ASSESSING THE READINESS TO ADOPT THE DIGITAL TWIN ENABLED FACILITIES MANAGEMENT TO REVAMP THE BUILDING OPERATION AND MAINTENANCE IN SRI LANKA

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Abstract. The Facilities Management (FM) industry is undergoing a transformation with the adoption of IT technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and Building Information Modelling (BIM), leading to the innovative concept of Digital Twin (DT), which is known as a dynamic virtual copy of a physical asset, process, system or environment that behaves identically to its real-world counterpart. The FM industry has seen a revolution due to DT enabled FM (DT-FM), shifting the focus from basic monitoring to advanced prediction and simulation of conditions, transforming FM activities into proactive, data-driven strategies. However, Sri Lanka has not practically adopted the DT concept for FM, even though it has numerous modern buildings with complex maintenance processes. This research was designed to assess the readiness for adopting the DT-FM for operations and maintenance (O&M) of facilities. A leading 43 modern buildings of more than 75,000 sq.ft floor area in Colombo metropolis were randomly selected for data collection. The study employed a mixed method approach, starting with qualitative data collection and analysis using expert interviews, and further followed by a quantitative phase involving a questionnaire survey. Research findings indicate that 58% of FM organisations are aware of DT-FM concept. However, willingness and readiness for adopting DT-FM are at a lower level, and this gives a strong message for facility managers to rethink how to bridge the gaps for the successful implementation of DT-FM.

Keywords. Facilities Management, Digital Twin, Operation And Maintenance, Building Information Modelling, Artificial Intelligence

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1. Introduction

A transformative era in facilities management (FM) has begun with the widespread adoption of cutting-edge technologies like Artificial Intelligence (AI), Internet of Things (IoT), and Building Information Modelling (BIM) which enhance the decision-making capabilities throughout a building's life cycle and giving rise to the ground-breaking concept of Digital Twin (DT) (Pomè & Signorini, 2023). The DT serves as a virtual representation of the real-time status of objects, processes, and systems, bridging the gap between physical and digital realms by connecting digital objects, and is instrumental in integrating the physical and digital worlds (Javaid et al., 2023). According to Pomè & Signorini (2023), the FM industry has seen a revolution due to DT enabled FM (DT-FM), especially during the O&M phase, shifting the focus from basic monitoring to advanced prediction and simulation of conditions, transforming FM activities into proactive, data-driven strategies. Martin and Fjeld (2020) mentioned that DT offers capabilities such as simulation, decision assistance, automation and integration, which are necessary to move the FM industry into Industry 4.0, which entails a continuous interaction between people and technology. Real-time monitoring of assets (Eyre & Freeman, 2018), predictive maintenance of equipment (Elyasi et al., 2023), efficient energy management (Shahzad et al., 2022), improved occupant comfort (Arowoiya et al., 2023), data driven decision making (Yao et al., 2023), comprehensive performance analysis (D. G. J. Opoku et al., 2022), remote monitoring and control (Elyasi et al., 2023), long

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term sustainability (Omrany et al., 2023), and collaboration between stakeholders (Zhao et al., 2022) are few other benefits of DT-FM.
Groombridge (2023) predicted that by 2027, more than 40% of large enterprises globally will incorporate DT technology into their projects to drive revenue growth. Furthermore, a study conducted by Pomè and Signorini (2023), revealed that several case studies in the global proving the use of DT is supported by substantial cost savings, including a notable 15% reduction in FM expenses, 40% reduction in energy costs, and 30% reduction in operating costs, primarily attributable to optimised resource management and overall efficiency.

In the Global context, developed countries such as the UK, USA, Australia, and Italy have been the top countries in advancing DT adoption in the built environment, while developing countries like Brazil, China, and South Africa have made commendable contributions (D. G. J. Opoku et al., 2022). This is proven by successful DT integration in different countries. For instance, the Centre for Digital Built Britain (CDBB) in the UK is running the National Digital Twin Programme (NDTp) to access high quality and secure data to improve how infrastructure is built, managed, operated and decommissioned (CDBB, 2017). The Sydney Opera House restoration team in Australia created a unified central data repository utilising some DT concepts to improve O&M (Cooperative Research Centre for Construction Innovation, 2007). Further, this repository integrates data from various building systems to support more informed O&M decisions, ultimately improving the performance and longevity of the iconic structure. The framework proposed by Zhao et al. (2022) for an effective Building O&M process is another good example which integrates real-time data analytics, predictive maintenance, and automated feedback mechanisms, demonstrating how DT can transform traditional O&M practices into proactive, data-driven strategies.

