Factors Influencing Data Quality in Malaysian Public Sector Immovable Asset Management Strategy

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ABSTRACT

Organizations with large, immovable assets, particularly in the public sector, are facing growing demands to improve efficiency and sustainability. Recent advancements in asset management strategies have intensified the need to identify optimal methods for managing engineering assets to achieve consistent, desired outcomes. The quality of immovable asset data plays a crucial role in asset management, directly impacting operational efficiency. However, while data availability is increasing, having more data does not necessarily improve the effectiveness of sustainability efforts in managing these assets. Many organizations lack a structured approach to information quality management, as the factors affecting information quality often go unrecognized. Addressing gaps in previous research, this study seeks to identify the factors that influence the quality of immovable asset information in asset management. Qualitative data were gathered through semi-structured interviews with eight industry experts in asset management. The findings from this research can guide the development of sustainable policies, strategies, and programs related to data quality, enhancing decision-making in asset management.

Keywords: Sustainability, Asset Management, Asset Information System, Immovable Asset, Data Quality

INTRODUCTION

A critical factor in an organization's success is its ability to leverage available information and knowledge effectively. Information, or data, is a crucial asset that can significantly enhance value creation and productivity. However, organizations must address several challenges to fully realize the potential of their data. To ensure data's success in driving decision-making and improving productivity, it needs to be managed efficiently and effectively, ensuring its availability when needed. Asset management plays a central role in organizational strategy, blending both technical and business processes across the enterprise to support strategic goals. Increasingly, asset management is seen as a key driver of success, as it aligns asset performance with competitive strategies [9]. It involves the planning and control of immovable asset activities within an organization, integrating strategic, operational, and tactical elements to improve asset performance in support of the organization's mission [5].

To be effective in asset management, organizations must have timely access to the right data. Without quality data (DQ), it is impossible to make accurate, well-informed decisions. The foundation of any asset management strategy lies in understanding the data associated with immovable assets and how this data interconnects [13]. Knowing what data needs to be gathered and how to structure it for decision-making is the essential first step toward building a robust asset information management strategy [12]. Moreover, poor data quality (DQ) can significantly hinder an organization's ability to make timely, informed decisions. Although public organizations are often assumed to be well-equipped to handle data, this is not always the case [16]. Additionally, having more data does not always result in better decisions [19]. In fact, poor data quality can

lead to inefficient data utilization and potentially critical mistakes in decision-making regarding immovable asset management. Data quality issues can have far-reaching consequences for the effectiveness and efficiency of both organizations and businesses [8]. The ultimate aim of data collection is to provide meaningful information that can be transformed into knowledge that adds value and enhances decision-making processes [17].

While much research on DQ has been explored across various fields such as statistics, information systems, and computer science, there has been limited attention to DQ in the asset management domain. For example, studies have explored DQ in infrastructure management in Australia [18], [14]. However, research on data quality in immovable asset management in Malaysia remains sparse, with studies often focusing on issues like asset documentation and cost management in building maintenance, rather than directly addressing data quality [20], [21], [22], [23]. This indicates a significant gap in addressing DQ in asset management in the local context.

To bridge this gap, it is essential to identify the factors that contribute to poor data quality and prioritize solutions to enhance the effectiveness of asset management services. This research aims to examine the factors influencing data quality in the management of public immovable assets in Malaysia. By focusing on government-owned building assets, this study will help government organizations identify the root causes of poor data quality, categorizing factors that impact data quality in immovable asset management. The findings will be valuable for refining existing data management policies or developing new strategies for managing immovable assets in the public sector. Given the limitations of previous studies, this research aims to build upon existing literature by identifying key factors affecting data quality. The study will employ semi-structured interviews with asset management experts to further explore these issues. The findings of this research will serve as a guide for developing asset management policies, strategies, and programs related to immovable data quality, and will highlight the importance of effective data quality management in public organizations, particularly in Malaysia.

