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Adopting Systematic Review in Conceptual Digital Maturity Modelling: A Focus on Facilities Management Sector

Abdulmalik Adozuka Aliu[1], Nor Rima Muhamad Ariff[1,*], Sheikh Ali Azzran Sh Said[1], Divine Senanu Ametefe[2], Dah John[3], Terdoo Michael Dugeri[4], Muhammad Isah[5]

[1] College of Built Environment, Universiti Teknologi MARA (UiTM), 40450 Shah Alam, Selangor, Malaysia
[2] Wireless Communication Technology Group, College of Engineering, School of Electrical Engineering, Universiti Teknologi MARA (UiTM), 40450 Shah Alam, Selangor, Malaysia
[3] College of Computing, Informatics and Mathematics, Universiti Teknologi MARA (UiTM), 40150 Puncak Perdana, Selangor, Malaysia
[4] School of Built Environment, Engineering and Computing, Leeds Beckett University, Leeds LS1 3HE, United Kingdom
[5] Department of Mechanical Engineering, School of infrastructure, Process Engineering and Technology, Federal University of Technology, Minna 920101, Niger, Nigeria

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ABSTRACT

In the rapidly evolving digital landscape organizations must undergo digital transformation (DT) to maintain competitiveness. However, the facilities management (FM) sector lacks systematic guidance in its DT efforts. The absence of a specific digital maturity model (DMM) for the FM sector hinders its ability to effectively navigate and benchmark its DT progress. This paper aims to address this gap by proposing a conceptual maturity model tailored to the FM sector, providing a roadmap for continuous improvement in DT. The research adopts a systematic literature review (SLR) approach, utilizing content analysis to select and analyse 21 relevant papers. The SLR identifies crucial dimensions for achieving DT maturity, encompassing strategy and leadership organization, technology, process, client (end-user), people and data management. Building on these findings, a conceptual Facilities Management Digital Maturity Model (FM-DMM) is proposed. Theoretically, this study advances the understanding of DT in FM by integrating dynamic capability theory, highlighting the necessity of specific capabilities for DT maturity. Practically, the FM-DMM offers a structured framework for FM organizations to benchmark their DT progress, aiding in strategic decision-making and operational optimization. This model provides targeted guidance for successfully navigating the complex terrain of DT in the FM sector.

1. Introduction

Facilities management (FM) is a critical component of many organizations, encompassing a wide range of activities that help to ensure the safety, efficiency and functionality of the built environment. With the acceleration of a broader digital revolution, the FM sector is presented with a paramount opportunity to enhance its operations and processes by adopting digitalization [1]. Digital

* *Corresponding author.*
E-mail address: norri550@uitm.edu.my

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transformation (DT) empowers organizations to collaborate, learn and innovate at an unprecedented scale [2], creating a fertile ground for industries like FM to leverage emerging technologies effectively. Revamping the FM sector by utilizing digital solutions is anticipated to reduce waste, improve performance and support a data-driven decision-making process [3,4]. As a result, digital innovations have the potential to revolutionize FM.

The growing prevalence of building information modelling (BIM), internet of things (IoT) devices (e.g., sensors), digital twin and building automation systems (BAS) has revolutionized the way facilities managers operate. These advancements, such as the integration of BIM and IoT, have empowered facilities managers to effectively support decision-making, monitor real-time energy consumption, address health and safety concerns, store asset information, track hazards and automate maintenance work orders [5-9]. Moreover, incorporating digital twins of physical assets through simulation has shown promise in enhancing planning, delivery, operation and maintenance practices in the field of FM [10]. With increasing data sharing, the FM sector can unlock substantial economic advantages and promote greater reliability. However, despite the availability of emerging technologies that enable digitalization in FM [11], the sector continues to struggle with adopting these digital technologies effectively [12,13]. Criticisms have been raised regarding the FM sector's lag in both digital maturity and technology penetration [14,15]. A key challenge identified is the lack of standardized tools and references to support FM in the DT journey [16]. Therefore, there is a clear need for strategic frameworks and systematic guidance that provide a path for DT, facilitating continuous assessment and improvement of FM practices and operations. One approach gaining interest among academics and practitioners is the use of a roadmap informed by digital maturity assessment, which can guide the development of a DT agenda across various industries [17,18]. By adopting such an approach, the FM sector can overcome its digitalization challenges and reap the benefits of digital technologies in a structured and effective manner.

To assess an organization's digital maturity and guide its improvement towards maturity, the utilization of a maturity model proves valuable. Such a model allows organizations to evaluate their current digital status across predefined dimensions and criteria, while also providing extensive guidance and a roadmap for enhancement maturity [19-22]. Furthermore, the use of a maturity model enables benchmarking against industry standards, facilitating the evaluation of an organization's digital maturity in comparison to peers and competitors [23]. However, the literature currently lacks a widely accepted digital maturity model (DMM) specifically designed for the FM sector, highlighting a significant lacuna that requires attention.

Digital maturity frameworks and metrics have been pivotal in guiding industries and organizations to understand the prerequisites and factors driving DT, empowering decision-makers to intervene effectively in achieving their DT goals [24]. Digital maturity represents the level of advancement achieved through DT, encompassing implemented changes and acquired capabilities [25]. In recent years, academia and industry experts have developed numerous DMMs to navigate DT, assess an organization's digital maturity and provide recommendations for improvement, enabling progress to higher levels [26,27]. Embracing and implementing these DMMs strategically enhances organizations' digital maturity and equips them to navigate the complexities of DT. These models are often tailored to specific sectors or industries, such as manufacturing [28], airline [29], defence [30], education [31], healthcare [32] and telecommunication [33], among others. Deloitte's DMM developed in partnership with TM Forum [34], PricewaterhouseCoopers PwC's Building the digital enterprise model [35] and McKinsey & Company's 'Raising your Digital Quotient Model' [36], are examples of consultancy models towards digitalization, but these models lack theoretical foundations and have not been adequately described or validated in terms of their methodologies [37]. As such, these frameworks are excluded from consideration in this study. Furthermore, certain

maturity models focus exclusively on Industry 4.0, encompassing knowledge areas or dimensions that are tailored to manufacturing and industrial settings [38-41], but they are not taken into account in this study. Additionally, there are general maturity models that aim to measure maturity across various industries for comparison purposes [42,43].

