Assessing the Barriers to Data Analytics Adoption in Facilities Management in Malaysia

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DOI: https://dx.doi.org/10.47772/IJRISS.2025.907000378

Received: 09 July 2025; Accepted: 17 July 2025; Published: 19 August 2025

ABSTRACT

Data analytics offers significant potential for improving decision-making and operational efficiency in facilities management (FM). However, despite its recognised benefits, the FM sector in Malaysia has been slow to adopt data analytics technologies. This study aims to identify and assess the key barriers contributing to this slow adoption. A structured questionnaire was distributed to facilities managers across Malaysia, yielding 31 valid responses. The data were analysed using frequency analysis and the Relative Importance Index (RII) method. Findings reveal that organisational inefficiency, financial constraints, and technology integration challenges are the primary barriers. Sub-barriers such as lack of staff expertise, limited budget, data quality issues, and cybersecurity concerns further compound the problem. These insights provide a foundation for strategic interventions aimed at accelerating the adoption of data analytics in FM practices in Malaysia.

Keywords: data analytics, facilities management, organisational efficiency, financial constraints, technology integration

INTRODUCTION

The proliferation of data in the digital age has transformed how organisations perceive and use information. Data analytics, which involves extracting meaningful insights from large volumes of data, is increasingly seen as a strategic tool for improving operational efficiency and decision-making. In facilities management (FM), where data is generated from building systems, maintenance operations, energy usage, and space utilisation, data analytics offers significant value in optimising service delivery.

As a result, numerous sectors have adopted data analytics to optimise their organisational processes and decision-making capabilities. This sentiment aligns with the insights by [36] highlighting the growing reliance of organisations on data analytics as a critical component of business strategy and the enhancement of decision-making processes. However, [20] argue that firms must increase their data analytics competency (the capacity of a company to successfully employ data analytics-based resources in combination with other related sources and competencies) in order to make better, more informed, and faster decisions.

The field of facilities management recognises the increasing significance of data analytics in its operations. [58] emphasised the abundance of data generated within the FM sector, encompassing various details like maintenance work specifics, job type and required skills, time spent on the job, travel time, location, site, spatial and temporal data. This diverse data landscape presents a unique opportunity for FM professionals to leverage data analytics techniques, enabling them to gain valuable insight into their operational practices. As FM holds a pivotal role in supporting the effective functioning of core businesses, the decision-making process within this field carries significant importance. [3] highlighted the competitive and complex nature of the FM industry, necessitating fact-based decision-making and analysis for survival in the industry. Several studies have highlighted the potential of data analytics as a viable solution for FM, recognising its ability to address the challenges faced by organisations. With its promising aspects, data analytics emerges as a key pursuit for

FM organisations and will be used to increase operational effectiveness in the future of facilities management [21, 59].

In addition to empowering decision-making processes, data analytics could help improve operational efficiency in numerous ways. A study by [52] found that data analytics has a positive and significant impact on organisational performance. By using data analytics in an organisation, it can help to provide organisations with meaningful insights, allowing them to make data-driven decisions and operational enhancement. For instance, predictive analytics, such as forecasting future trends, can be facilitated through data analytics and proves to be a valuable tool for organisations to derive actionable insights and improve their overall performance and efficiency [1].

Despite the growing acknowledgement of the importance of data analytics in FM, the field encounters hurdles in fully embracing this transformative approach. The FM sector often faces problems in adopting new methodologies and technologies, leading to a delay in leveraging the full benefits of transformation and technology integration. This delay can be attributed to several factors, as identified in a study by [17] in the context of sustainability in FM practices, the most significant barriers are lack of understanding, focus and commitment of management in grasping the potential and risks. [60] on the other hand stated that to reap the benefits of new technologies and remain competitive, organisations must undertake large-scale changes in the operating system, business models, and organisational structure, which renders various problems such as cost, lack of required competencies, and resistance to change. Therefore, a lot of factors could contribute to the conservative adoption of technology in the FM sector.

In recent years, the FM sector has experienced the emergence of new technologies, leading organisations across diverse industries to enthusiastically adopt and integrate them into their operations. However, despite this wave of technological progress, the FM sector has exhibited a slower uptake in fully capitalising on the immense potential offered by these advancements. Embracing technology within the FM industry can yield numerous benefits for professionals in the field, FM professionals [52] highlighted firms that employ data analytics become proactive and future-oriented, lowering client acquisition costs by 47% and increasing firm revenue by 8%. However, there is still a lack of research focused on understanding why the FM sector continues to be slow to adopt data analytics. To fill this gap, this study aims to identify the barriers that contribute to the slow adoption of data analytics in facilities management in Malaysia.

LITERATURE REVIEW

The integration of data analytics in facilities management (FM) has gained increasing attention in recent years, particularly as organisations seek to enhance operational efficiency and asset performance. Data analytics enables FM professionals to make informed decisions based on real-time data, predictive insights, and performance trends. Applications include energy management, maintenance scheduling, space optimisation, and sustainability monitoring.

Facilities Management (FM) is gaining increasing recognition as a crucial contributor to the overall effectiveness of many organisations in the world [38]. The integration of processes inside an organisation to maintain and develop the agreed services that support and increase the effectiveness of its primary activities and user conveniences is known as Facilities Management [54]. These services include building and equipment maintenance and repair, utility management such as water and energy usage, waste management and the execution of security and safety measures. Its responsibilities extend beyond mere maintenance and operations and encompass creating a comfortable environment that supports the core business, improves building occupant efficiency, optimises productivity, and cultivates a conducive atmosphere for innovation.