LITERATURE REVIEW

Data quality (DQ) is vital for effective decision-making in asset management, ensuring that accurate and reliable information is available throughout the asset lifecycle. In Malaysian public immovable asset management, maintaining high DQ is crucial for efficient planning, maintenance, and policy implementation, especially given the complexity of managing assets like land, buildings, and infrastructure. However, challenges such as inadequate technology, limited human resource capacity, and poor system integration hinder the achievement of optimal data quality. Key factors influencing DQ in asset management include data accessibility, human expertise, technological infrastructure, and the establishment of clear management policies, all of which must be effectively addressed to enhance asset management practices and outcomes.

Data Quality (DQ)

Organizations increasingly rely on data to inform decision-making, aiming to reduce risk, improve efficiency, and achieve business objectives. The quality of data is crucial when it becomes a central resource in supporting organizational activities [10]. Data Quality (DQ) is fundamental to business processes, influencing every step, from data capture to decision support. Each stage can impact the final quality of the data [7]. DQ is essential for operational, tactical, and strategic decisions [6], with effective data management involving tasks that treat data as a strategic asset—encompassing organizational, technical, and conceptual tasks [20].

Achieving DQ requires overcoming various technical, organizational, and cultural barriers. Organizations may need to invest in DQ-enabling tools and professional services. Pohlmann [20] and Knightsbridge [20] predicted a $1 billion market for software and professional services in big data by 2008, reflecting the increasing attention to DQ problems. Furthermore, the McKinsey Global Institute [20] warned of a talent shortage in organizations seeking to capitalize on big data, predicting a shortage of 140,000 to 190,000 people with advanced analytical skills in the U.S. alone by 2018, alongside a need for 1.5 million managers and analysts proficient in big data utilization for decision-making. DQ is integral to all stages of the business process, from data capture to decision-making. Continuous improvement of data management practices,

including DQ management, is essential for ensuring data quality [8], [20], [19]. DQ is defined by how fit the data are for use, which relates to their ability to meet user requirements in specific contexts. A user can only assess if data are fit for use if the DQ is known and reported [18]. Olszak [18] emphasized that DQ depends not just on data collection but also on how data are processed, a view supported by Lee [20], who noted that unstructured data, collected from multiple sources, often suffers from quality degradation.

To assess DQ in an organization, it is necessary to evaluate the importance and quality of the data. This process involves defining the current state of DQ, identifying issues and dimensions, implementing DQ governance strategies, and focusing on continuous improvement [18]. According to Lee et al. [13], an organization cannot track its DQ status without proper assessment methods. Woodall et al. [19] defined DQ assessment as the process of collecting data to measure DQ, which allows organizations to determine their current data quality state and identify areas for improvement. If data inputs are not properly controlled, DQ degradation becomes apparent. Therefore, it is vital for organizations to implement DQ assessments to evaluate and diagnose the current state of DQ within their information systems. The evaluation process includes identifying the dimensions of DQ, which are then used to drive the improvement process, aligned with the organization's business strategy [18], [19].

Effective decision-making and operations depend heavily on the quality of organizational data and information [12]. Levitin and Redman [6] stressed the importance of DQ in managing information as a key organizational resource, as decisions based on high-quality data directly impact business success [16], [17], [12] and overall organizational efficiency [8], [7]. Information and data are regarded as some of the most valuable assets in organizations [14]. Thus, the global significance of DQ is evident, with substantial investments made to find effective solutions. Properly harnessed, high-quality data can lead to cost reductions, improved service delivery, greater transparency, and enhanced decision-making [9].

Data Quality in Asset Management

Data quality (DQ) has been widely studied across various disciplines, such as statistics, information systems, information quality management, and computer science [12], [13], [16], [4], [17], [19], [18], [14]. However, the application of DQ specifically in asset management has been more limited, with notable research in the Australian infrastructure industry [11], [14] and in various service and educational sectors in the United States [13], [10].