The fundamentals of designing maturity models lie in comparison with existing models [44,45]. With the continuous publication of digital maturity frameworks in various sectors, there is an opportunity to develop a framework tailored specifically tailored to the FM sector, providing systematic guidance and structure to its DT efforts. This paper aims to propose a conceptual maturity model for FM organization for business scenarios leading to successful DT. The primary objective is to identify the key dimensions and assessment criteria crucial for assessing DT maturity and propose a Facilities Management Digital Maturity Model (FM-DMM) to guide FM organizations on the path to DT. The findings of this research contribute to the innovative development of DT and maturity model research within the FM field. The study strategically addresses the transformation of FM into the digital realm by identifying critical dimensions and assessment criteria for evaluating digital maturity. By adopting this strategic approach, FM organizations can enhance their digital maturity and effectively leverage the advantages of a rapidly evolving digital environment. This research fills a gap in understanding the significance of maturity for FM organizations in the context of DT and provides insights into the intermediate steps necessary to maximize their digital potential.

The remainder of this article is stratified as follows: Section 2 outlines the methodology employed to identify and select the relevant papers for the content analysis in this study. Section 3 presents literature review relevant to DT and FM and the synthesis of the selected papers pertaining to DMM. Section 4 presents the finding and discussion, encompassing the statistical and content analysis of the review. Finally, Section 5 wraps up the paper and provides recommendations for future research.

2. Methodology

In developing a new digital maturity framework for FM, it is essential to consider existing frameworks in related domains and improve upon them [44]. Previous researchers have employed systematic literature reviews (SLRs) to construct maturity frameworks in order to achieve this goal. Therefore, in this study, an SLR was conducted to identify the dimensions of digital maturity from existing DMMs in a similar domain, which is used to develop a conceptual framework for digital maturity in FM.

2.1 Initial Stage

For an SLR, the research question must be crafted in a way that is clear, succinct and logical to aid in the identification, screening and access of relevant articles [46,47]. The PICO framework (Population, Intervention, Comparison, Outcome measures) [48] was thus applied in creating the following research question: “How can a conceptual maturity model be developed to guide FM organizations in effectively transitioning to DT business scenarios?”. This question incorporates the four PICO components as follows: FM organizations (Population), conceptual maturity model (Intervention), Transition to DT (Comparison), Effective transition and guidance (Outcome).

Based on these elements, preliminary research commenced using a combination of keywords such as digital transformation, facilities management, maturity model, readiness and transition. This approach was crucial to identify similar terms and concepts utilized by previous researchers. Keywords extracted from the titles and abstracts of the sourced articles were further explored using a thesaurus and systematically organized into a logic grid table as shown in Table 1.

Table 1
Logic grid with identified keywords

Population (FM Organization)	Intervention (conceptual maturity model)	Comparison (Transition to DT)	Outcome (Effective transition and guidance)
FM firms	Maturity assessment framework	adopting digital transformation	successful digital transformation
FM entities	Maturity framework	Implementing digitalization	Efficient implementation
FM divisions	Maturity assessment model	Integrating digital technologies	Strategic alignment
FM Operations groups	Capability model	Digital transformation journey	Enhanced operational efficiency
building management organizations	Readiness model		
FM companies	Digital maturity assessment tool		
Facility service providers			

2.2 Paper Selection Approach

For the systematic selection of papers in this study, two online databases, Web of Science (WoS) and Scopus, were utilized to ensure broad and comprehensive coverage of research papers relevant to the topic. WoS is one of the most popular databases for multidisciplinary research [49] and Scopus is the largest citation database of research literature and quality web sources across diverse fields, including social sciences, technology, management and arts [12,50]. Systematic reviews differ from other types of reviews by following a rigorous and unbiased methodology that ensures transparency and reliability [51]. To maintain this standard, the steps for this systematic review were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [52], as depicted in Figure 1.