According to the International Facility Management Association (IFMA), FM can be defined as “an organisational function which integrates people, place, and process within the built environment with the purpose of enhancing the quality of life for individuals and improving the productivity of the core business”. It can be summarised that FM is a multidisciplinary field that includes the management of numerous components of a physical environment to guarantee optimal operation, productivity, and sustainability.

A) Technology in FM in Malaysia

Limited technology adoption has been identified as a key factor impacting the quality of FM services in Malaysia, as reported by [2]. This lack of technological integration, as stated by [4], has resulted in low service quality within the country. Therefore, it becomes crucial for FM to recognise that offering excellent service is not merely a goal but a fundamental driver for overall organisational success. The enduring demand for FM is highly consistent and important as reflected in the timeless saying, "As long as buildings exist, there will be a demand for facilities management" [37]. Given its critical role in the built environment, it is imperative to initiate necessary improvement and implement reforms within the FM sector.

The current condition of FM in Malaysia calls for a strategic and forward-thinking strategy to maximise the potential of technology. The Malaysia FM sector may improve operation efficiency, remain competitive, and satisfy the increasing needs of the built environment by embracing innovation and actively adopting technological solutions. FM in Malaysia may position itself for long-term growth and success in the digital era through collaborating, sharing expertise and being willing to embrace change. Based on a survey by [38], Hong Kong and Singapore have shown clear signs of improvement in the FM sector, whilst Malaysia shows mixed signals, with minimal visible progress and a lack of practical advancements. This emphasises the importance of Malaysia's FM sector to proactively address current gaps and accelerate the pace of technological integration. By doing so, the industry can unlock several benefits and foster major advancements in productivity, market position and overall service delivery.

B) The Role of Data Analytics in FM

The rapid expansion of data analytics tools, as well as the acceptance of the concept in the public and corporate sectors, leaves little time for academic discourse to evolve and mature [19]. Facilities management is a complex field that covers all areas of real estate, space, environmental control, health and safety, and support services [41]. To effectively manage these resources, facilities managers rely on accurate data and insights to make informed decisions and optimise operations. Data analytics is the process of evaluating large datasets to identify unseen patterns, market trends, and other business insights to improve decision-making and its connection to other data-driven technologies [29, 36, 42]. By leveraging the power of data analytics, Facilities managers may improve their ability to proactively address maintenance needs, optimise resource allocation, and offer superior service quality in a data-driven FM environment.

In today's modern era of FM, the seamless integration of data from diverse sources, including IoT devices and building systems, plays a pivotal role. The Internet of Things (IoT) represents the evolution of the internet, enabling processing devices integrated into everyday ecosystems to independently transmit and receive data [9]. Within this interconnected landscape, sensors and IoT devices continuously collect and transmit data on various aspects of facilities operations, such as energy consumption, temperature, humidity, occupancy levels, and equipment performance. This wealth of data can be analysed using advanced analytics techniques to derive valuable insights. Additionally, [11] support this by highlighting how sensors and IoT devices are connected to a smart network and therefore gain communication capabilities and are able to collect FM-related parameters in the form of Big Data. Therefore, FM practitioners can unlock the potential of this data by using the power of data analytics, enabling informed decision-making, resource optimisation, and improving facilities management outcomes.

C) Impact of Data Analytics

Data analytics has become an important tool because only valuable information is analysed and retrieved, which makes it essential for the FM sector [1]. The impact of data analytics in FM is profound and has the potential to revolutionise the way facilities are maintained. According to [47], the current technological advances in data collection and analysis of massive data sets are likely to lead to revolutionary changes in business, and society. Therefore, it could bring benefits to the organisations. [59] highlighted data analytics allow for the discovery of important information and hidden values, which may then be used to assist evidence-based decision-making. The ability to analyse data and derive actionable insights enables FM teams

to handle maintenance needs proactively, predict equipment failures, optimise energy use, and provide a better customer experience.

[46] classified data analytics into four types which are Descriptive Analytics: Organise data in visual formats, allowing for easy understanding and insights. Next, is Predictive Analytics: Utilise the available data and tell what is expected to happen in the near future. Exploratory or Discovery Analytics: This discovers a surprising relationship between parameters in large data sets. The collection and analysis of data from many sources provided the extra potential for insights and fortuitous discoveries. Lastly, Prescriptive Analytics: Based on the data acquired, opportunities to optimise solutions to current problems. In other words, the analysis advises us on what to do to achieve a goal. These analytics enable the execution of maintenance initiatives. FM teams can foresee future issues and plan maintenance tasks before problems occur. This proactive strategy reduces downtime, increases equipment lifespan, and lowers the expenses associated with reactive maintenance.

D) Adoption of Technology in FM in other countries

The integration of technology in the FM industry has become increasingly prevalent in countries all over the world. This trend may be seen in countries such as the United States, the United Kingdom, Australia, Singapore etc. Facilities Management firms in the United States, for example, have adopted technology to streamline their operations and boost productivity. This includes monitoring and maintaining equipment using computerised maintenance management systems, Internet of Things devices, and advanced analytics. Many academics have extensively discussed this topic, which has become the subject of study in recent years. This is supported by a study conducted by [52], A significant scientific output was observed in the UK, Australia and China and the findings indicate a substantial increase in the number of publications with an annual growth rate of 220.11%. This demonstrates the increasing interest and recognition of the role of technology in Facilities Management.