In recent years, organizations managing large immovable assets have faced increasing pressure to improve efficiency, particularly within the public sector. As a result, the development of Asset Management strategies has become essential to optimizing the management of engineering assets to achieve long-term outcomes. Most studies in Asset Management emphasize the alignment of these strategies with organizational needs, particularly in managing public assets [20], [21], [7], [14], [17], [6]. Asset management plays a pivotal role in achieving strategic objectives by meeting stakeholder needs. For organizations to maintain a competitive advantage in the global market, it is crucial to optimize asset management. Asset Management is a decision-based process that uses quantitative data to optimize returns and evaluate performance, with critical strategic decisions made throughout the asset lifecycle. Without quantitative data, an Asset Management strategy cannot be fully realized [22]. Numerous studies have explored methods to improve the efficiency and effectiveness of managing physical assets to support organizational goals [5], [21].

Asset Management is inherently data-centric. Every aspect of managing immovable assets relies on data, which serves as the critical input for decision-making at all levels of the organization. The quality of the data used directly impacts the quality of decisions made. Data enables organizations to plan, organize, and control resources efficiently. For effective asset lifecycle management, data integration is essential. The data requirements for asset management should inform how asset lifecycle planning, execution, and management are approached [11]. However, capturing lifecycle information during asset acquisition, deployment, usage, maintenance, and disposal can be challenging, and often, valuable data is lost [8]. These challenges underscore the need for improvements in the quality of data in asset management services, which can hinder organizational effectiveness if not addressed.

Organizational success is increasingly dependent on the ability to leverage high-quality data to drive performance and improve decision-making, thereby enhancing competitive advantage [22]. The foundation of operational, tactical, and strategic decision-making lies in data quality [6]. Olszak [18] highlighted that organizations' ability to capitalize on available data is crucial for success. Moreover, Ouertani et al. [8] argued that effective asset information management relies on a comprehensive set of data collection processes. These include determining the type of data to collect, the methods of collection and measurement, analyzing data in context, and interpreting and responding to insights. Such processes are vital for developing asset expertise and fostering best practices in asset management.

Despite the growing importance of data in asset management, simply accumulating more data does not guarantee effectiveness in managing engineering assets. Effective asset management requires coordinated processes across operations to ensure that decision-making is reliable and supported by accurate, timely information. Dettbarn [23] identified the necessity of integrating operational, tactical, and strategic aspects in asset management to improve the performance and effectiveness of engineering assets in supporting an organization's mission. Effective asset management is achieved when there is a clear alignment of policy goals, performance metrics, intervention criteria, and infrastructure objectives [24], [25], [26]. Jolicoeur and Barrett [5] further emphasized that asset effectiveness improves when it is aligned with organizational resources supporting the strategic direction.

Ultimately, an organization's success depends on having the right data at the right time to manage assets effectively. A core element of any Asset Management strategy understands asset data and its interconnections [22]. Identifying what information is needed and the data required generating that information is the first step toward building an effective asset information management strategy [8]. To bridge the gap in asset management, it is necessary to identify the factors contributing to poor data quality and prioritize efforts to improve data quality, thus enhancing asset management effectiveness.

Data Quality in Malaysian Public Immovable Asset Management Practices

In 2009, the Malaysian government introduced the Government Asset Management Policy and Total Asset Management Manual (TAMM) as part of an effort to enhance the quality of public service delivery, especially in relation to public immovable assets. A key objective of this policy is to optimize the value of government-owned immovable assets through a systematic asset management approach, thereby improving the delivery of services within the public sector (Government of Malaysia - TPATA, 2012). To support the implementation of TAMM, the Malaysian Public Works Department (PWD) and the Modernisation and Management Planning Unit (MAMPU) developed the Immovable Asset Management System, known as MySPATA. This database application registers immovable assets across various government ministries and departments. Alongside MySPATA, a standardized asset coding system, SKATA, was also developed to ensure uniform coding for all government-owned immovable assets [24].