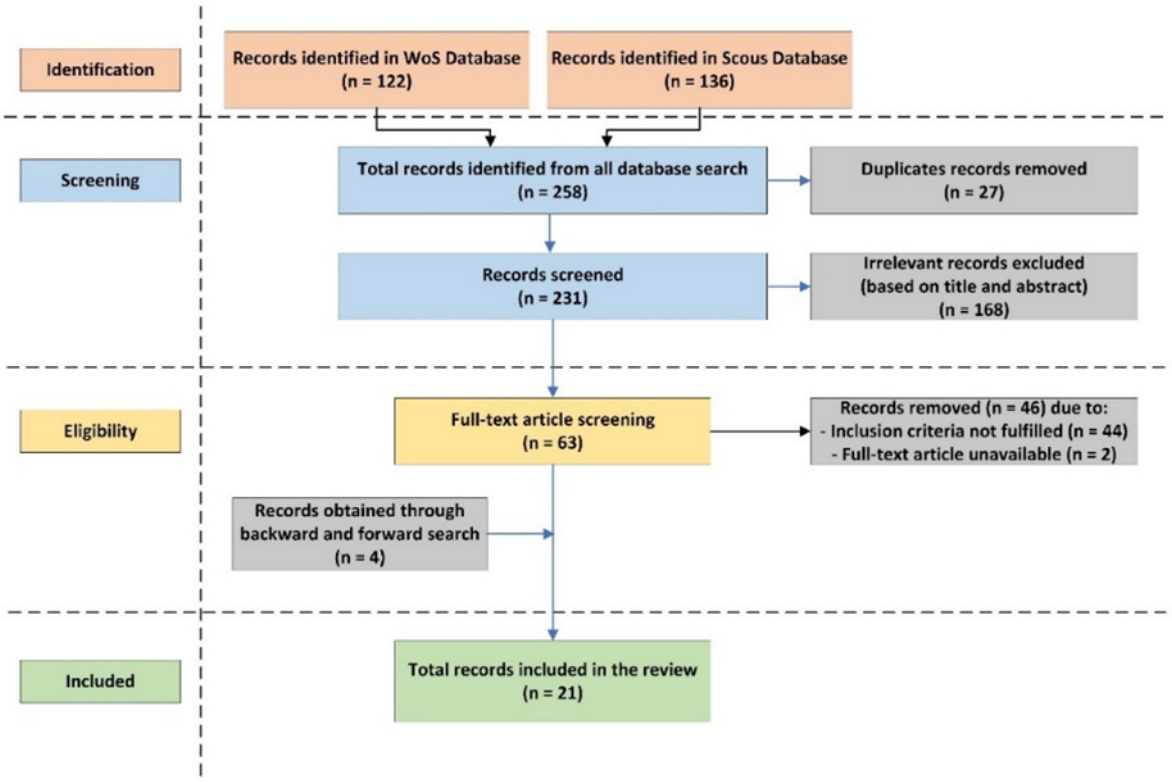

Fig. 1. Flowchart of the systematic review process

The search was restricted to research papers published from 2016 to 2023. This is because DT maturity model development is a new field and publication on the topic became active in 2016 [53].

The inclusion of the most recent academic journal publications was ensured by setting the endpoint to the year 2023. Advanced search techniques were employed to enhance the keyword matching process across titles, abstracts and document topics. These techniques included the use of Boolean operators, exact phrases, truncation and wildcards (Table 3). In order to ensure the relevance and quality of the documents included in this review, we established a set of inclusion and exclusion criteria. Two inclusion criteria were used to select documents that were most relevant to the study, while three exclusion criteria were used to eliminate irrelevant or low-quality documents.

Inclusion Criteria 1: The scope of the study is to develop a DMM or a framework that contains maturity dimensions. Inclusion Criteria 2: The study is written in English, which is the most frequently used in scientific papers. Exclusion Criteria 1: The study is focused on one aspect of DT such as AI, cloud computing, etc. Exclusion Criteria 2: The study is not subject to peer review in journal or conference proceedings. As such, DMMs developed solely by consultancy companies are excluded. Exclusion Criteria 3: Studies that focus solely on Industry 4.0 maturity models will be excluded from this review, as these models may have a specific focus on manufacturing and industrial processes, which may not be directly relevant to the broader context of DT in other industries. To be considered relevant for the systematic review, a paper must meet all the inclusion criteria and not meet any of the exclusion criteria.

2.3 Selected Papers

Following the application of the selected keywords and phrases, we obtained a total of 258 publications - 136 from the Scopus database and 122 from the WoS database, all filtered using the same criteria. After removing 27 duplicates, 231 publications remained. We then carried out a detailed screening process, involving a review of the title and abstract, which resulted in the exclusion of 168 irrelevant publications that did not address the development of a DMM. Subsequently, we performed a full-text screening of the remaining 63 publications, of which 44 were deemed irrelevant based on our criteria (Table 2) and 2 were inaccessible, leading to the identification of 17 relevant publications. To augment our search, we conducted both backward and forward search strategies, as recommended by Wolfswinkel *et al.,* [54] which yielded 4 additional relevant publications. Thus, we selected a final set of 21 publications, comprising 16 journal articles and 5 conference papers, that met our inclusion criteria and were deemed suitable for review.

Table 2
Manual screening criteria for full-text eligibility stage

Criteria	Description	Rationale
Relevance to Research Questions	The scope of the study is to develop a DMM that contains maturity dimensions.	Ensures relevance to the research focus on DT maturity models.
English Language	The study is written in English.	Ensures accessibility and comprehension.
Narrow focus Exclusion	The study is focused on one aspect of DT such as AI, cloud computing, etc.	Eliminates studies with a narrow focus not aligned with the comprehensive approach required.
Peer-Reviewed sources	The study is not subject to peer review in journal or conference proceedings. Excludes DMMs developed solely by consultancy companies.	Ensures academic rigor and reliability.
Exclusion of Industry 4.0 Focus	Studies that focus solely on Industry 4.0 maturity models.	Avoids irrelevant contexts and ensures focus on broader DT applications.

The content analysis for this SLR involved a rigorous process to identify and delineate the dimensions critical for digital maturity. Krippendorff [55] described content analysis as a research technique used for making replicable and valid inferences by examining data in relation to their context. This technique offers new insights, enhances a researcher's understanding of a particular phenomenon or guides practical actions [56]. During the content analysis, dimensions were identified and categorized by utilizing specific terms that captured the distinctions between them. These terms were carefully chosen based on the researcher's semantic understanding of the subject matter, as the dimensions found in the papers might exhibit similarities. Previous studies have employed comparable methods of content analysis to discern patterns and groupings within data acquired through systematic literature reviews [57-59]. The findings are depicted in a weighted graph in Section 4.2, while the specific terms established for each dimension are outlined in Sections 4.2.1 to 4.2.7. The comprehensive content analysis methodology adopted in this study contributes to the robustness and validity of the dimensions identified for the FM-DMM conceptual model.

Table 3
Database and key search string

Database	Search string
Scopus	TITLE-ABS-KEY(("digital transformation" OR "DT" OR digitalization OR "Maturity model" OR "Readiness" OR "Capability model" OR "Maturity framework") AND ("Facilities Management" OR "FM" OR "facility management" OR "building management" OR "facility management entities" OR "FM organizations")) AND (assess* OR evaluat* OR measure* OR benchmark* OR diagnos* OR analys* OR framework*))
WoS	TS=(("digital transformation" OR "DT" OR digitalization OR "Maturity model" OR "Readiness" OR "Capability model" OR "Maturity framework") AND ("Facilities Management" OR "FM" OR "facility management" OR "building management" OR "facility management entities" OR "FM organizations") AND (assess* OR evaluat* OR measure* OR benchmark* OR diagnos* OR analys* OR framework*))

3. Literature Review

3.1 Digital Transformation in Facilities Management

FM is a critical function responsible for ensuring the optimal coordination and management of the built environment, with the goal of enhancing the quality of life for occupants and improving the productivity of the core business [60,61]. FM encompasses a broad range of services, such as building maintenance, real estate management, contract management and more, making it a crucial partner for enhancing business performance and value [62,63]. However, the increasing pace of technological advancements and changing client expectations have led to the adoption of digital capabilities to enable FM organizations to remain competitive and responsive to the environment.

