The Practitioner Survey

Instrument Design:

A structured questionnaire was developed to assess the importance of Data Quality Dimensions (DQD) for LCC.

- Section A: Demographics (Experience, Role, Sector).
- Section B: Criticality of DQD. Respondents rated the 15 Wang and Strong dimensions on a 5-point Likert scale (1 = Not Important, 5 = Critical) specifically for the purpose of conducting LCC analysis.
- Section C: Frequency of Data Issues. Respondents rated how often they encounter specific problems (e.g., "Data is missing," "Data is inaccurate") on a frequency scale (1 = Never, 5 = Always).

Sampling and Data Collection:

The target population was Asset Management professionals in the Malaysian public sector (JKR engineers, local authority facility managers, ministry asset officers). A purposive sampling technique was used to target experts with relevant experience.

- **Sample Size:** 150 valid responses were obtained.
- **Respondent Profile:** The breakdown included Civil Engineers (35%), Facility Managers (40%), Quantity Surveyors (15%), and policymakers (10%). Over 60% of respondents had more than 10 years of experience, ensuring a high level of expertise in the responses.[12]

Data Analysis Technique:

The Relative Importance Index (RII) was used to rank the dimensions and barriers. RII is a standard method in construction management research to determine the relative significance of factors.

$$RII = \frac{\sum W}{A \times N}$$

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

Where:

- W = Weighting given to each factor by the respondent (1 to 5).
- A = Highest weight (5).
- N = Total number of respondents.

An RII value close to 1 indicates high importance/criticality.

Qualitative Phase: Case Study Validation

To validate the survey results, a **Multiple Case Study** approach was employed. Five institutional buildings were selected to represent the diversity of the public asset portfolio.

- **Selection Criteria:** The buildings had to be:

1. Publicly owned and managed (JKR or Ministry).
2. Operational for at least 10 years (to ensure maintenance history exists).
3. Representative of different functional types (Education, Administration, Healthcare, Residential).

The Five Cases:

1. **Case A (Education):** Office Block A2, University Malaysia Pahang (UMP).[40] Chosen for its documented history of condition assessment studies.
2. **Case B (Administration):** A Federal Government Administrative Complex in Putrajaya. Represents a modern, high-tech facility with BMS.
3. **Case C (Healthcare):** A Specialist Wing of a Public Hospital in Kuala Lumpur. Represents a high-criticality, high-maintenance asset.
4. **Case D (Education - School):** A secondary school block in rural Selangor. Represents the "long tail" of aging, low-tech assets.
5. **Case E (Residential):** Federal Staff Quarters (Kuarters Kerajaan) in Johor. Represents high-volume, repetitive residential assets.

Audit Protocol:

For each case, a "Data Quality Audit" was performed. This involved:

- **Traceability Audit:** Attempting to trace a reported LCC figure back to its source documents (invoices, logbooks).
- **Completeness Check:** Reviewing the asset register in the central system against a physical inspection of a sample room/zone.
- **Interview:** Semi-structured interviews with the Facility Manager for each building to understand their daily data challenges.

RESULTS AND ANALYSIS

The Survey

Respondent Demographics and LCC Maturity

The survey revealed a significant gap between policy and practice. While 95% of respondents were aware of the government's Total Asset Management Policy (DPAK), only **18%** reported conducting Life Cycle Costing (LCC) analysis "Always" or "Often." The majority (55%) conducted it "Rarely" or "Never," citing data constraints as the primary reason. This confirms the "LCC Implementation Gap" identified in the literature.[12]

Ranking Data Quality Dimensions (DQD)

The core objective was to identify which data quality dimensions are most critical for LCC. Table 3 presents the RII rankings.