The primary purpose of an asset information system such as MySPATA is to serve as a comprehensive database to assist organizations with reporting, monitoring, and controlling the management of government immovable assets. However, increasing the amount of data does not necessarily equate to improved information quality or better decision-making. As noted by Yusof [20] in her study on the MySPATA application, many users found that the data was difficult to utilize effectively. Her findings indicated that the system's implementation was still limited to the asset registration phase, with additional efforts required in training, addressing time constraints, and providing clearer policy guidance to achieve the objectives set by the policy [20]. Similarly, Abdullah et al. [21] observed that Malaysia’s ability to develop systematic asset management strategies remains in the early stages, constrained by a lack of expertise and adequate facilities.

Despite MySPATA serving as a vital asset registration database for Malaysian government immovable assets, there remains a significant need for the effective utilization of the data captured within the system. This includes addressing organizational, methodological, conceptual, and technical tasks associated with managing data as an organizational asset. According to Dewan and Storey [7], understanding the key factors affecting data quality (DQ) characteristics, setting clear DQ objectives, and adopting a systematic approach are essential to organizational success. The capabilities of the organizations managing DQ in their asset databases

significantly impact the outcomes, as these capabilities encompass the processes and skills necessary to transform inputs into valuable outputs [19], [10].

The implementation of MySPATA as a registration system for immovable assets presents an opportunity to systematically assess the quality of available asset data. This includes identifying DQ issues and examining the factors influencing DQ in Public Immovable Asset Management Strategies within the Malaysian government. To effectively manage DQ, it is critical to understand the factors that influence it. The goal of data and information collection for immovable assets is to ensure that the collected data is meaningful and can be translated into valuable knowledge, combining quality, value, and relevant information [22].

Factors Influencing Data Quality in Asset Management

Asset management is defined as the process of organizing, planning, and controlling the acquisition, care, refurbishment, and disposal of infrastructure and engineering assets. It is a systematic, structured process that covers the entire lifecycle of physical assets [24]. According to findings from the Cooperative Research Centre for Integrated Engineering Asset Management (CIEAM), achieving comprehensive asset management requires integrating human factors, technology, information management, and organizational management [15]. As shown in Figure 1, it is essential for asset management to merge technical solutions, management processes, and human factors while addressing all three areas simultaneously for optimal outcomes.

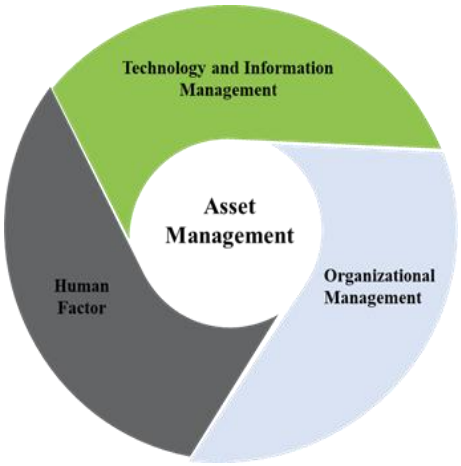

Fig. 1 Organizational dimension of asset management adopted from Laue, Brown, Scherrer, & Keast, 2014

From a strategic perspective, asset management principles should be based on aligning and optimizing an organization's resources to meet customer needs effectively and to maximize returns to stakeholders within a competitive environment [19]. Reference [1] shows that the most pressing challenges in asset management are related to knowledge management in technology and information, as well as the effective development of human resources in managing human factors.

In a similar vein, reference [6] emphasized the importance of integrating technology, processes, and resources in asset management, particularly in the petroleum industry. Key dimensions impacting asset management effectiveness include the reliability of data, tools for interpreting and transforming data into actionable information, and the role of skilled operational advisors who can utilize this information to benefit the organization. Table 2.1 outlines the process areas grouped by management dimensions, illustrating how these factors align with the integrated asset management approach [15]. Consequently, the integration of these dimensions with data quality (DQ) becomes critical for effective asset management.