In this context, FM has undergone significant evolution over the years, incorporating digitalization and information technology tools that facilitate information processing and management [64]. The integration of information technology into modern facility management has created opportunities for more effective, rapid and sustainable solutions for operational buildings [65]. As a result, various technologies, software and systems tailored for FM have sparked innovation and revolutionized the sector. Ebbesen [66] further provides a comprehensive categorization of these diverse systems (Table 4). These systems store and manage information and data from multiple FM processes. Furthermore, specific FM information systems such as Computerized Maintenance Management System (CMMS), Computer-Aided Facility Management (CAFM) and Integrated Workplace Management System (IWMS) play a pivotal role in supporting FM activities. While CMMS provides a database for recording, managing and communicating daily maintenance operations (such as inventory control, work order management, asset management, service request generation and resource tracking), CAFM integrates a relational database program with computer-aided design (CAD) graphics, offering

additional functionalities like move management and space management [67,68]. Similarly, IWMS shares many capabilities with CMMS and CAFM systems, with a primary focus on real estate portfolio management and space management [69]. These disparate FM information systems have traditionally supported FM activities on an individual level. For example, a study by Ahmad *et al.,* [70] investigated the implementation of a Building Maintenance Management System (BMMS) in banking organizations and found that it significantly improves maintenance processes, making them more systematic, efficient and beneficial for organizational operations.

However, in recent years, the FM sector has witnessed a paradigm shift, driven by the increasing client demand for proactive service strategies focused on anticipating occurrences rather than reacting to incidents. This shift has been made possible by the integration of advanced information and communication technology (ICT) solutions, prompting FM practitioners to undergo significant changes in their conventional practices, processes, references and tools [3]. Consequently, the FM sector is currently undergoing a profound DT, fuelled by disruptive technologies such as building information modelling (BIM), the Internet of Things (IoT), big data analytics (BDA), digital twin, cloud computing and artificial intelligence (AI), which have played a pivotal role in facilitating this transformation [71]. With new technologies emerging every year [72], these advancements present novel prospects to enhance the efficacy, sustainability and overall performance of FM operations. For example, BIM allows for the accurate and real-time modelling of building and asset data [6]. Similarly, IoT which broadly involves the connectivity of devices such as sensors, actuators and monitors through the internet and mobile platforms [73], plays a pivotal role in expanding the range of applications in FM. This connectivity enables the collection and analysis of vast amount of data from diverse sources, which when combined with BDA and AI agents, supports advanced analysis and effective decision-making [74-76]. Additionally, digital twin enables the optimization of Structural Health Monitoring (SHM) and building services monitoring functions, allowing for efficient inspection and fault detection and diagnostics (FDD) activities to be carried out more efficiently and effectively [77,78]. Other potential disruptive technologies, including virtual reality (VR), augmented reality (AR) and mixed reality (MR), have the potential to become powerful tools for interacting with facilities [79].

Table 4
Categorization of Information technology in FM

Information management system	Types
Data and Information Repositories	Spreadsheets, Database, CAD, GIS, BIM, VR/VE
Workflow Systems	ERP, CMMS, CAFM, IWM
Sensor and Mobile Technologies, RTLS	GPS, Optical Fibre, SMS, CCTV, Drones, RFID/Barcodes, Tablets/Cellphones, AR/MAR
Data Standardization and interoperability	IFC, COBie, Protocols, Exchange methods
Facilities Intelligence Systems	BAS, BMS, BEMS
Field Data Capture System	Remote Sensing, Photo-grammetry, Drones, Laser Scan
Communication Systems	Websites, Intranet, Apps, Social Medias, Services

** Source: Adapted from Ebbesen [66]*

Despite the growing recognition that “digital innovation” can serve as a crucial differentiator for FM, enabling organizations to reduce costs, increase value for clients, improve profit margins, optimize building operations and explore new revenue streams [80,81], the current FM practice is largely backward and characterized by a significant deficit in technological automation [82]. This is due to several challenges including the lack of technical skills for managing cutting-edge technologies, change-resistant attitude and incoherent information management [14,83]. Given these challenges,

it is essential to develop effective strategies for leveraging new digital tools and capabilities to stay competitive and meet evolving client needs. Moreover, a crucial need exists for more extensive scholarly inquiry into the complexities of DTs and their long-term effects on FM, particularly with regard to the requirements for FM organizations to achieve maturity. As such, it is important to furnish FM organizations with comprehensive information concerning the various aspects and paths towards DT to facilitate its effective implementation.

This study is grounded in dynamic capability (DC) theory to understand the phenomenon of DT in the context of FM. DC theory, proposed by Teece *et al.*, [84] provides insight into how organizations can adapt to rapidly changing environments by developing specific capabilities. DC theory focuses on the competencies, structures, processes and strategic decisions that enable organizations to recognize opportunities and reconfigure their capabilities in response to environmental changes [85]. Within the context of DT, the theory emphasizes the importance of these capabilities in guiding companies through the process, particularly in rapidly changing and turbulent sectors such as FM. By applying DC theory, this study elucidates how FM organizations can effectively harness DT to optimize operations and strategic decision-making.