The implementation of technology in FM is not limited to specific countries but is a global phenomenon. A prime example of this global trend can be seen in a case study conducted by [58], which focuses on the California Institute of Technology (Caltech). In the study, Caltech revamped the structure of its FM department to incorporate data-driven decision-making processes specifically tailored for educational facilities. This transformation allowed the FM department at Caltech to improve the overall efficiency of FM on campus. Consequently, this case study serves as a compelling example of how embracing technology in FM can drive substantial improvements in operational efficiency and service quality.

Technology in the FM industry extends beyond data management and data science and encompasses a wide range of tools and solutions. Notably, technologies such as Building Information Modelling (BIM), Computerised Maintenance Management Systems (CMMS) or Building Automation Systems have found widespread use in FM. These technologies have a disruptive impact on the FM sector. BIM, for instance, is the process of creating and managing information about a building over the course of its existence [30]. In addition, many countries including the United Kingdom, Italy and Brazil have pushed for BIM adoption [44]. Whilst CMMS enables companies to manage their equipment by arranging inspections and maintenance, as well as management supervision procedures and service documentation [33]. On the other hand, BAS controls the conditions of the interior environment automatically [13] where it automates and manages vital processes within a building. In addition to that, smart cities have also been utilising technology to improve facilities management.

The concept of smart cities has also leveraged technology to improve facilities management. Cities such as Agra, Chandigarh, Vadodara, Bengaluru, and Kakinada have effectively harnessed technologies like IoT, tele-healthcare and data analytics [48]. Smart cities integrate technology, data analytics and proactive maintenance practices to create sustainable, efficient, and user-centric urban environments. Among the various technological advancements, data analytics has emerged as one of the critical components in technology that have the potential to enhance FM practices in other countries.

A well-designed data analytics strategy enables organisations to access and analyse massive amounts of data, extracting relevant and actionable insights [48]. The convergence of IoT and Data Analytics has transformed

the field of FM, allowing organisations to use real-time insights to improve decision-making and operational efficiency. For instance, in a case study conducted by [9] on Al Nabooda Chulia Facilities Management Co LLC (AN.C), the integration of IoT and data analytics has reduced management costs and improved FM performance and service quality. By leveraging data analytics, FM professionals can unlock new opportunities, promote innovation, and build sustainable and thriving built environments.

Overall, technological adoption in FM is a worldwide phenomenon with many countries recognising its transformative impact. Nations are improving operational efficiency, sustainability, and overall service quality in the FM business by embracing technologies such as Building Information Modelling (BIM), Computerised Maintenance Management Systems (CMMS) and Building Automation Systems (BAS). This ongoing global trend emphasises the widespread acceptance of technology as a critical enabler of good facilities management.

E) Barriers to the Adoption of Data Analytics in Facilities Management

The use of data analytics in facilities management has the potential to transform how businesses manage their physical assets and operations. According to a notable study undertaken by [57], the field of data science (which includes data analytics) has received little attention within the facilities management sector, despite the potential benefits that have been realised in other disciplines. This lack of emphasis on data analytics in FM can be linked to a number of factors, including a historic dependence on manual methods and a reluctance to embrace technological advances.

The list of the main barriers and sub-barriers in Table 1, presents all of the barriers from various sources. Through this comprehensive review, three main barriers and eight sub-barriers that collectively contribute to the slow adoption of data analytics in facilities management were identified. The three main barriers identified in the study are ‘technology integration’, ‘organisational inefficiency’, and ‘financial constraints’. The first main barrier is ‘technology integration’, where according to [54] there is a lack of integration of data analytics technology is due to a lack of technical support and use of analytical techniques. This integration hinders the effective implementation and utilisation of data analytics in FM. The second main barrier is ‘organisational inefficiency’ which refers to the organisational barriers that impede the adoption of data analytics in FM. These barriers include resistance to change, staff constraints and data management issues. According to [34], organisational barriers have been one of the main hindrances to the adoption of data analytics. Addressing these issues is crucial for organisations to fully realise the potential of data analytics and resulting in enhanced operational efficiency and informed decision-making processes. The third main barrier identified in the study is ‘financial constraints’. This refers to the financial challenges faced by organisations in implementing data analytics in FM. Inadequate financial resources or financial readiness to bear the costs of data analytics and implementation can result in substantial failure, which can hinder the data analytics process [7].

Eight sub-barriers that contribute to the slow adoption of data analytics were also identified. For the first main barrier ‘technology integration’, the sub-factors included are ‘software interoperability’, ‘lack of knowledge in technology’, ‘cyber security and data privacy’ and ‘data quality issues’. ‘Software interoperability’ refers to the lack of compatibility and interoperability between FM software and data analytics tools restricts the seamless integration and utilisation of data analytics in FM. This is consistent from a study by [32], the data source systems created by different vendors do not speak the same language hence the FM industry had been long troubled with interoperability issues between its diverse systems.

‘Lack of knowledge’ in technology refers to the lack of knowledge in FM that pertains to data analytics and its implementation. In line with [47] the more knowledge that is created and shared, the easier it is for an organisation to adapt new technology and more likely to survive. Moreover, organisations must also address the issue of ‘cybersecurity and data privacy’. According to [26], there is great public concern about the improper use of personal data, particularly through the linkage of data from numerous sources. In addition, buildings might be regarded as simple targets for organised criminals looking to conduct research on a company as part of a targeted attack [32]. Lastly, ‘data quality issues’ data inconsistencies, inaccuracies, and incompleteness. Inconsistent data collection and report creation led to a data gap in the process [58].