Reference [10] identified a strong correlation between DQ factors and the dimensions of integrated asset management. They argue that aligning data/information needs with enabling infrastructure and business operations ensures that the organization not only meets its strategic goals but also integrates data governance into asset lifecycle management. This alignment is fundamental to making data resources a cohesive and strategic component of business operations [10]. Previous research on DQ in asset management organizations has consistently acknowledged that maintaining data quality is a significant challenge, but it is also crucial for

informed decision-making. Reference [12] and [13] presented studies examining DQ from the technological, organizational, and people perspectives. Their findings highlighted several factors influencing information

quality, which are summarized in Table I to Table IV.

The TOP model, developed by Linstone [16] and Mitroff & Linstone [17], was adopted to describe DQ requirements from a multiple-perspective approach. The model categorizes DQ factors into three perspectives:

1. **Technical Perspective (T):** Views organizations as hierarchical structures or networks of interrelationships between individuals, groups, organizations, and systems.
2. **Organizational Perspective (O):** Focuses on an organization's effectiveness and efficiency, including leadership and organizational structure.
3. **Personal Perspective (P):** Concentrates on individual concerns, such as job descriptions and job security.

Table I Dimensions of the Integrated Asset Management Organizational Approach (Laue, Brown, Scherrer, & Keast, 2014)

Asset Management Organisation		Corporate Governance
		Corporate Policy
	Organisational	Corporate Strategy
	Management	Strategic Management (Strategic Analysis Techniques)
		Innovation Management
		Financial Management (Accounting Techniques)
	Technology and Information Management	Data Management Document Management, Asset Register Information Systems Knowledge Management
		Competence Management
	Human Factors Management	Leadership Communication Organisational Culture
		Change Management

However, according to reference [9], the challenge of maintaining high DQ has been compounded by several factors. Information technology, while crucial for the collection of large volumes of data, has also inadvertently led to information quality (IQ) problems. Organizations often assume that implementing the latest software tools will improve information quality, but this can paradoxically exacerbate the issue [9].

Table II People Factor on Dq in Asset Management

	Factors influencing DQ in Asset Management (Lin, C. S. 2008)	**Information Quality Barriers (Haug et al., 2013)**	**Factors Influencing Information Quality in Asset management (S. Lin et al., 2006)**
PEOPLE	Teamwork and communication	Missing placement of responsibilities for specific types of data	Management commitment

	Performance evaluation and motivation	Lack of reward/ reprimand in relation to information quality	Training-People's skills and abilities
	Education and training	Lack of training and education of data users	Data Recording-motivation and skill levels of the personnel
	Personnel competency and experience	Lack of emphasis on the importance of information quality from manager	Communication and Management Feedback
	Data stewardship		
	Disconnect among data stakeholders		

Reference [9] further acknowledged that poor DQ in organizations is a multifaceted challenge, influenced by multiple quality barriers. These barriers have been classified into 12 types and grouped into three main categories, as outlined in Table II to Table IV.

Table III Technology Factor on Dq in Asset Management

	Factors influencing DQ in Asset Management (Lin, C. S. 2008)	**Information Quality Barriers (Haug et al., 2013)**	**Factors Influencing Information Quality in Asset management (S. Lin et al., 2006)**
TECHNOLOGY	Support of computing infrastructure resources	Lack of IT systems for data management	System Integration
	System adoption, implementation, and documentation	Lack of possibilities for input in existing IT systems	Data Access
	System integration and database synchronisation	Poor usability of IT systems	Database Synchronization
	Capability constraint of system and user interface		Data Exchange
	Data cleansing and use of DQ tools		Data Collection
	DQ monitor/control and data verification		Coding of Information
	Automated data capture		Information Technology
			Extraction of Data

Table IV Organization/ Process Factor on Dq in Asset Management

	Factors influencing DQ in Asset Management (Lin, C. S. 2008)	**Information Quality Barriers (Haug et al., 2013)**	**Factors Influencing Information Quality in Asset management (S. Lin et al., 2006)**
ORGANIZATION /	Manual/paper-based data acquisition	Lack of written information quality policies and procedures	Organizational Readiness and Business Process Reengineering
	Data input control	Lack of clarity of roles in relation to data creation, use and maintenance	Lack of Codified Business Standard