3.2 Dynamic Capabilities Theory and Digital Transformation

Dynamic capabilities (DC) theory has emerged as a widely studied topic in the field of strategic management due to its relevance in explaining how organizations can effectively respond to the changing market and technological environment [84,86]. DC extends the resource-based view (RBV) by emphasizing the reconfiguration of organizational processes and resources as a means to attain competitive advantages [85,87,88]. Teece *et al.,* [84] refers to DC as “the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments”. More recently, Helfat *et al.,* [86] broadened the concept of DC to emphasize the organization's capacity to purposefully create, extend or modify its resource base in order to effectively adapt and respond to the evolving external environment. Considering the current context organizations face an unpredictable business environment characterized by rapid technological changes [89]. Vial [90] asserts the significance of integrating DC into research on DT, highlighting the conceptual alignment between these two constructs. This is further supported by the fact that DC emphasizes the critical capabilities that managers must possess in order to sustain a competitive edge [91]. Teece [88,92] maintains that these capabilities can be categorized into three broad clusters of sensing, seizing and reconfiguring. Sensing capabilities involves a firm’s ability to identify and assess opportunities and potential threats [84,93]. Seizing capabilities involve strategically mobilizing resources, responding to organizational needs and capitalizing on identified business opportunities to create value and minimize risks for the organization [88,92,94]. Finally, reconfiguring capabilities encompass the continuous renewal and transforming of organizational resources (such as assets, structures and cultures) to ensure adaptability and support the business model in a changing environment [88,95]. This mechanism emphasizes the ongoing need for organizations to consistently renew their resource base [94].

The theory of DC is particularly relevant for underpinning DT characterized by rapid change [88,96,97]. Such processes require DC to sense an organization’s needs, identify opportunities and threats, mobilize resources to seize those opportunities and transform operations to develop innovative products and business models. By leveraging these capabilities organizations can effectively adapt to dynamic environments and capitalize on their digital assets and business resources, leading to the creation of sustainable competitive advantages [98]. Furthermore, it is crucial for organizations to continuously monitor and adapt their capabilities in response to evolving

market trends and technological advancements [99]. This iterative and adaptive approach to DC will enable organizations to stay ahead in the dynamic digital landscape and thrive in an era of ongoing transformation and disruption.

4. Finding and Discussion

4.1 Dimensions for Digital Transformation Maturity

Dimensions are specific, quantifiable and independent element that represents a significant, fundamental and distinctive aspect of digital maturity and outlines an actionable area [22]. The literature search identified seven dimensions of digital maturity which includes strategy and leadership organization, technology, process, client (end-user), people and data management. Each dimension provides actionable areas for organizations to focus on in their DT efforts. The findings of the content analysis conducted on the selected papers are outlined in Table 5.

Table 5
Content analysis of selected papers to identify the dimensions for assessing digital maturity

Dimensions							
Source	Strategy & Leadership	People	Organization	Data management	Technology	Client (End-user)	Process
Valdez-De-Leon [33]	✓		✓		✓	✓	✓
De Carolis *et al.,* [100]			✓		✓		✓
Rossmann [101]	✓	✓	✓		✓		✓
Aguiar *et al.,* [43]			✓	✓		✓	✓
Ifenthaler *et al.,* [31]	✓	✓	✓		✓		
Pirola *et al.,* [102]	✓	✓			✓		✓
Gollhardt *et al.,* [103]	✓		✓				✓
Büyüközkan *et al.,* [104]			✓		✓		
Kljajić Borštnar *et al.,* [105]	✓				✓		
Johannes *et al.,* [106]	✓		✓	✓			
Gökalp *et al.,* [28]	✓				✓		✓
Aagaard *et al.,* [37]	✓		✓		✓	✓	✓
Wernicke *et al.,* [107]				✓			
Goumeh *et al.,* [108]	✓				✓	✓	✓
Ting *et al.,* [109]						✓	
Kırmızı *et al.,* [53]	✓	✓	✓	✓		✓	✓
Kıyıklık *et al.,* [29]	✓		✓	✓	✓	✓	
Das *et al.,* [110]	✓	✓	✓	✓			
Haryanti *et al.,* [111]	✓	✓	✓		✓	✓	✓
Nebati *et al.,* [30]	✓		✓		✓		✓
Pinto *et al.,* [89]	✓		✓		✓		✓

Additionally, a radar chart depicting the dimensions for digital maturity is presented in Figure 2, which will be further discussed in the subsequent sub-sections. This visual representation provides a concise and clear understanding of the relative importance of the dimensions and the extent of their selection among the chosen papers.

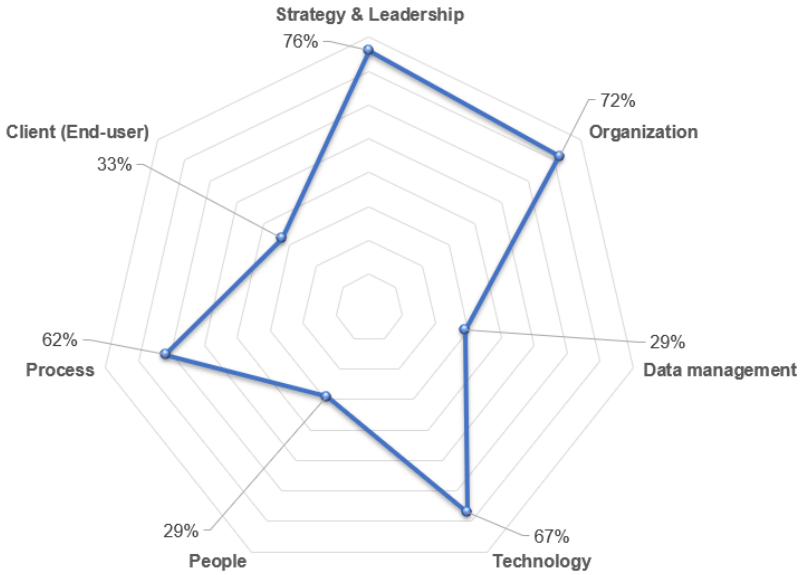

Fig. 2. Dimensions for digital maturity

4.1.1 Strategy & leadership

According to the reviewed papers, the strategy & leadership dimension was identified as the most critical for achieving success in DT, with a mention rate of 76%. This dimension involves an organization's use of a DT plan to achieve goals and global competitiveness, including adapting business models [97,112]. Chanias *et al.,* [113] emphasize the need for a well-crafted DT strategy that coordinates various DT components and guides through complexity to capture the business value of DT. Thus, a strong DT strategy is vital for an organization's digital maturity. Key components of a digital strategy include a comprehensive vision, collaboration and a digital mindset for disruptive innovation [90]. To complement the importance of digital strategy, it is essential to consider the role of leadership in driving successful DT. Aguiar *et al.,* [43] contend that organizations must not only adopt a strategic dynamic plan but also communicate it effectively across the organization to harness the potential of digital technologies and secure a competitive edge. Within this context, leadership commitment becomes the linchpin for expediting the pace of DT. As stressed by Gökalp *et al.,* [20], a clear, compelling vision emanating from top leadership is indispensable for forging a new future that embodies shared value through DT strategy. Thus, by developing a robust DT strategy and effectively communicating it throughout the organization with strong leadership organizations can stay competitive and drive DT success.