In addition to the sub-barriers under the main barrier of ‘technology integration’, several sub-barriers also fall

under the main barrier of 'organisational inefficiency'. These include 'work culture', 'lack of staff', and 'data management', each of which presents a significant barrier to the adoption of data analytics in facilities management (FM).

Firstly, work culture can act as a fundamental barrier, as it forms the backbone of organisational behaviour and influences how new initiatives, such as data analytics, are received. A resistant or traditional work culture may hinder the development of a data-driven mindset, ultimately obstructing efforts to embed analytics into FM practices [50].

Secondly, the lack of staff with adequate knowledge and skills presents a critical barrier. The shortage of data-literate professionals, particularly data scientists who can derive actionable insights from complex datasets, limits the organisation's capacity to implement and benefit from data analytics. This concern is echoed by [49], who notes the general scarcity of trained personnel with analytics expertise in the FM sector.

Lastly, data management itself is a barrier. The unstructured nature of data and the overwhelming volume in which it is generated challenge existing data processing capabilities. Traditional data management systems often struggle to keep pace with the demands of modern analytics, particularly in handling large and complex datasets [20]. Legacy systems are frequently inadequate for processing such volumes of data, further impeding analytical efforts. Without robust data management practices, ensuring data accuracy, consistency, and accessibility becomes difficult, thereby hindering effective analytics deployment in FM.

The main barrier of 'financial constraints' encompasses two key sub-barriers: 'lack of budget' and the 'high cost of purchasing and maintaining analytics systems'. These issues hinder the adoption of data analytics in FM.

TABLE 1 Main Barriers and Sub-Barriers to the Adoption of Data Analytics

References	**Main Barriers**	**Sub-Barriers**	**Description**
[6], [58], [32]	Technology integration	Software interoperability	▪ Data processing software ▪ Need to insert data manually ▪ Issues between diver systems
[22], [34], [32]		Lack of knowledge of technology	▪ Lack of competence ▪ Employees prepared knowledge ▪ Falling behind in human expertise and talents
[32], [55]		Cyber security and Data Privacy	▪ The inability to control data has consequences ▪ Strong security infrastructure
[58]		Data quality issue	▪ Inconsistency in data collection and report creation
[43], [5], [15]	Organisation inefficiency	Work culture	▪ Impact on organisation positively and negatively ▪ Resistance to early adoption of technologies ▪ Cultural change
[58], [55], [15], [6]		Lack of staff	▪ Lack of trained personnel ▪ Lack of skilled staff with analytics skills ▪ Scarce in the market ▪ Shortage of qualified individuals
[55]		Data	▪ Ability to process large datasets

		management	
[32], [58], [15]	Financial constraints	Lack of budget High cost of purchasing and maintaining analytics systems	▪ Expensive add-ons ▪ FM struggle to have financial stability

Firstly, the lack of budget remains a persistent barrier, particularly in organisations where FM is not prioritised in strategic investment. The high cost of acquiring digital infrastructure and advanced analytics technology places an additional strain on limited financial resources [31, 16]. While the expense of full system integration is acknowledged as a substantial barrier, [40] introduces a contrasting view by highlighting that flexible solutions such as "pay-as-you-go" models can mitigate financial pressure and offer a more manageable approach for organisations with constrained budgets.

Secondly, the ongoing maintenance costs of analytics systems constitute another notable barrier. Even though some systems may appear affordable at the initial stage, the long-term costs of maintaining, upgrading, and securing analytics infrastructure can be substantial [20]. These hidden or recurring costs often discourage organisations from fully committing to analytics initiatives, especially when return on investment is unclear or delayed.

In sum, the financial constraints posed by limited budgets and high ownership and maintenance costs of analytics systems represent real and tangible barriers that must be addressed to enable broader adoption of data analytics in FM. Overcoming these financial hurdles is essential for realising the transformative potential that analytics can bring to the sector.

RESEARCH METHODOLOGY

This study adopts a quantitative research approach to systematically investigate the barriers affecting the adoption of data analytics within the facilities management (FM) sector in Malaysia. The quantitative method was deemed appropriate due to its ability to capture measurable patterns, quantify respondent perceptions, and enable statistical comparison of factors. The research process involved the development of a structured questionnaire, pilot testing and reliability assessment, sampling and data collection, and statistical analysis to interpret the results.

A) Questionnaire Design and Structure

The research instrument, a structured online questionnaire, was developed based on a synthesis of past studies on digital transformation, data analytics, and facilities management. The questionnaire was divided into two major sections:

1) Part A: Perceptions of Main Barriers

This section focused on gathering respondent views regarding three overarching categories of barriers to data analytics adoption in FM:

1. Technology Integration
2. Organisational Inefficiency
3. Financial Constraints

Respondents were presented with statements reflecting each of these categories and asked to rate their level of

agreement using a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). This scale enabled the quantification of subjective opinions and facilitated comparison across responses.

2) Part B: Evaluation of Sub-Barriers

This section sought to explore the granular drivers contributing to the broader categories identified in Part A.

- Under technology integration, sub-barriers included:
  - Interoperability of software and platforms
  - Lack of knowledge and awareness of emerging technologies
  - Cybersecurity and data privacy concerns
  - Data quality and consistency issues
- For organisational inefficiency, sub-barriers addressed:
  - Resistance to change in work culture
  - Shortage of skilled and trained personnel
  - Poor data governance and management practices
- Regarding financial constraints, the sub-barriers explored were:
  - Inadequate budget allocation for digital innovation
  - High cost of purchasing and maintaining analytics systems

Each sub-barrier was presented as a specific statement and rated on the same 5-point Likert scale. This structure ensured continuity and ease of completion for respondents while also enabling detailed statistical analysis.