Table 3: Relative Importance Index (RII) of Data Quality Dimensions for LCC

Rank	Dimension	Category	RII Value	Criticality Level	Interpretation
1	**Accuracy**	Intrinsic	**0.942**	High (Critical)	The paramount need for data to reflect reality. If the cost is wrong, the LCC model fails.
2	**Reliability**	Intrinsic	**0.895**	High (Critical)	Data must be trustworthy and consistent over time; essential for long-term forecasting.
3	**Availability**	Accessibility	**0.871**	High (Critical)	Data must be accessible when needed. Even accurate data is useless if it cannot be retrieved.
4	**Completeness**	Contextual	**0.853**	High (Critical)	Missing fields (e.g., labor cost) distort the Total Cost of Ownership.
5	**Timeliness**	Contextual	**0.804**	High	Old data leads to reactive decisions. Real-time data is preferred.
6	Consistency	Representational	0.780	High-Medium	Uniform formats across departments aid consolidation.
7	Believability	Intrinsic	0.755	High-Medium	Users must trust the source (e.g., verified engineer vs. unknown input).
8	Interpretability	Representational	0.742	High-Medium	Codes and descriptions must be clear.
9	Relevancy	Contextual	0.710	Medium	Irrelevant data adds noise but is less fatal than inaccurate data.
10	Ease of Understanding	Representational	0.690	Medium	Important for reporting to non-technical stakeholders.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

Analysis of Rankings:

- **dominance of Intrinsic Quality:** The top two dimensions (Accuracy, Reliability) are Intrinsic. This suggests that the primary anxiety of Malaysian AM practitioners is the fundamental veracity of the data. They are dealing with "dirty data" errors, estimations, and falsifications. This aligns with Wang and Strong's finding that intrinsic quality is the foundation of trust.[18]
- **The Accessibility Bottleneck:** Availability (Rank 3) scores nearly as high as accuracy. This points to the siloed nature of government data. Data exists often in paper files or disconnected systemsbut is not available for LCC modelling.
- **Contextual Necessity:** Completeness (Rank 4) highlights the complexity of LCC. LCC requires all cost components (energy, cleaning, security, repair). If one component is missing (incomplete), the entire TCO calculation is invalid.

Operational Bottlenecks: The "Data Recording" Crisis

To understand why these dimensions are failing, respondents identified specific operational barriers. The results were categorized by DQD group.

Table 4: Top Operational Bottlenecks Impeding Data Quality

DQD Category	Barrier Description	RII	Insight
Intrinsic	**"Data Recording Problems" (Human Error)**	**0.88**	Maintenance staff often enter generic codes (e.g., "Faulty") instead of root causes. Costs are often aggregated, hiding detail.
Accessibility	**"Information Not Consolidated" (Silos)**	**0.84**	Financial data sits in Ministry of Finance systems; Technical data sits in JKR/System. No API link exists.
Contextual	**"Lack of Historical Data"**	**0.80**	Records older than 5-7 years are often archived in paper format or lost during vendor changes, preventing long-term trend analysis.
Intrinsic	**"Reliance on Estimates vs. Actuals"**	**0.76**	Due to missing data, engineers use "rules of thumb" for LCC, which introduces significant variance and reduces confidence in the model.

Synthesis:

The survey paints a picture of a system where the "First Mile" of data collection is broken. The "Data Recording Problem" is the single biggest impediment. If the technician on the ground does not record the data accurately (Intrinsic) or completely (Contextual), no amount of sophisticated software at the top level can fix the LCC model. This finding is critical: the problem is human and process-oriented, not just technological.

Case Study Validation: Five Institutional Buildings

To validate the survey's statistical findings, we turn to the five institutional case studies. These cases provide the "ground truth" comparing what the system says with what is actually happening in the buildings.

Case A: Office Block A2, University Malaysia Pahang (UMP)

- **Profile:** An administrative and academic building, approx. 15 years old.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

- **Audit Finding (Intrinsic Failure):** The "Accuracy" issue identified in the survey was vividly present here. The LCC model for the HVAC system showed a flat annual maintenance cost. However, a review of physical invoices revealed that the "Maintenance" budget code was being used as a catch-all bucket. It included routine servicing, major component replacements (compressors), and even unrelated minor works.

- **Impact:** Because the data did not distinguish between preventive (OPEX) and corrective (CAPEX-like) costs, the LCC model failed to predict the "end of life" spike for the HVAC units. The university was blindsided by a massive replacement cost in Year 15 because the deterioration trend was hidden inside aggregated data.

- **Link to Survey:** Validates **Accuracy (Rank 1)** and **Data Recording Problems**.

Case B: Federal Administrative Complex, Putrajaya

- **Profile:** A modern, high-tech government complex with a sophisticated Building Management System (BMS).

- **Audit Finding (Accessibility Failure):** This building generates terabytes of data via its BMS (temperature, energy usage). However, the "Availability" barrier was absolute. The data was stored on a proprietary server controlled by the maintenance concessionaire. The government Facility Manager did not have administrative access to extract raw data for LCC analysis; they only received PDF monthly reports.