4.1.2 Organization

The organization dimension was identified as a dimension towards DT maturity in 72% of the selected papers. It assesses an organization's formalized structures and its capacity to undergo structural changes to transform the value creation process. As Vial [90] highlights, DT often triggers significant structural changes, similar to other transformative initiatives. These changes can result

from the adoption of emerging technologies [86] or alterations to the business model [114]. Two critical aspects of structural change within the organization are cultural transformation and organizational structure. Nadkarni *et al.,* [115] stress that a suitable organizational culture is essential for successful business transformation. Organizational culture encompasses shared values, beliefs and principles held by members of the organization [116,117]. However, rigidities in organizational culture that resist change often impede DT initiatives [118]. Raza *et al.,* [119] further underscore the challenge of working in silos as a hindrance to DT, emphasizing the need to cultivate a digital culture that encourages innovation and risk-taking. This will involve adopting an agile working approach, fostering collaboration among cross-functional teams and experimenting with digital technologies in small-scale pilot projects before widespread implementation [120]. In addition to a conducive organizational culture, an appropriate organizational structure is crucial for successful DT [112]. Organizational structure involves how activities like task allocation, coordination and supervision are organized to achieve organizational goals [121]. Several studies emphasize the need to redesign the organizational structure for DT success [112]. This includes establishing a business model, strategy and leadership team with a digital focus [97]. Furthermore, creating a 'Digital Control Tower' led by a dedicated chief digital officer (CDO) or transformation officer, responsible for harnessing DT opportunities, is a recommended approach [119]. Some advocate for the establishment of autonomous business units to promote innovation while retaining access to organizational resources [80]. Overall, a successful DT journey necessitates the adaptation of the organizational structure. Organizations should explore various options to ensure their structure and processes align with their DT strategies.

4.1.3 Technology

The technology dimension assesses the implementation and adoption of efficient digital technologies, systems, services and IT infrastructure within an organization. This involves using data and digital modelling to optimize strategies, automate processes and promote collaboration. Technology plays a pivotal role in DT, with Morakanyane *et al.,* [122] considering it the primary driver of DT and Verhoef *et al.,* [112] emphasizing its importance in creating new business models. Digital technologies offer value and new opportunities for organizations in DT [15,123]. Teichert [22] highlights technology's prominence in DT maturity models and its impact on various dimensions of digital maturity. Digital technologies encompass a wide range of tools and solutions, including cloud computing, AI, IoT devices, VR/AR, data analytics and automation systems. They enable organizations to optimize operations, enhance customer experiences, drive innovation and create new business models [124]. These technologies also open doors to new market opportunities and facilitate efficient collaboration with partners. Effectively leveraging digital technologies is critical for propelling an organization's DT journey and sustaining a competitive edge in today's dynamic digital landscape [125]. While technology is a crucial component of DT as highlighted in the literature, comprehensive evaluations indicate the significance of other factors [90,126]. Raza *et al.,* [119] assert that investments in digital technologies, effective governance, leadership commitment and cultural shifts are essential for organizations to fully realize the benefits of DT. Therefore, addressing these multidimensional aspects enables organizations to leverage DT's advantages, achieve digital maturity and position themselves for sustained growth in the digital era.

4.1.4 Data management

The data management dimension encompasses the extent to which organizations capture, store, retrieve and analyse raw data in real-time for effective decision-making to significantly improve operational efficiency. Data serves as the foundation for strategic decisions in DT [127], necessitating the development of effective data exploitation capabilities. Gökalp *et al.,* [28] emphasized that dynamic data management, covering data collection, storage, analysis and distribution, is fundamental to an organization's DT journey. DT aims for continuous process improvement by collecting data through IoT devices and utilizing analytical tools for trend predictions. Kıyıklık *et al.,* [29] affirm the importance of a data strategy centred on enhancing the value proposition for customers through strategic data utilization to achieve digital maturity. Moreover, effective data management has far-reaching implications for DT, enabling data-driven decision-making and information exchange among stakeholders through standardized data structures. To harness this dimension's potential organizations, need the requisite technological infrastructure, analytical tools and a shift in employee mindset. Data management facilitates seamless communication and standardized data structures among stakeholders, empowering organizations to achieve their DT goals in the digital era.

4.1.5 People

The people dimension assesses stakeholders' digital literacy and willingness, particularly among employees, to embrace digital systems. This dimension emphasizes digital education, experience and literacy, focusing on individuals' knowledge and skills in utilizing digital technologies for decision-making [89]. It is widely acknowledged that people play a central role in DT programs across industries and sectors [119]. The impact of DT on employees is evident, with studies highlighting their vulnerability and the challenges they pose to successful DT implementation [128]. Barriers such as a lack of urgency and limited digital vision among individuals hinder the progress of DT [119], often rooted in a preference for familiar ways of working, fear of the unknown or a lack of motivation to disrupt established routines. To overcome these obstacles organizations pursuing DT must prioritize the development of their employees and enhance their digital maturity [97]. This involves implementing comprehensive training and development programs that focus on upskilling, reskilling and redefining roles and responsibilities to fully exploit the potential of emerging technologies [102]. In addition, acquiring digitally skilled employees and fostering a knowledge-sharing culture are critical for enhancing digital maturity. Attracting talent with digital and change management capabilities from diverse industries broadens an organization's skillset and perspectives [119]. Prioritizing the 'people' dimension in DT empowers organizations to create a digitally adept workforce capable of driving innovation, positioning them for success in the digital era.