The key factor driving a rise in the total life-cycle cost of a building project is the O&M phase (Yalcinkaya & Singh, 2014). Mohanta and Das (2016) state that O&M expenses account for 60% - 85% of total life cycle costs, with the remaining percentage going towards design and construction. Moreover, the conventional FM techniques frequently struggle with issues including incomplete, inadequate or outdated documentation, which makes it difficult to make effective decisions and maintenance planning regarding the facility (Chen & Tsai, 2021). Through the smooth integration of IoT sensors and data analytics, DT enabled proactive decision-making, empowering facility managers to optimise maintenance schedules, improve operational performance, save costs, increase sustainability, and offer a seamless FM experience (Elyasi et al., 2023). As a result of the creative application of DT technology, building maintenance has changed significantly in the last few years (Errandonea et al., 2020). This widespread tendency denotes a paradigm change in the upkeep of buildings.

However, while the global landscape showcases successful DT implementations, the specific readiness of Sri Lanka's building sector remains a research gap. Also, Sri Lanka has not practically adopted the DT concept for FM, even though Sri Lanka has many modern buildings with complex maintenance processes. Therefore, there is an essential need to assess the readiness to promote the successful adoption of

DT-FM unique to the Sri Lankan context. Hence, this research focused on assessing the readiness to adopt the DT-FM to revamp the building O&M in Sri Lanka.

2. Literature Review

2.1 DIGITAL TWIN (DT)

DT technology is part of the rise of new digital technologies that support digital transformation by facilitating capabilities to enable new business models and decision support systems (VanDerHorn and Mahadevan, 2021). DT has been defined in various ways in the extant literature, as per the characteristics derived from multiple use cases and the conceptual understanding of DT has continuously evolved during its development (van der Valk et al., 2020). Further, Muctadir et al. (2024) defined DT as a pairing of a physical entity and a corresponding virtual entity (VE), mimicking certain aspects of the former depending on the use case.

2.2 DT ENABLED FM (DT-FM)

A paradigm shift in FM has been brought about by the use of DT, especially in the Architectural, Engineering & Construction (AEC) sector and the O&M of built environments represent primary domains of application for DT-FM (Dixit et al., 2019). Arowoiya et al. (2023) underscored that the integration of DT to FM operations aims to provide a complete and dynamic method to maximise efficiency and resource utilisation, hence greatly enhancing data-driven decision-making throughout the asset lifespan. Brilakis et al. (2019) conclude that a DT in the built environment is a 3D model-based representation of a physical asset, which may be created to serve a specific purpose in a project lifecycle and would contain the related data required to simulate the realistic characteristics of the physical twin within the defined use case of the DT.
Based on these facts, the DT-FM can be defined as a sophisticated DT technology integration into the O&M segment of the built environment in the AEC industry, imparting a sensible and comprehensive digital representation for real-time monitoring, decision making, and predictive maintenance throughout the facility's life cycle (Zhao et al., 2022).

2.2.1 Application and Benefits of DT-FM

Research conducted by Slioa (2022) found that the main applications of DT concept in FM are energy monitoring, energy savings, predictive maintenance, error detection, occupant detection, occupant prediction, comfort, and cost savings.

DT applications enable enterprises to accurately monitor and evaluate patterns of energy use within a facility, leading to effective optimisation. (Bortolini et al., 2022). Organisations may proactively identify energy-intensive activities, optimise operations, and save needless spending by integrating IoT sensors and sophisticated analytics through the DT (Omrany et al., 2023). Further, Pomè & Signorini (2023) revealed that it could save the building energy cost by 40% via the use of DT enabled energy management system.

Liu et al. (2018) highlighted the usefulness of DT in predictive maintenance by explaining how these tools can be optimised to improve asset performance and resource allocation, giving facility managers the power to make well-informed decisions and promoting an efficient and sustainable built environment through the synchronised synergy between physical assets and their digital counterparts. Research conducted by Zhao et al. (2022) revealed that the main advantages of using DT in FM are real-time data gathering and monitoring, a more effective decision-making process and improved predictive maintenance.