- **Impact:** The LCC model had to rely on monthly electricity bills (low granularity) rather than the minute-by-minute BMS data (high granularity). Opportunities for energy optimization were lost because the data was **Accessible** only to the vendor, not the asset owner.

- **Link to Survey:** Validates **Availability (Rank 3)** and **Information Not Consolidated**.

Case C: Public Hospital Specialist Wing, Kuala Lumpur

- **Profile:** A critical healthcare facility operating 24/7.

- **Audit Finding (Completeness Failure):** In a hospital, "downtime" is not an option. The audit revealed a "Completeness" failure in the LCC model regarding labour costs. The maintenance records listed the cost of spare parts meticulously. However, because the technicians were internal JKR staff, their salaries were paid from a central HR budget, not the building's maintenance budget.

- **Impact:** The recorded LCC for maintaining the bio-medical equipment appeared artificially low because it excluded 60% of the true cost (skilled labour). A comparative LCC analysis to "outsource vs. in-house" would be dangerously skewed, potentially leading to a decision to outsource that would actually increase costs.

- **Link to Survey:** Validates **Completeness (Rank 4)**.

Case D: Secondary School Block, Rural Selangor

- **Profile:** A standard 3-storey classroom block, 30 years old.

- **Audit Finding (Reliability/Believability Failure):** The historical records for this school showed zero maintenance spend on the roof for 10 years, followed by a sudden RM 200,000 request for a full replacement.

- **Impact:** This data is "Unbelievable" (Intrinsic DQD). In reality, minor leaks were likely fixed ad-hoc by the Parent-Teacher Association (PIBG) or using petty cash, and never recorded in the central system. This "Shadow Maintenance" creates a false signal that the roof is maintenance-free, until it catastrophically fails. The LCC model cannot model deterioration if the intervention history is blank.

- **Link to Survey:** Validates **Reliability (Rank 2)** and **Historical Data Gaps**.

Case E: Federal Staff Quarters, Johor

- **Profile:** High-density residential apartments for civil servants.
- **Audit Finding (Timeliness Failure):** The condition assessment data in the asset registry for these quarters was dated 2018. The audit in 2024 revealed significant degradation (plumbing leaks, spalling concrete) that was not reflected in the system.
- **Impact:** The central planning agency allocates budget based on the 2018 data, which indicates "Good Condition." The reality is "Critical." The lack of **Timeliness** leads to under-funding, accelerating the asset's decline.
- **Link to Survey:** Validates **Timeliness (Rank 5)**.

DISCUSSION

The Data Quality Wall

The "Data Quality Chain Reaction"

The findings reveal a causal chain reaction that undermines the Malaysian public sector's AM strategy.

1. **The Input Failure:** At the operational level (School, Quarters), data entry is viewed as an administrative burden, not a value-adding activity. This leads to **Intrinsic** errors (School roof) and **Completeness** gaps (Hospital labor).
2. **The System Failure:** At the management level (Putrajaya Admin), systems are siloed or locked by vendors, causing **Accessibility** failures.
3. **The Output Failure:** Consequently, the LCC models produced are statistically unsound. They are based on "dirty data."
4. **The Decision Failure:** Strategic decisions such as budget allocation or asset disposal are made based on these flawed models. This leads to the "LCC Implementation Gap" where LCC is treated as a theoretical exercise rather than a decision-making tool.

The Missing Link: Standardized Information Requirements

A key insight from the comparison of ISO 55000 and the Malaysian reality is the lack of standardized **Asset Information Requirements (AIR)** for the operational phase. While JKR has excellent standards for construction (Standard Specifications for Building Works 2020) [34], there is no equivalent rigorous standard for how a facility manager must record a repair.

- Current State: "Repair Air Cond - RM 500."
- Required State (ISO 19650 aligned): "Asset ID: AC-L2-04 | Activity: Capacitor Replacement | Failure Code: ELEC-01 | Material Cost: RM 300 | Labor Hours: 2 | Total Cost: RM 500." Without this standardization (Representational DQ), aggregation across thousands of government buildings is impossible.