	Information supplier's quality management	Inefficient organisational procedures	Disconnect between Business and IT
	Disparate information sources	Lack of management focus on relation to information quality	
	Implementation of data standards	Lack of information quality measurement	
	Data integration		
	Large volumes of data		
	Organizational Commitment		
	DQ policies & supports		
	IT governance		

In conclusion, effective asset management relies heavily on maintaining high data quality, as it directly impacts decision-making and operational efficiency. The challenges identified in managing data quality, particularly in the context of Malaysian public immovable assets, highlight the need for improved systems, training, and policies. Addressing the factors influencing data quality, such as technology, human factors, and organizational processes, will be crucial for enhancing asset management practices and ensuring the sustainability of public assets in the long term.

RESEARCH METHODOLOGY

To investigate the factors influencing data quality (DQ) in immovable asset management, a comprehensive literature review was conducted alongside semi-structured interviews. The use of semi-structured interviews allowed for in-depth exploration of the topics and offered flexibility for follow-up questions that provided richer insights than would have been possible in structured interviews. This method enables interviewees to freely express their views while maintaining a consistent structure across all interviews, ensuring comparability of data.

For this study, the unit of analysis was asset and facility management organizations. The respondents were selected from a pool of government and industry experts in the field of asset and facility management, each with at least 10 to 15 years of experience. These professionals represented a broad spectrum of asset management, encompassing strategic, tactical, and operational domains.

Table V Experts' Background

Code	**Gender**	**Age**	**Current Position**	**Position Level**
P1	Male	47	Managing Director	Strategic
P2	Male	40	Project Manager	Tactical/ Operational
P3	Male	43	Senior Electrical Engineer	Strategic/ Tactical
P4	Male	50	Executive Director	Strategic
P5	Male	40	Senior Building Surveyor	Tactical/ Operational
P6	Male	55	Technical Expert / Director	Strategic
P7	Male	43	Senior Mechanical Engineer	Tactical/ Operational
P8	Male	39	Senior Assistant Director	Strategic

Table V provides an overview of the professional backgrounds of the experts selected for the study. A total of eight respondents from various organizations consented to participate after the purpose and scope of the research were clearly outlined. The interviews were conducted on-site, and relevant data were gathered directly from the participants through the semi-structured interview process.

The interview began with a brief introduction, explaining the objectives of the research and providing background information on the researcher. Respondents were then invited to introduce themselves and provide context about their roles and the organizations they represent in the asset and facility management sector. In many cases, this led to a discussion of existing issues or challenges related to data quality in immovable asset management. As the interview progressed, more specific questions from the interview protocol were introduced, focusing on particular aspects of the research topic.

Although the interview protocol served as a guide to ensure consistency across interviews, interviewees were encouraged to elaborate on or challenge the questions, introducing new insights. The sequence of questions was flexible and adapted according to the responses provided, allowing the interviewees to address emerging issues in their own words [5], [21]. This dynamic approach ensured a thorough exploration of all relevant topics, while maintaining the integrity and focus of the study.

RESULTS AND DISCUSSION

For data analysis, the thematic analysis procedure suggested by Braun and Clarke [4] was adapted, using their 6-Step Framework. This analysis was guided by the research questions and the primary focus of the study, aligning with Braun and Clarke's [4] approach to top-down analysis. To ensure the accuracy of the data, the researcher employed electronic aids such as mobile phone recording applications for interviews, which minimized transcription errors. Additionally, NVivo software was used to organize and manage the data effectively.