DT transforms the comfort of facility users through occupancy prediction, energy-efficient HVAC system adjustments, and the integration of many data sources, including occupant feedback and emotion detection (Clausen et al., 2021). It allows for customised indoor environmental settings, adjusting interior conditions to suit individual preferences and effortlessly monitors temperature, humidity, and CO_2 levels, optimising air conditioning cycles to minimise the need for natural ventilation and cut down on energy waste (Desogus et al., 2021).

A recent interpretation of the DT concept within the built environment research relates it to the use of DT of an asset to provide simulations and to an information link to a real-world entity, thus enabling opportunities for data-centric decision making in asset O&M (Shahzad et al., 2022). DT technology, paired with cutting-edge Machine Learning and AI capabilities, offers to forecast future maintenance needs of built environments, preventing unplanned downtime and optimising asset performance in the field of FM (Negri et al., 2020).

DT offers a new visual for facilities monitoring with the use of BIM and XR technologies, which enables the visualisation of equipment and subsequent realisation of equipment management (Zhang et al., 2023). Further, Lu et al. (2020) suggested a Bayesian optimisation-based change point detection system to assess the DT data and find abnormalities and anomalies in the facility.

Almatared et al. (2023) mentioned the application of DT technology to fire management in the venues used for early warnings and emergency management evacuation path guidance for fire safety. The major goals of utilising DT in emergencies include fire evacuation and guidance, prevention of future cases, personalised treatment, supporting decision making, and improving visualisation (Zhang et al., 2023).

As a summary, the diverse applications and key benefits of DT-FM are indicated in Table 1.

Table 1: Application & Benefits of DT-FM

Application	Benefits	References
Energy Monitoring & Management	Optimised energy use, cost reduction up to 40%	(Bortolini et al., 2022; Pomè & Signorini, 2023; Omrany et al., 2023)
Predictive Maintenance	Reduced downtime, efficient resource allocation, extended asset life	(Liu et al., 2018; Negri et al., 2020; Zhao et al., 2022)

Occupancy Detection & Comfort	Customised indoor settings, HVAC efficiency, improved occupant satisfaction	(Clausen et al., 2021; Desogus et al., 2021)
Real-Time Monitoring & DecisionsReal-Time Monitoring & Decisions	Improved decision-making and operational efficiency	(Shahzad et al., 2022; Slioa, 2022)
Visualisation (BIM & XR)	Better equipment management and anomaly detection	(Lu et al., 2020; Zhang et al., 2023)
Emergency & Fire Management	Early warnings, evacuation planning, incident prevention	(Almatared et al., 2023; Yao et al., 2023)

2.2.2 Prerequisites for DT-FM

The essential conditions, technologies, and frameworks that must be in place to successfully implement and operate a digital replica of physical assets can be introduced as the prerequisites for DT-FM (Zhao et al., 2022).

1. Technological resources

- Data perception technologies

According to Khajavi et al. (2019), two essential technological components can be identified as the data perception for developing a DT model for a building, including the required data components from BIM or BMS and a Wireless Sensor Network (WSN). A BIM is a computable representation of all building physical and functional attributes, as well as related lifecycle information, and it serves as a repository of information for building owners and operators to maintain the systems (Edirisinghe et al., 2017). BIM is essential for DT integration due to the DT visualisation for a building can rely on 3D CAD model extracted from BIM or a custom 3D model of the building (Khajavi et al., 2019). Li et al. (2022) stated that the sensors are the 'must-have' components in every form of DTs, coupled with data transmission technologies, they guarantee that DT can realise real-time data collection and synchronisation. DT uses IoT as its primary technology in every application to sense real time building conditions, and it is predicted that more than 90% of all IoT platforms will have DT capability by 2027 (Attaran & Celik, 2023).

- Data transmission technologies

In any kind of DT, there are generally three types of connections, including the connection between the physical entity and the virtual side, the connection between the virtual side to humans and the connection from humans to the physical side (Li et al., 2022). Further, (Li et al., 2022) revealed that Big data, IoT, 5G, Wi-fi and satCom are fundamental to the connectivity of DT.