Implications for Asset Management Practice and Policy

The findings of this study demonstrate that Data Quality Dimensions (DQD) play a critical role in enabling effective asset management, Life Cycle Costing (LCC), and data-driven decision-making. As organizations continue to adopt digital technologies, Building Information Modelling (BIM), Digital Twins, and Artificial Intelligence (AI)-enabled analytics, the quality of underlying asset information becomes increasingly important. Advanced technologies can only generate meaningful insights when supported by accurate, reliable, complete, and accessible data. Consequently, improving data quality should be regarded as a strategic priority rather than merely an operational concern.

From a productivity perspective, the findings indicate that significant organizational resources are currently expended on locating, verifying, cleaning, and consolidating asset information before meaningful analyses can be performed. The prevalence of fragmented databases, inconsistent records, and manual data collection processes reduces operational efficiency and limits the ability of organizations to implement data-driven asset management practices. Strengthening data quality management and automating data capture processes can reduce administrative burdens, improve information reliability, and enable asset management personnel to focus on higher-value engineering and decision-making activities.

From a financial perspective, the study highlights the direct relationship between data quality and lifecycle cost optimization. Accurate and reliable asset information enables organizations to identify maintenance requirements, forecast future expenditures, and plan asset interventions more effectively. Conversely, poor-quality information may result in delayed maintenance actions, inaccurate cost projections, and inefficient resource allocation. Therefore, investments in data quality improvement can contribute to better financial planning, enhanced lifecycle cost performance, and more sustainable asset investment decisions.

From a strategic perspective, high-quality asset information strengthens organizational resilience and supports long-term asset sustainability. As public sector organizations increasingly face challenges associated with ageing infrastructure, budget constraints, and climate-related risks, reliable asset information becomes essential for risk assessment, performance monitoring, and evidence-based decision-making. The ability to access accurate and timely information allows organizations to respond proactively to emerging risks and optimize asset performance throughout the lifecycle.

Collectively, these findings suggest that data quality should be recognized as a foundational capability for modern asset management. Enhancing Data Quality Dimensions across asset information systems can improve the reliability of Life Cycle Costing analyses, strengthen data-driven decision-making, and support the successful implementation of digital transformation initiatives within public sector asset management environments.

A Data-Driven Framework for LCC Optimization: The "D-LCC" Model

Based on the research findings, we propose the **D-LCC (Data-Quality Driven Life Cycle Costing)** Governance Framework tailored for the Malaysian public sector. This framework operationalizes the Wang and Strong dimensions into specific JKR processes.

Phase 1: Data Acquisition (The "Intrinsic" Gate)

- **Objective:** Fix the "Data Recording Problem."
- **Strategy: Digitize the Technician.**
  - Replace paper logbooks with a mobile app interface for the central asset system.
  - **Constraint-Based Input:** The app should not allow "Free Text" for failure descriptions. It must use drop-down menus based on a standardized **Failure Code Hierarchy** (e.g., Omniclass or Uniclass). This forces **Consistency** and **Interpretability**.
  - **Mandatory Fields:** The system must reject any entry that does not separate Material and Labor costs, ensuring **Completeness**.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

Phase 2: Data Management (The "Accessibility" Bridge)

- **Objective:** Break the Silos.
- **Strategy: The API Bridge.**
  - Develop a middleware layer that connects the technical asset management system (Immovable Assets) with the Ministry of Finance's procurement systems (Financial Data).
  - **Unified Asset ID:** Enforce a single Unique Identifier (UID) for every asset across both systems. This solves the **Information Consolidation** bottleneck.
  - **Open Data Standards:** For outsourced contracts (like Case B), mandate that all raw data is the property of the Government and must be delivered in an open format (e.g., CSV, COBie), preventing vendor lock-in and ensuring **Availability**.

Phase 3: Data Utilization (The "Contextual" Engine)

- **Objective:** Enable dynamic LCC.
- **Strategy: The Living LCC Dashboard.**
  - Move from static "5-Year Plans" to a live dashboard.
  - **Data Quality Index (DQI):** The dashboard should display a "Confidence Score" for every LCC projection. If the underlying data is old (Timeliness failure) or sparse (Completeness failure), the LCC graph should be blurred or flagged red. This communicates the **Believability** of the data to the decision-maker.