2) Pilot Testing and Instrument Reliability

Before full deployment, a pilot study was conducted to assess the clarity, validity, and reliability of the questionnaire. Ten FM professionals with more than five years of experience were invited to participate in the pilot phase. This is in alignment with best practices in instrument pre-testing where 5 to 15 participants are commonly considered sufficient for evaluating questionnaire clarity and face validity [12, 44]. They reviewed the draft instrument for comprehensibility, logical flow, and relevance to the FM context in Malaysia.

Feedback obtained from the pilot study led to revisions in language clarity, the reordering of some items for better logical progression, and the removal of redundant items. The refined instrument was then subjected to a reliability test using Cronbach's Alpha to measure internal consistency. Result of the reliability test is as follows:

- The main barriers (Part A) yielded a Cronbach's Alpha of 0.83
- The sub-barriers (Part B) produced a Cronbach's Alpha of 0.87

These values exceed the commonly accepted threshold of 0.70, confirming the instrument's reliability and internal coherence for each section.

3) Sampling and Data Collection

A purposive sampling technique was employed to ensure the inclusion of organisations with relevant expertise and operational experience in FM. The researchers identified 50 facilities management companies actively operating in Malaysia, based on listings from the Malaysian Association of Facilities Management (MAFM) and publicly available business directories.

Each of the 50 companies was contacted via email and invited to participate in the study. The email included an official cover letter explaining the purpose of the research, assurances of confidentiality and anonymity, and a link to the online survey platform. Follow-up reminders were sent at two-week intervals to maximise participation.

After the data collection period of six weeks, a total of 31 complete and valid responses were received. This represents a 62% response rate, which is considered robust for organisational surveys and provides a reasonable basis for exploratory analysis [39]. Although the ideal scenario would have been a full response from all 50 companies, the achieved sample size is sufficient to offer a generalisable understanding of the barriers to data analytics adoption in the FM sector within Malaysia.

4) Data Analysis Procedures

The collected data were analysed using a combination of descriptive and ranking-based statistical techniques to fulfil the study's objectives.

First, the frequency distribution of responses for each item was computed to identify dominant perceptions across the major and sub-barriers. This analysis supported the achievement of Objective 1, which was to establish the most commonly perceived barriers.

The second stage of analysis involved the use of the Relative Importance Index (RII) to rank the severity or perceived importance of each barrier. The RII provides a standardised score that reflects the relative significance of each item, based on respondent ratings. The RII was calculated using the following formula:

$$\boldsymbol{RII = \frac{\sum W}{(A * N)}}$$

Where:

RII - Relative Importance Index

W - is the weight assigned to each factor by the respondents ranging from 1 to 5; such 1 indicates the least implying (Strongly Disagree) and 5 indicates the most implying (Strongly Agree)

A - Highest weight (in this case is 5)

N - Total number of respondents

FINDINGS

The results of the analyses are as discussed below.