- Data storage technologies

The technology known as database technology, which oversees managing and storing data related to the DT, is facing escalating demands due to the continuous progression of continuous expansion of data volume (Zhang et al., 2023). The two most common data storage methods used for the DT concept now are cloud storage and local storage environments (Yu et al., 2021).

- Data processing technologies

The main function of data integration and analytics is to gather, process and analyse the data and in general, the virtual side is made up of sets of models with different functions, which are mainly divided into two forms, including traditional modelling methods that are mostly physics-based, and data-driven modelling (Li et al., 2022). AI can assist DT by providing an advanced analytical tool capable of automatically analysing obtained data and providing valuable insights, making predictions about outcomes, and giving suggestions as to how to avoid potential problems (Attaran & Celik, 2023). Li et al. (2022) explained that most AI applications on the virtual side reflect on using ML to create the data-driven analytical model, and these models are widely applied in diagnosis, manufacturing, and decision making due to their proven performance in classification, clustering, and generation tasks. Glaessgen and Stargel (2012) also pointed out that high-performance computers will be necessary for the construction of the high dimensional and complex DT with huge data to deal with DT related issues like handling large and noisy data, quantifying uncertainty and a huge number of equations. Cloud computing is an emerging technology and a 'good-to-have' infrastructure to meet the requirements of DTs while breaking up the limitations of local computing devices, whilst improving the overall computing capacity (Li et al., 2022). Furthermore, edge computing technology plays a more significant role in data strain in confined environments, and it will expedite reaction times and effectively reduce the time lag between data collecting and processing (Li et al., 2022).

- Data visualisation technologies

Immersive technologies such as Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) are together referred to as Extended Reality (XR) and these innovations have the power to expand our perception of reality by fusing the actual and virtual realms (Stacchio et al., 2022).

2. Financial resources

Securing adequate funds and financial investment is identified as the crucial dimension for the successful adoption of DT technology in FM, as it enables the procurement of necessary resources, supports the development of infrastructure, and facilitates the implementation of DT to drive innovation and efficiency in projects (Deepu & Ravi, 2021). Further, a study conducted by Huang et al. (2023) identified that the affordability of software and hardware upgrades and maintenance costs is a crucial determinant towards the adoption of DT, as it significantly influences financial planning, resource allocation, and the overall strategy for technological investments, thereby playing a vital role in ensuring the long-term viability and efficiency of implementing DT in FM.

3. Human resources

Liu et al. (2022) highlighted that the skills and experience of the workforce regarding DT implementation are important for its successful integration. Supporting that, the Centre for Digital Built Britain (CDBB's) National Digital Twin (NDT) programme, in partnership with the Construction Innovation Hub, has released a Skills and Competency Framework to help individuals.

4. Regulatory factors
Muhlheim et al. (2022) mentioned that the industry and regulators must develop agreed-upon guidance and frameworks for the acceptance of DT applications that are consistent and explicit and that enable the use of DTs. Further, clear and robust regulations provide a framework that facilitates the safe and ethical use of DT, fostering trust among stakeholders and mitigating risks associated with breaches and misuse, thereby enhancing the overall reliability and acceptance of DT solutions in the industry.

5. Organizational support & readiness
Deepu & Ravi (2021) highlighted that top management commitment and Stakeholders’ awareness of technology benefits are crucial for the successful adoption of DT for
providing resources, fostering a culture of innovation, and ensuring organisational alignment with technological advancements. Supporting that, Opoku et al., (2022) pointed out that stakeholder engagement is pivotal for the adoption of DT, as it ensures collaborative support, aligns interests, and fosters a shared commitment to leveraging DT for enhanced project outcomes.

6. Data privacy, security & compliance
The adoption of DT technology in industries necessitates stringent attention to data privacy, security, and compliance, and the assurance of data privacy and security is paramount, as it protects sensitive information from unauthorised access and breaches, thereby maintaining the integrity and confidentiality of organisations (Agnusdei et al., 2021).

7. Knowledge, expertise & competencies
The availability of knowledge, skills, and competencies to adopt the technology is fundamental, as it ensures that personnel are equipped with the necessary understanding and capabilities to effectively implement and utilise DT technology (Hong et al., 2019).