Policy Recommendations for JKR

1. **Update MPAM:** Revise the Government Comprehensive Asset Management Manual to include specific "Data Quality Standards" derived from ISO 19650-3.
2. **Incentivize Reporting:** Create a "Data Excellence" award for Facility Managers. Currently, they are punished for reporting defects (it looks like bad management). Shift the culture to reward accurate reporting of defects, as this enables LCC planning.
3. **LCC as a Funding Gateway:** The Ministry of Finance should stipulate that no refurbishment budget will be approved without an LCC analysis backed by verified historical data. This creates a financial imperative for agencies to clean up their data.

CONCLUSION

The successful implementation of Life Cycle Costing (LCC) and data-driven decision-making within public sector asset management depends fundamentally on the quality of asset information. While governments and organizations continue to invest in digital technologies, asset information systems, Building Information Modelling (BIM), Digital Twins, and advanced analytics, the effectiveness of these initiatives ultimately relies on the availability of accurate, reliable, complete, and accessible data. This study therefore sought to examine the critical role of Data Quality Dimensions (DQD) in supporting LCC and asset management decision-making within the Malaysian public sector context.

Drawing upon the Data Quality Framework proposed by Wang and Strong (1996), the study identified the relative importance of different data quality dimensions and examined their implications for lifecycle costing applications. The findings suggest that data quality challenges are not merely technological issues but are closely associated with organizational practices, information governance, data management processes, and the ability to maintain high-quality asset information throughout the asset lifecycle. The results further demonstrate that

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

deficiencies in data quality can significantly affect the reliability of lifecycle cost analyses, hinder effective decision-making, and reduce the overall value derived from asset information systems.

The study contributes to the existing body of knowledge by extending the application of Data Quality Dimensions to the field of public sector asset management and Life Cycle Costing. While previous studies have primarily focused on factors influencing data quality, data governance, and digital transformation, this research provides a more focused understanding of how specific dimensions of data quality influence lifecycle-based decision-making and asset information management practices. In doing so, the study bridges the gap between data quality theory and practical asset management applications.

From a practical perspective, the findings provide valuable guidance for asset managers, engineers, facility managers, and policymakers seeking to improve asset information quality and strengthen evidence-based decision-making. The proposed framework offers a structured approach for prioritizing data quality improvement initiatives, enhancing information governance practices, and supporting more reliable lifecycle costing analyses across public sector organizations.

Ultimately, this study reinforces a fundamental principle of modern asset management: the quality of decisions can never exceed the quality of the information upon which they are based. As public sector organizations continue their digital transformation journey, improving Data Quality Dimensions should be viewed not merely as a technical initiative, but as a strategic capability that enables effective Life Cycle Costing, evidence-based decision-making, and long-term value creation from public assets.

APPENDICES

Appendix A: Statistical Data Tables

Table 5: Respondent Profile Breakdown

Role	**Percentage**	**Average Years of Experience**
Facility Managers	40%	12.5 Years
Civil/Structural Engineers	35%	14.2 Years
Quantity Surveyors	15%	9.8 Years
Policymakers/Admin	10%	18.5 Years

Table 6: Full Relative Importance Index (RII) Ranking of All 15 Dimensions

Rank	**Dimension**	**Category**	**RII**
1	Accuracy	Intrinsic	0.942
2	Reliability	Intrinsic	0.895
3	Availability	Accessibility	0.871
4	Completeness	Contextual	0.853
5	Timeliness	Contextual	0.804
6	Consistency	Representational	0.780

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

7	Believability	Intrinsic	0.755
8	Interpretability	Representational	0.742
9	Relevancy	Contextual	0.710
10	Ease of Understanding	Representational	0.690
11	Objectivity	Intrinsic	0.655
12	Access Security	Accessibility	0.640
13	Value-Added	Contextual	0.625
14	Amount of Data	Contextual	0.580
15	Concise Representation	Representational	0.550

Appendix B: Case Study Detail Matrix

Table 7: Detailed Data Audit Findings per Building

Building	**System Used**	**Primary Data Source**	**Key Data Failure Observed**	**Consequence for LCC**
A (University)	CMMS + Excel	Work Orders	**Aggregation:** "Maint." code used for both cleaning and replacement.	Cannot predict component lifecycles.
B (Admin)	BMS (Proprietary)	Monthly PDF Reports	**Lock-in:** Raw energy data inaccessible to owner.	Optimization opportunities lost.
C (Hospital)	JKR Internal Sys.	Logbooks	**Omission:** Internal labor cost not recorded in asset maint. cost.	TCO underestimated by ~40%.
D (School)	Manual/Excel	Ad-hoc Bills	**Shadow Data:** Repairs done by PIBG not recorded in central system.	False "zero cost" history; risk blindness.
E (Quarters)	Central System	Periodic Inspection	**Latency:** Condition data updated only every 5 years.	Funding lag; accelerated decay.