Part A: The Main Barriers to Data Analytics in FM

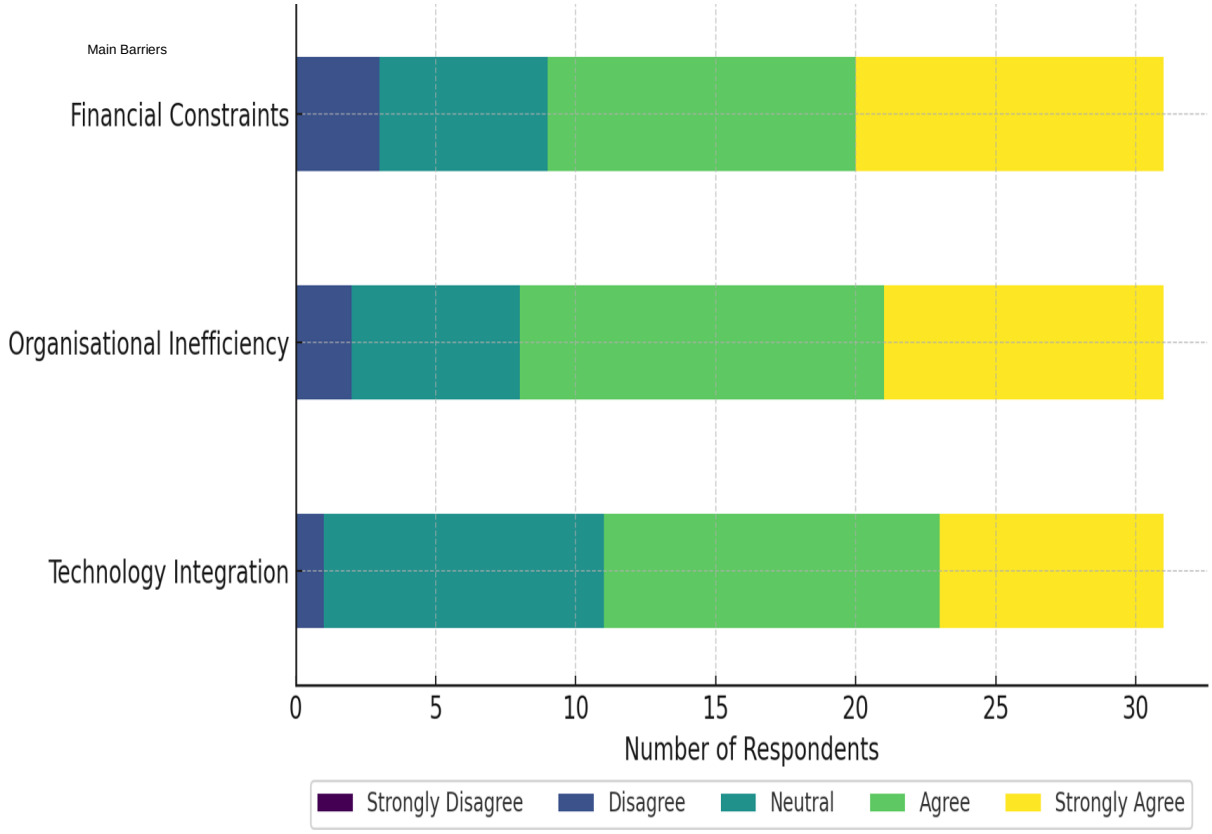

Fig 2. Level of Agreement on Main Barriers to Data Analytics Adoption in FM

TABLE 2 Ranking of Main Barriers to Data Analytics Adoption in FM

Main Barriers	RII	Rank
Technology Integration	0.7742	3
Organisational Inefficiency	0.8000	1
Financial Constraints	0.7935	2

Based on Figure 2 and Table 2, among the three main barriers, “organisational inefficiency” is considered as the most influential main barrier with an RII of 0.8000. This finding emphasises the importance of resolving organisational inefficiencies plays a significant impact in the successful deployment of data analytics. These inefficiencies might manifest resistance to change, lack of staff and data management. In previous research, the study by [7], organisational structure has been widely mentioned as one of the most significant barriers that influence the success of data analytics projects.

“Financial Constraints” with an RII of 0.7935 highlights the influence of financial considerations in impeding the broader adoption of data analytics. For organisations with limited financial resources, the costs involved with data analytics adoption, such as investing in complex technologies, training and maintenance can pose substantial challenges. This finding resonates with studies by [7] and [31], which highlight that data analytics adoption is costly and in need of a cost-conscious approach to cover the initiatives.

“Technology Integration” is the third ranked main barrier with an RII of 0.7742. This shows that the inconsistent integration of data analytics within existing organisational systems affects the adoption and wider acceptance of data analytics. Research by [61] declared that data analytics integration is one of the significant leading variables in setting the manner that would support the industry’s efficiency.

Part B: The Sub-Barriers to Data Analytics in FM

The results of the sub-barriers analyses are as follows:

1) The Technology Integration Sub-Barriers to Data Analytics in FM

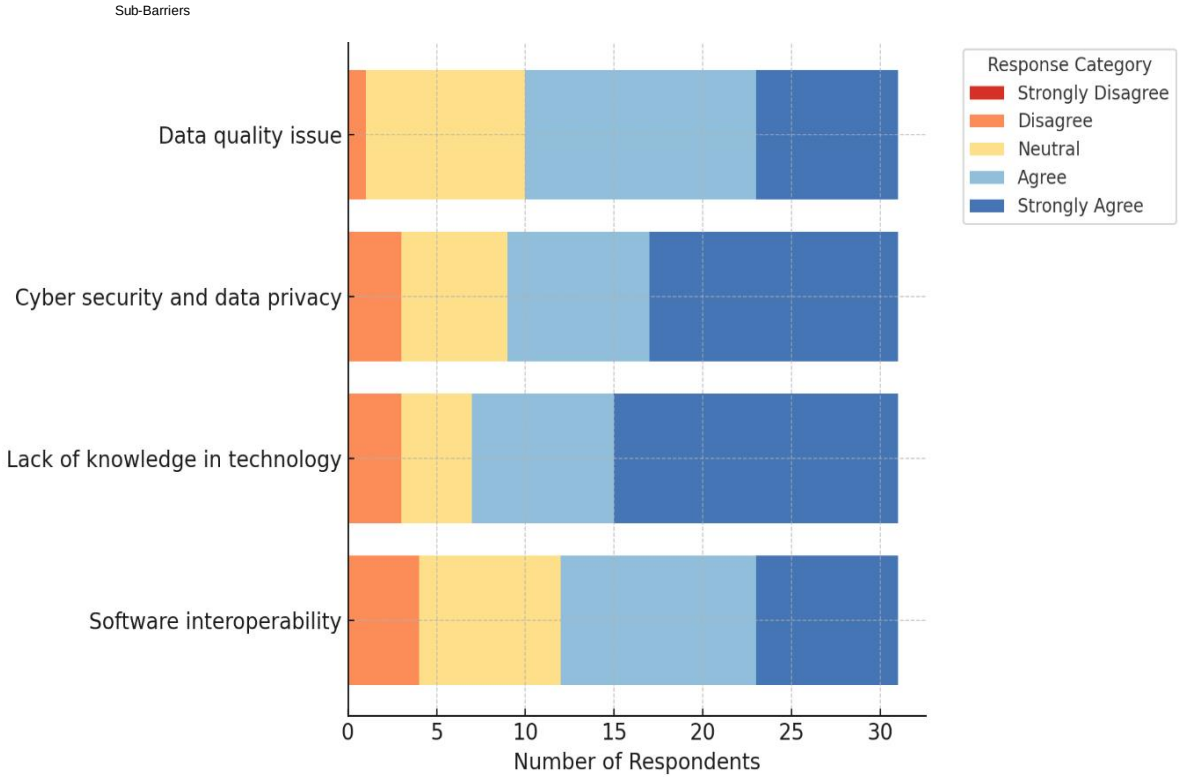

Fig 3. Level of Agreement on Technology Integration Sub-Barriers to Data Analytics Adoption in FM