The interviews were analyzed by interpreting responses line-by-line through thematic analysis to identify themes that could explain factors affecting data collection. Thematic analysis is a process of categorizing data into patterns and themes to better understand and explain social phenomena [3]. Themes in this study were derived from the frequency and intensity of responses from operators, as well as their relevance to data quality (DQ). While these themes were generated from the data, they were also compared to existing constructs in the literature to ensure theoretical validity [19]. Based on the analysis, three key themes emerged, identifying factors affecting immovable asset DQ, along with corresponding sub-themes, as shown in Figure 2 below:

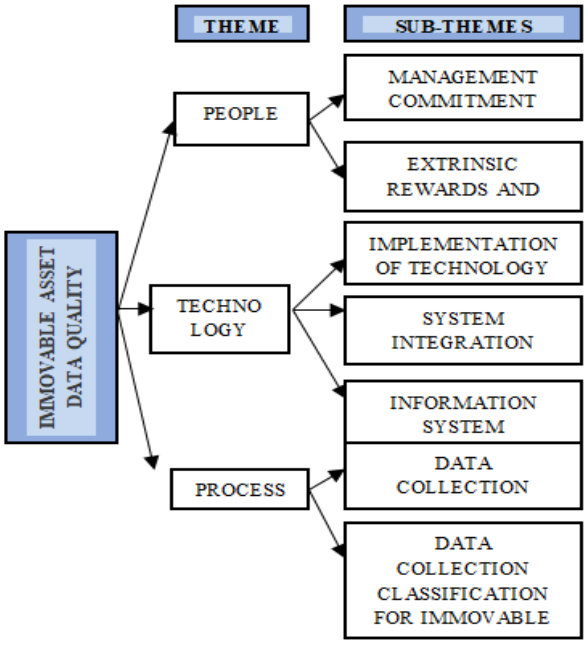

Fig 2 Key Finding of themes and sub-themes factor affecting immovable asset DQ

The findings focus on asset management from the perspectives of data accessibility, training, human factors, and resource management. Specifically, the study emphasizes that, during the asset acquisition process, all asset iXnformation necessary for ownership and operation should be transferred to the user organization at the commissioning stage in a format that can be easily integrated into the organization's asset information systems.

However, the research found a significant data gap between asset makers and users. The study identified the need to clarify user requirements, the types of data required, and the sources of this data. This observation is highlighted in the following interview extract:

"…from my point of view, establishing data quality in asset management is crucial. Currently, we are creating management systems to handle data quality, so it's important to determine if our systems can produce reliable and accurate data. This will ensure the output is beneficial."

"…in terms of data quality, there hasn't been much focus on its management and establishment. The focus is primarily on the module itself."

This finding aligns with the work of El-Akruti and Dwight [8], who stress the importance of establishing clear information flow to facilitate integration across all asset-related activities. Asset management efficiency depends on the deployment of robust data quality management processes, standards, and policies. Effective IT tools and computational techniques are required to meet DQ objectives, including record linkage, lineage, data uncertainty, semantic integrity constraints, and ensuring information trust and credibility [11].

The capabilities of an organization to manage data and ensure accessibility were found to be critical in improving organizational performance, as well as promoting data accuracy and reliability. The study suggests that establishing a reliable data collection and updating process, conducting periodic audits, and developing procedures for ensuring data accuracy are vital components for enhancing DQ.

Furthermore, the study highlights the need for comprehensive training for all personnel involved in asset management to ensure the continual improvement of data quality. The analysis emphasized the importance of the human factor in maintaining data quality, alongside critical knowledge areas. This is evident in the following interview extract:

"…in asset management, during the planning stage, officers or technical staff for facilities should have a background in knowledge. Although procedures are created by JKR, agencies face limitations in hiring technical staff, and they assign any available officer to the asset team. However, competency depends on training."

The human ability to use the systems effectively is as critical as asset management itself, as employees are key in ensuring high levels of data quality. As Dewan and Storey [7] note, the human aspect of information systems is just as crucial as the technological components to improve DQ. This is in line with Laue et al. [12], who emphasize the need to consider human factors and the management of technology to achieve comprehensive asset management.