4.1.6 Process

The process dimension evaluates the extent to which processes are digitized, integrated and effectively managed, encompassing data collection, sharing and utilization within the organization. A significant 62% of selected papers underscore the critical role of the process dimension in DT. This dimension focuses on both existing and newly developed routines and procedures that enhance data gathering, analysis and application, ultimately increasing operational effectiveness [129]. Digitized processes drive efficiency, productivity and agility by automating tasks and reducing manual efforts. Parviainen *et al.,* [130] highlight the streamlining effect of process digitization on operational

efficiency by eliminating time-consuming manual steps. Moreover, leveraging automation systems and workflow management tools further enhances operational efficiency and accuracy [131], resulting in improved performance, faster responses, better decision-making, cost reduction and increased competitiveness [15]. In addition to streamlining processes, process integration at intra-organizational and inter-organizational levels plays a vital role in promoting seamless coordination and collaboration [28]. By interconnecting workflows, sharing data and facilitating communication organizations can enhance operational efficiency and effectiveness [102]. Moreover, continuous process optimization is a key aspect of digital maturity, enabling organizations to enhance efficiency, eliminate bottlenecks and adapt to evolving business needs [19]. Looking to the future, the prospects of process digitization are promising, with advanced technologies like IoT, cloud computing and predictive analytics poised to revolutionize organizational processes and further drive digital maturity. These technologies have the potential to transform traditional processes and unlock new opportunities for organizations in the digital era.

4.1.7 Client (end-user)

The client (end-user) dimension, also known as the 'customer' dimension in the literature, focuses on how digital systems are designed and configured with end-users in mind and the level of empowerment provided to these users in accessing and utilizing relevant information and data. This dimension is crucial as it directly impacts end-user satisfaction and experience. Designing digital systems with a user-centric approach is essential for enhancing user satisfaction. By implementing intuitive interfaces, personalized experiences and seamless interactions, user satisfaction is enhanced, leading to greater adoption of digital solutions [132]. In addition, empowering end-users to access and utilize relevant information and data through digital systems is paramount. To ensure a positive end-user experience, gathering feedback from users and incorporating it into iterative improvements is essential [97]. Implementing feedback loops, conducting user surveys and leveraging user analytics enable organizations to identify pain points, address usability issues and continually enhance the digital experience [96,133]. Personalization and customization features play a significant role in tailoring digital experiences to user preferences, behaviours and historical data, fostering higher levels of user satisfaction, engagement and perceived value [37]. Furthermore, comprehensive user training and support programs are critical to enable users to effectively utilize digital systems [134]. Providing user documentation, tutorials and responsive support channels ensures that users have the necessary knowledge and assistance to maximize the benefits of digital solutions [135]. By addressing the needs of end-users and empowering them to access and utilize information effectively organizations can foster a positive and productive digital environment.

4.2 Conceptual FM Digital Maturity Model (FM-DMM)

This research envisions a digitally mature FM organization that effectively harnesses the opportunities presented by DT to optimize operations, enhance service delivery and drive strategic decision-making. To assess the progression of such organizations, a conceptual maturity model, depicted in Figure 3, is proposed. The proposed dimensions within the FM-DMM have been derived from a comprehensive analysis of selected papers (Table 5), taking into account the theoretical lens of DC. DC theory provides insight into how organizations can adapt and respond to the rapidly changing business and technological environment. It relates to the competencies, structures, processes and strategic decisions that enable organizations to recognize opportunities and reconfigure their capabilities [88], in response to rapid environmental changes [136]. In this study,

we argue that cultivating specific capabilities aligned with the identified dimensions of digital maturity is crucial for organizations to achieve such maturity and gain a competitive edge. The three clusters of DC proposed by Teece [88,92] - sensing, seizing and reconfiguring - are particularly relevant in the FM-DMM. Given the current state of the FM business landscape, characterized by significant environmental and technological volatility, including factors such as ever-increasing client expectations, a shift towards data ecosystems, competitive pressures and the digital shift, FM organizations must incorporate digital capabilities to identify and seize emerging opportunities. They must also reconfigure their strategies to proactively respond to the dynamic business environment.