8. Market & external factors
Götz et al. (2022) highlighted that market demand for the technology plays a significant role, as it drives the industry's investment and development in DT and managing industry resistance to adopting new technology is essential for overcoming uncertainty and encouraging widespread acceptance.

3. Methodology

This study aims to assess the willingness and readiness of organisations in the FM industry to adopt DT-FM for O&M. The study was carried out in multiple stages to address the research question. Initially, a comprehensive literature review was carried out on a broader perspective to review the concept of DT and its usage in the FM sector to familiarise with the research problem and identify the background of the research area.
The study employed a mixed method approach, starting with qualitative data collection and analysis, including expert interviews, and further followed by a quantitative phase involving a questionnaire survey. In the first phase, expert

interviews were conducted with five experts to validate the findings derived from the literature review on requirements for adopting DT-FM. As mentioned in the above section, the identified eight dimensions and twenty-four sub-dimensions (refer Section 2.4) that can be used to assess the readiness for adopting DT-FM were discussed by the selected experts. Manual content analysis was employed to analyse the data gathered through expert interviews. The profile of the interviewees is shown in Table 2.

Table 2: Profile of the Interviewees

No	Interviewer Code	Designation	Years of Experience
1	R1	Building Automation Manager	10 years
2	R2	Digital Transformation Practitioner	13 years
3	R3	DT Engineer	5 Years
4	R4	Lead Digital Transformation Engineer	7 Years
5	R5	Building Automation Engineer	8 Years

In the second phase, a questionnaire survey was conducted to gauge the awareness of DT-FM and their perceptions of its potential benefits and assess the existing willingness. The questionnaire was distributed among 50 organisations in the FM industry with more than 75,000 sqft of floor area. The questions based on the identified prerequisites for adopting DT-FM at the O&M phase were included with a 1-5 Likert scale. 24 sub-dimensions were organised under eight identified dimensions including (1) Technological resources, (2) Human resources, (3) Financial resources, (4) Regulatory factors, (5) Organizational resources, (6) Knowledge, Expertise and Competencies resources, (7) Market and external factors, (8) Data privacy, security and Compliance. Facility managers/Building managers/Facility engineers were invited to participate in the survey.
IBM SPSS (Statistical Package for the Social Sciences version 26) software was utilised to perform statistical analysis on the data collected under the questionnaire survey, with a one-sample t-test applied to evaluate the significance of the results.

4. Research Findings

Experts' opinions on the literature findings for DT-FM prerequisites are shown in Table 3. Since all experts believed that all literature findings were important, all twenty-four sub-dimensions under 8 dimensions were included in the questionnaire.

Table 3: Summary of Expert Responses

Dimensions	**Sub dimensions**	**Literature**	**Interviewee**				
			R1	**R2**	**R3**	**R4**	**R5**
Technological infrastructure	Data perception tools • BIM, BAS/BMS, WSN (EMS, CMMS)	✓	✓	✓	✓	✓	✓
	Data transmission tools • Wired, Wireless (Wi-Fi,5G, IOT)	✓	✓	✓	✓	✓	✓
	Data storage tools • Local, Cloud	✓	✓	✓	✓	✓	✓

	Data processing technology • AI, ML, DL, Cloud computing, Edge computing, HPC hardware	✓	✓	✓	✓	✓	✓
	Data visualisation tools • AR, VR, Dashboards	✓	✓	✓	✓	✓	✓
Financial Resources	• Availability of funds and financial investment	✓	✓	✓			
	• Affordability of software and hardware upgrading and Maintenance costs	✓	✓	✓	✓	✓	✓
Human Resources	• Skilled human resources	✓	✓				
	• Technology operators	✓	-	✓	-	-	-
Regulatory factors	• Rules and regulations provided by the Government	✓	✓				
Organisational support and readiness	• Top management supportiveness	✓	✓				
	• Organisation's readiness to adopt the technology	✓	✓	✓	✓	✓	✓
	• Personnel readiness to change and adopt new technology	✓	✓	✓	✓	✓	✓
	• Stakeholders' awareness of technology benefits	✓	✓	✓	✓	✓	✓
	• Stakeholder engagement to adopt the technology	✓	✓	✓	✓	✓	✓
Knowledge, Expertise and Competencies	• Availability of knowledge, skills, and competencies to adopt the technology	✓	✓				
	• Availability of practical cases of the technology	✓	✓	✓	✓	✓	✓
	• Continuity of research and development efforts to enhance the adaptability of the technology	✓	✓	✓	✓	✓	✓
Data privacy, security and compliance	• Assurance of data privacy and security	✓	✓				
	• Availability of clear project documentation and requirements	✓	✓	✓	✓	✓	✓