TABLE 3 Ranking of Technology Integration Sub-Barriers to Data Analytics Adoption in FM

Technology Integration Sub-Barriers	RII	Rank
Software interoperability	0.7484	4
Lack of knowledge in technology	0.8387	1
Cyber security and data privacy	0.8129	2
Data quality issue	0.7806	3

The results shown in Figure 3 and Table 3 indicate that the top ranked Technology Integration sub-barrier is "Lack of knowledge in technology" with an RII of 0.8387, This shows that the technology knowledge gaps lead to the slow adoption of data analytics. According to [35] over two-thirds of skills are deemed significant in today's employment needs and one of the essential abilities is technology competencies. Addressing these knowledge gaps necessitates focused training and upskilling programmes that provide staff with the capabilities they need to use data analytics.

Meanwhile, "Cybersecurity and data privacy" with an RII of 0.8129 is the second highest rank reflecting the critical relevance of data protection and privacy considerations in moulding stakeholders' readiness to embrace data analytics. This finding also supported from past research by [51] the difficult challenge of integrating data analytics in organisations due to factors such as data security and privacy, as well as technological variety, all of which have a negative impact on its adoption.

"Data quality issue" with an RII of 0.7806 ranks third, suggesting that low data quality, though not deemed as the most substantial issue, is still seen as a deterrent to the adoption of data analytics in FM. [28] mentioned the importance of high-quality data in an organisation is to derive meaningful business outcomes. Without high-quality data, it contributes to the slow adoption of data analytics in organisations.

The sub-barrier in the fourth rank is "Software interoperability" with RII=0.7484 highlighting compatibility issues among various software systems leading to reluctance of adopting data analytics in FM. Incompatible software systems can obstruct data flow and integration, making it difficult for organisations to fully exploit data analytics.

2) The Financial Constraints Sub-Barriers to Data Analytics in FM

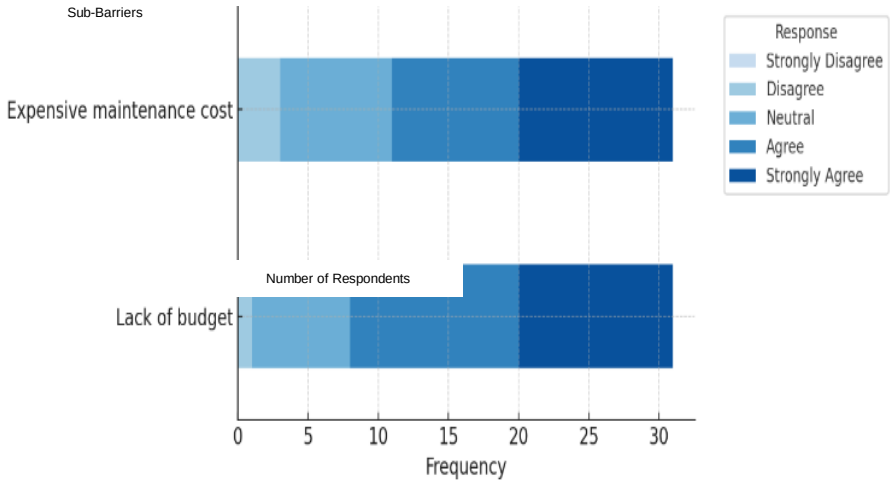

Fig 4. Level of Agreement on Financial Constraints Sub-Barriers to Data Analytics Adoption in FM

TABLE 4 Ranking of Financial Constraints Sub-Barriers to Data Analytics Adoption in FM

Financial Constraints Sub-Barriers	RII	Rank
Work culture	0.8000	3
Lack of staff	0.8194	1
Data management	0.8129	2

Figure 4 and Table 4 indicate that the "Lack of Budget" with an RII of 0.8129 is ranked as the most critical Financial Constraints sub-barrier. The critical role of finance may hinder the broader implementation of data analytics where organisations may find it challenging to allocate sufficient resources to invest in these kinds of technologies. This issue has been reported by [18] where facility managers are constantly under pressure to save cost while increasing efficiency and productivity, forcing them to balance facility requirements against financial constraints. Hence, they choose not to adopt latest technological advancements to reduce capital expenditures (CapEx).

The second ranked sub-barrier is "Expensive maintenance cost" with an RII of 0.7806. This result emphasises the influence of continuing operating expenses (OpEx) in data analytics endeavours. The high OpEx of data analytics systems and acquiring appropriate technologies may be a substantial impediment. According to [9] the budget allocation for maintenance work is shrinking year after year and as a result, managers confront challenges in carrying out maintenance tasks due to lack of funds. Since data analytics requires high maintenance services, thus many organisations opt to not implement data analytics in their organisation due to expensive maintenance costs.