Training should be provided to all employees to ensure they have a thorough understanding of the system and the necessary documentation and skills specific to their functional areas. The quality of data is directly impacted by the capability to assign the right tasks to the right personnel, which in turn enhances the overall process. As one participant explained:

"…support from management and technological innovations can help in managing assets and data. However, when difficulties arise, it can derail the process, especially when tasks need to be repeated, which may lead to more errors... because it becomes tedious."

The study underscores the need for training in data quality for all personnel involved in asset management, with an emphasis on human factors and critical knowledge areas. Employees' ability to use systems effectively is equally important as asset management itself, contributing significantly to the maintenance of high data quality.

Employee domain knowledge and analytical skills, as noted by Draganidis and Mentzas [9], refer to a combination of knowledge and skills that enable effective data analysis. Data alone has limited value unless it is used to enhance asset management efficiency. The ability to analyze and interpret data is crucial for generating business insights that lead to improved decision-making [22]. Many organizations have invested in data analytics tools, yet the human component required for data interpretation has not received sufficient attention.

In ensuring data quality, the organization's ability to effectively manage and organize data is paramount. The use of technology, such as asset information systems, is critical to developing comprehensive measures for asset information quality and benchmarking asset performance. Without the capability to assess the quality of their information, organizations cannot gauge the state of their organizational IQ or monitor improvements [6]. This highlights the need for tools and methods that can assess and enhance information quality [2].

The study points to the need for essential outputs to effectively manage immovable assets by analyzing asset data. The findings underscore the importance of open-source systems that allow for communication and information sharing, integrated operational control, and a central knowledge repository. Despite advances in technology, the integration of human factors, technology, and organizational management remains one of the most pressing challenges in asset management.

The Human-Technology-Organization (HTO) approach posits that humans, technology, and organizations are interdependent and collectively influence asset management processes. As Laue [12] suggests, asset management must address the integration of new technological solutions, management processes, and human factors simultaneously and equally.

CONCLUSION

The qualitative analysis of data gathered through in-depth, semi-structured interviews with asset management experts has highlighted the critical role of data quality (DQ) in the effectiveness of asset management services. It is clear that data quality should not be underestimated or neglected in asset management practices. Information should always be at the core of decision-making processes, and it is essential to ensure that decisions are based on accurate, timely, and reliable data. In asset management organizations, a commitment to continuous consultation with data will lead to better-informed decisions and optimized asset performance. By systematically assessing the available information on immovable assets, organizations can identify key factors that influence asset management outcomes. This, in turn, will reflect the overall DQ of immovable assets within the organization. The findings of this research emphasize the importance of adopting a comprehensive Human-Technology-Organization/Process (HTO/P) approach to enhance asset management practices. This approach will ensure that the right data is provided—accurate, timely, and relevant—which ultimately leads to more effective asset management services and improves organizational efficiency.

The primary objective of this research was to raise awareness of the importance of data quality, especially within the context of Malaysian public-sector immovable asset management. The study aims to motivate public-sector agencies and departments to recognize the value of high-quality data and its role in shaping information that aligns with the organization's strategic objectives. The promotion of high-quality data management is essential for driving value creation within asset management systems and for ensuring the alignment of operational activities with long-term organizational goals. The insights gained from this study can be used to refine existing data management policies or to develop new strategies and frameworks for improving immovable asset management practices. In particular, the integration of advanced data governance, technology, and human resource strategies into the asset management processes will ensure more effective decision-making and enhanced overall service delivery.

However, it is important to acknowledge that this study was limited to qualitative methods only, and its findings are based on expert opinions from a relatively small sample of public-sector practitioners. To achieve a more comprehensive understanding of data quality issues in asset management, future studies should adopt a mixed-methods approach, incorporating both qualitative and quantitative research techniques. This would provide a more holistic view of the factors affecting data quality and enable a broader generalization of the

findings across different sectors and contexts.

In conclusion, improving data quality in asset management is not just about having access to more information, but about ensuring that the information is accurate, accessible, and reliable. Organizations that prioritize data quality will be better equipped to manage their assets efficiently, reduce operational risks, and ultimately provide more value to their stakeholders.

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