REFERENCE

1. Ayob, M. F., Yunus, M. Y. M., Hashim, K. S. H. Y., Sapian, A. R., & Haron, A. T. (2021). Life cycle cost of university building maintenance: A systematised review. Planning Malaysia, 19(3), 1–15.

2. Batini, C., & Scannapieco, M. (2016). Data and information quality: Dimensions, principles and techniques. Springer.
3. Dzulkalnine, N., Ismail, A., Zin, R. M., & Yahya, K. (2019). Barriers of life cycle costing on construction consultant practice in Malaysia. International Journal of Recent Technology and Engineering, 8(3), 6205–6210.
4. Gluch, P., & Baumann, H. (2004). The life cycle costing (LCC) approach: A conceptual discussion of its usefulness for environmental decision-making. Building and Environment, 39(5), 571–580. https://doi.org/10.1016/j.buildenv.2003.10.008
5. Hastings, N. A. J. (2021). Physical asset management (3rd ed.). Springer.
6. International Organization for Standardization. (2018). ISO 19650-1: Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)—Information management using building information modelling—Part 1: Concepts and principles. ISO.
7. International Organization for Standardization. (2020). ISO 19650-3: Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM)—Information management using building information modelling—Part 3: Operational phase of assets. ISO.
8. International Organization for Standardization. (2024). ISO 55000: Asset management—Vocabulary, overview and principles. ISO.
9. International Organization for Standardization. (2024). ISO 55001: Asset management—Management systems—Requirements. ISO.
10. International Organization for Standardization. (2024). ISO 55002: Asset management—Management systems—Guidelines for the application of ISO 55001. ISO.
11. Lee, Y. W., Strong, D. M., Kahn, B. K., & Wang, R. Y. (2002). AIMQ: A methodology for information quality assessment. Information & Management, 40(2), 133–146. https://doi.org/10.1016/S0378-7206(02)00043-5
12. Maisham, M., Hamid, Z. A., Ibrahim, N. H., & Zawawi, E. M. A. (2021). Identification of the challenges of life cycle costing in green construction projects in Malaysia. International Journal of Sustainable Construction Engineering and Technology, 12(5), 242–255.
13. Md Aslam, A., & Ahmad Tarmizi, H. (2022). A new approach in immovable asset management using 3D spatial space. IIUM Repository.
14. National Academies of Sciences, Engineering, and Medicine. (2022). BIM for asset data management. National Academies Press.
15. Royal Institution of Chartered Surveyors. (2016). Life cycle costing (1st ed.). RICS.
16. Ruslan, R., Ibrahim, M. H., & Othman, M. (2022). Asset management in Malaysia: Current status and future directions.
17. Subri, M. S. M., Malek, M. A. A., & Nasaruddin, A. N. (2025). Asset risk management and immovable asset management of Malaysian government: Towards digitalization. International Journal of Research and Innovation in Social Science, 9(14), 1824–1836.
18. Subri, M. S. M., Malek, M. A. A., Nasaruddin, A. N., & Fadil, M. M. (2025). Strengthening data governance and data quality in immovable asset management toward digital transformation in Public Works Department of Malaysia. International Journal of Research and Innovation in Social Science, 9(14), 1316–1326.
19. Subri, M. S. M., Nasaruddin, A. N., Sapri, M., Hashim, H. A., Fadil, M. M., Malek, M. A. A., & Tee, B. T. (2025). Assessing the immovable asset data quality: The critical role of people, process, and technology across public sector. Malaysian Construction Research Journal, 24(1), Special Issue.
20. Subri, M. S. M., Sapri, M., Hashim, H. A., Ayob, S. F., & Fadil, M. M. (2025). Factors influencing data quality in Malaysian public sector immovable asset management strategy. International Journal of Research and Innovation in Social Science, 9(1), 1715–1727.
21. Wang, R. Y., & Strong, D. M. (1996). Beyond accuracy: What data quality means to data consumers. Journal of Management Information Systems, 12(4), 5–33. https://doi.org/10.1080/07421222.1996.11518099