3) The Organisational Inefficiency Sub-Barriers to Data Analytics in FM

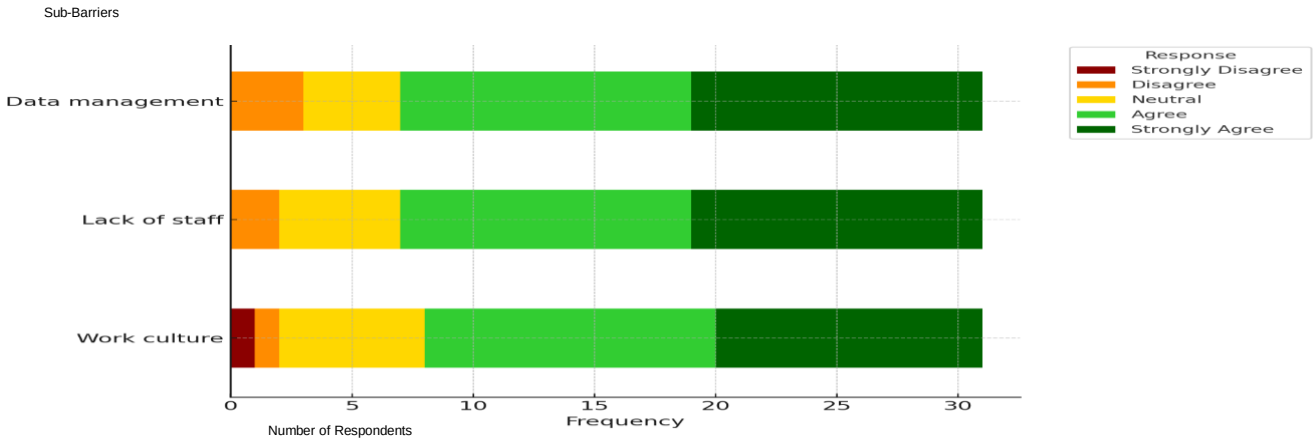

Fig 5. Level of Agreement on Organisational Inefficiency Sub-Barriers to Data Analytics Adoption in FM

TABLE 5 Ranking of Organisational Inefficiency Sub-Barriers to Data Analytics Adoption in FM

Factors	RII	Rank
Work culture	0.8000	3
Lack of staff	0.8194	1
Data management	0.8129	2

Figure 5 and Table 5 show that the highest ranked Organisational Inefficiency sub-barrier is "Lack of Staff" with an RII of 0.8194. This result indicate that workforce constraints play hinder the integration of data analytics initiatives and its widespread adoption. This is consistent with a previous study by [9] which highlighted that it is critical for the maintenance department to have staff that are knowledgeable and skilled in all aspects of maintenance work. FM manages every aspect of its client organisation's physical facilities and support services, from the strategic standpoint to the tactical and operational activities. Thus, FM companies often find themselves to be in need for additional staff to meet the demands of the numerous never-ending long-term, short-term, and daily-routine tasks that they need to carry out. Thus, inadequate staff especially in specialised areas (such as data analytics) will most definitely be a barrier to the adoption of data analytics in FM companies.

"Data management" with an RII of 0.8129, ranks second, suggesting that the laborious task of data management is discouraging FM companies from adopting data analytics in their businesses. Furthermore, organisational inefficiencies in managing and governing data may lead to reduced trust in the accuracy and reliability of the data used for analytics. Inadequate data management practices, such as uneven data governance, inadequate data control, or a lack of data standardisation, can lead to a loss of trust in the accuracy and reliability of analytics data.

Lastly, "Work culture" with an RII of 0.8000, indicates that unwillingness to change in work culture to adapt to new technology discourages the adoption of data analytics in facilities management. This finding is similar to [52] who reported that employee resistance to change is a major cause of the innovative system's failure and negatively affects the relationship between intention to utilise and actual use of data analytics.

CONCLUSION

This research paper delved into the adoption of data analytics in the FM sector, aiming to identify the main barriers and sub-barriers that influence its delayed uptake. Through a comprehensive analysis of survey responses, key insights were collected to assist in overcoming these issues and promoting the widespread usage of data analytics in the FM industry. By understanding and addressing these key factors, decision-makers in the

FM sector can focus strategies to overcome barriers and promote extensive data analytics integration by identifying and addressing these critical aspects. The analysis in this study gave valuable quantitative data and insights into the factors that lead to data analytics' delayed adoption in FM.

The RII analysis results show that all of the components evaluated in this study have RII scores close to 1. This study demonstrates that each element has a substantial impact on Malaysia's slow adoption of data analytics in FM. The RII values which are close to 1, indicate a significant relationship between the identified characteristics and problems encountered while implementing data analytics in the FM sector.

The sub-barriers analysis under "Organisational inefficiency" shed light on workforce-related problems, data management inefficiencies, and the need to develop a suitable work culture. While in the analysis of the sub-barriers in "Technology integration" emphasised the necessity of addressing knowledge gaps, maintaining data privacy and security, improving data quality, and encouraging software compatibility to promote smooth integration. Furthermore, the sub-barriers under "Financial constraints" highlighted the financial constraints issue in adopting data analytics and the costs associated with it to maintain are known as major obstacles.

These findings provide an in-depth insight into the multiple factors or barriers to data analytics adoption in FM in Malaysia. To address these issues, strategic interventions such as targeted training and upskilling programmes, cost-effective data management systems, build a data-driven organisational culture are required. By overcoming these barriers, FM organisations in Malaysia may unleash the revolutionary power of data analytics, paving the way for improved decision-making processes, optimised operational efficiencies, and long-term growth in the quickly changing landscape of data-driven enterprises. Overall, this study adds to the body of knowledge on the subject of data analytics adoption and serves as a significant resource for stakeholders seeking to leverage data-driven practices for organisational success in facilities management in Malaysia.

ACKNOWLEDGMENT

The authors would like to express our utmost gratitude to University Technology Malaysia for the provision of exceptional research facilities that make the undertaking of this research and authoring of this paper possible.

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