	• Availability of standards and codes for the new technology	✓	✓	✓	✓	✓	✓
Market and External Factors	• Market demand for the technology	✓	✓				
	• Readiness of the industry to manage and overcome resistance to adopting technology	✓	✓	✓	✓	✓	✓
	• Availability of KPIs for tracking progress	✓	✓	✓	✓	✓	✓

Out of 50, 43 respondents completed the questionnaire, accounting for an 86% response rate. Figure 1 shows the type of facilities of the respondents.

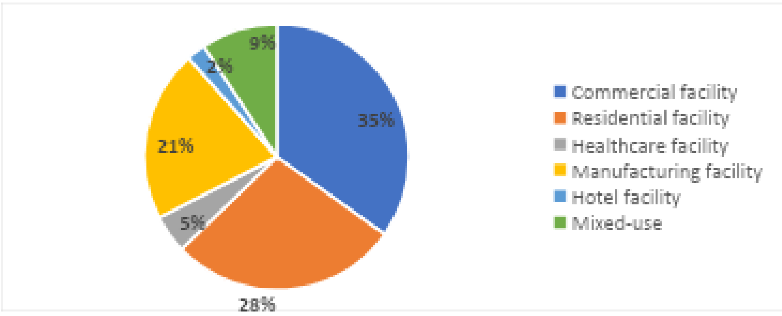

Figure 1: Type of facilities of the participating organizations

4.1 AWARENESS OF DT-FM INDUSTRY

According to the findings of the questionnaire survey, the awareness level of the FM industry towards DT-FM is demonstrated in Figure 2.

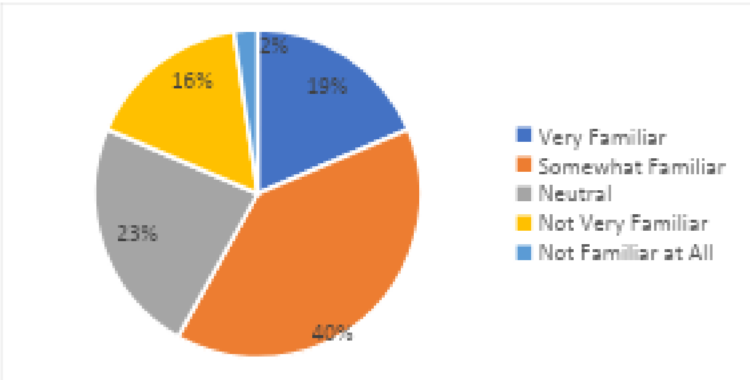

Figure 2: Awareness level of the FM industry towards DT-FM

Following the survey findings, 18.6% of stakeholders in the industry were very familiar with the concept of DT-FM. And 39.53% of Stakeholders are somewhat familiar with the concept, while 23.26% of stakeholders had neutral familiarity with DT enabled FM concept. On the other hand, 16.28% of Stakeholders in the FM industry were not very familiar with DT enabled FM concept. Further, 2.33% of stakeholders were not familiar with DT enabled FM concept. According to that, 58.13% of the building managers/ in the FM industry are aware of the DT-FM concept and it can be identified as a higher awareness level.

4.2 WILLINGNESS TO ADOPT DT -FM

Based on the questionnaire survey findings, the willingness to adopt DT-FM was assessed using a one-sample t-test. The hypotheses were defined below,

- Null Hypothesis (H_0): The willingness to adopt DT-enabled FM is not significantly different from the threshold, indicating insufficient willingness.
- Alternative Hypothesis (H_1): The willingness to adopt DT-enabled FM is significantly different from the threshold, indicating sufficient willingness.

The results of the test were tabulated in Table 4.

Table 4: Result of one-sample t-test for Level of willingness to adopt DT

Code	Level of Willingness	N	t statistic	Significance (P value)	Mean
Int	Willingness to adopt DT-enabled FM	43	-4.887	<.001	2.72

The negative T value and the P value less than 0.05 indicate that the mean willingness score is significantly below the threshold of 3.5. This result is statistically significant, suggesting a notable lack of willingness to adopt DT-enabled FM within the industry. Therefore, the null hypothesis (H_0) is accepted.

4.3 READINESS TO ADOPT DT-FM

The level of readiness in the FM industry to adopt the DT-FM was analysed via a statistical analysis through IBM SPSS 25, and the hypotheses were defined below,
Null Hypothesis (H_0): The dimension is not ready for DT-enabled FM implementation.
Alternative Hypothesis (H_1): The dimension is ready for DT-enabled FM implementation. The results of the test were tabulated in Table 5.

Table 5: One-sample t-test results of DT-FM prerequisites

Code	Prerequisites for DT-FM	N	T Value	P value
Tec1	Availability of data perception tools like BIM, BMS, EMS, CMMS, IoT	43	-5.991	<.001
Tec2	Availability of data transmission tools like Wireless (WiFi,5G, IOT) or wired data transmission	43	-12.136	<.001
Tec3	Availability of Data storage tools like Cloud Storage or Local Storage	43	-11.225	<.001
Tec4	Utilising Artificial Intelligence (AI) for O&M	43	-21.387	<.001
Tec5	Utilising Machine Learning (ML) for O&M	43	-9.487	<.001
Tec6	Utilising cloud computing and Edge computing for O&M	43	-26.536	<.001
Tec7	Utilising high-performance computer hardware for O&M	43	-9.871	<.001
Tec8	Availability of Data visualisation tools like Interface, AR, VR	43	-8.210	<.001

Fin1	Availability of funds and financial investments	43	-26.679	<.001
Fin2	Affordability of software and hardware upgrading, and maintenance costs	43	-9.942	<.001
HR1	Skilled human resources for adopting DT	43	-11.429	<.001
Reg1	Rules and regulations imposed by the Government	43	-17.202	<.001
Org1	Top management supportiveness	43	-7.942	<.001
Org2	Readiness of the individual business units	43	-13.516	<.001
Org3	Personnel readiness to change and adopt new technology	43	-14.401	<.001
Org4	Stakeholder engagement to adopt the technology	43	-14.206	<.001
Dat1	Assurance of data privacy and security	43	-9.498	<.001
Dat2	Availability of clear project documentation and requirements	43	-22.920	<.001
Dat3	Availability of standards and codes for the new technology	43	-7.954	<.001
Knw1	Availability of knowledge, skills and competencies to adopt the technology	43	-10.546	<.001
Knw2	Availability of practical cases of the technology	43	-37.481	<.001
Knw3	Continuity of research and development efforts to enhance the adaptability of the technology	43	-15.974	<.001
Mar1	Market demand for the technology	43	-20.347	<.001
Mar2	Readiness of the industry to manage and overcome resistance to adopting the technology	43	-24.059	<.001
Mar3	Availability of KPIs for tracking progress	43	-25.875	<.001

Based on the findings, all tested dimensions have negative T values and P values less than 0.05, indicating that the mean readiness scores are significantly below the threshold of 3.5. The p-value suggested that this result is highly statistically significant, and it suggested rejecting the alternative hypothesis and accepting the null hypothesis. Further, it is concluded that none of the prerequisites is ready for DT-FM implementation in the Sri Lankan FM industry.

5. Conclusion

This study has assessed the awareness and willingness to adopt the digital twin-enabled facilities management to revamp building O&M in Sri Lanka. The study assesses the awareness of the DT en3able FM among stakeholders, and findings revealed that 18.6% were very familiar with the concept, 39.53% of stakeholders were somewhat familiar with the concept and 23.26% of stakeholders were neutral familiar. On the other hand, 16.28% of Stakeholders were not very familiar with DT enabled FM concept. Moreover, this research assessed the willingness level to adopt the DT enabled FM among stakeholders. The findings highlighted that there was a notable lack of willingness to adopt DT-enabled FM within the industry. However, the findings of this paper emphasise the awareness and willingness of the Lankan FM industry towards the adoption of DT enabled FM concept for their O&M activities.

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