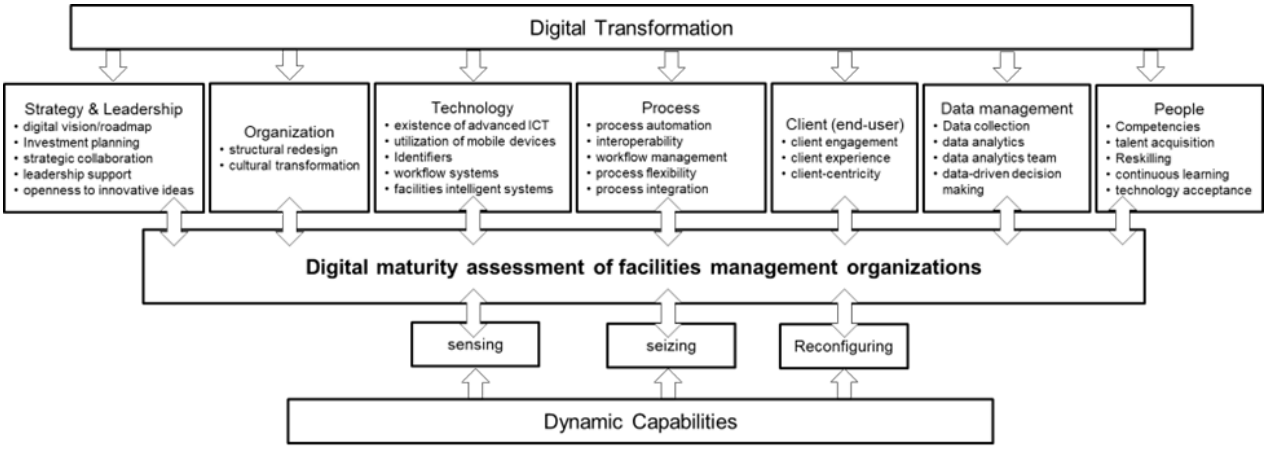

Fig. 3. Dimensions for digital maturity

At the core of the FM-DMM lies the dimension of strategy and leadership, which resonates with existing literature acknowledging its paramount importance in attaining maturity in the DT [30,110,137,138]. This dimension places emphasis on the strategic alignment of FM with DT initiatives and aligns with the seizing capabilities elucidated in the DC theory. It allows the model to assess FM organizations' ability to mobilize resources and make strategic decisions to capitalize on identified opportunities and mitigate potential threats. Furthermore, the model will assess the formulation of a well-defined DT roadmap and gauge the level of leadership commitment in propelling DT initiatives within the FM discipline. The organization dimension of the FM-DMM focuses on the structural aspects of FM organizations in the context of DT. It aligns with the sensing capabilities described in the DC theory, specifically through the cultivation of culture and structure capabilities that enable FM organizations to effectively sense their needs, identify business opportunities and recognize potential threats. By assessing the sensing ability of FM organizations, the model aims to evaluate their capacity to foster a digital culture and establish adaptive structures that facilitate the identification of DT opportunities. Additionally, the model will assess the agility, flexibility and adaptability of FM organizations in navigating the dynamic digital landscape.

In the context of DT within the FM sector, technology and process dimensions plays a pivotal role [3]. The technology dimension in the FM-DMM emphasizes the importance of adopting an integrated and strategic approach to leverage emerging digital technologies. Key areas of assessment will include the adoption and integration of various cutting-edge solutions such as CAFM, IWMS, BIM, IoT, digital twin, BDA, cloud computing, AI, reality technologies and smart building solutions. On the other hand, the process dimension focuses on optimizing FM operations through digitalization. On the other hand, the process dimension focuses on optimizing FM operations through digitalization. This will allow the model to assess the level of automation, efficiency gains and standardization achieved through the implementation of digital technologies in areas like maintenance, space management, energy management and asset tracking. By acting as reconfiguring capabilities, both

the technology and process dimensions align with the DC theory, enabling the integration of workflows and information to optimize facility operations and exploit business opportunities.

One unique feature of the model is the inclusion of the client (end-user) dimension, which is often overlooked in the FM literature related to digitalization [139]. The client (end-user) dimension emphasizes the importance of designing FM digital systems that prioritize end-users' needs and preferences, aiming to provide an exceptional user experience. This will enable the model to assess the extent to which FM organizations can customize their digital solutions to align with individual client requirements and workflows, ensuring seamless integration of client processes into digital systems for enhanced user satisfaction and adoption of digital FM solutions. An additional distinctive aspect of the model is the inclusion of data management as a dimension, recognizing that FM involves numerous information-intensive activities [140]. The model will assess the ability of FM organizations to acquire, integrate, store, analyse and utilize data, facilitating informed decision-making and leveraging data-driven insights. It will also assess the utilization of data analytics, predictive maintenance and performance monitoring to drive data-informed decision-making through a well-defined data management process. Finally, the people dimension emphasizes the skills, competencies and capabilities necessary to drive DT in FM. This will allow the model to assess the FM organization's initiatives in upskilling the workforce, acquiring talent and fostering a culture of continuous learning and innovation among its employees.

FM organizations are undergoing a transformative journey, transitioning towards data ecosystems centred around service analytics platforms that foster seamless integration and connectivity within the ecosystem [71]. This evolution is characterized by its dynamic and continuous nature, progressing from a moderate stage to a highly advanced state. However, accurately mapping the progress of this transformation becomes challenging due to the absence of a fixed point. The proposed FM-DMM will be designed to thoroughly explore and analyse the significant advancements within this evolutionary process, providing valuable guidance to FM organizations as they navigate the path towards maturity in the context of DT.

5. Conclusions

This study made significant contributions to the advancement of research on DT and maturity models in the FM domain, thereby pushing the boundaries of knowledge in this field. It endeavours to establish a systematic approach for facilitating the transformation of FM organizations into the realm of DT by proposing a conceptual maturity model. Grounded in dynamic capability theory, this study rigorously analyses the findings from systematic literature reviews to identify and incorporate seven key dimensions including strategy and leadership organization, technology, process, client (end-user), people and data management, into the proposed model for assessing the DT maturity of organizations. Dynamic capability theory was used in this study to substantiate the argument that organizations need to cultivate specific capabilities aligned with the identified dimensions of digital maturity in order to attain such maturity and consequently gain competitive advantages. The proposed Facilities management Digital Maturity Model (FM-DMM) holds significant theoretical implications as it provides cohesion to the strategic planning process of FM organizations through a comprehensive assessment of their capabilities across dimensions of strategy and leadership organization, technology, process, client (end-user), people and data management. The FM-DMM directly addresses the knowledge gap regarding DMMs in FM literature by aligning with the requirements of DT business scenarios. For instance, client (end-user) and data management have been less explored in digitalization projects within the FM sector, despite their significant relevance and impact on the overall DT process.

The proposed conceptual FM-DMM presented in this paper has the potential to establish benchmarks for DT within the FM sector by delineating the progressive characteristics of maturity, spanning from an initial state to a desired state of heightened maturity. This may indirectly benefit policymakers, decision makers and government bodies by providing them with valuable insights into the current state of the FM sector within their purview. This understanding can assist them in formulating targeted strategies, setting realistic targets and informing necessary policies and initiatives to foster DT in the FM sector. Further, the FM-DMM can serve as a valuable tool for consultants in evaluating the digital competencies of their clients, enabling them to provide tailored recommendations and develop comprehensive strategic roadmaps to guide organizations towards digital maturity and success.

While the findings of this study provide valuable insights, it is important to acknowledge the limitations of the proposed conceptual model. One limitation is that the FM-DMM is currently in a conceptual phase with identified dimensions critical for DT maturity. Nevertheless, it is our intention to further refine the model to ensure its comprehensiveness as an assessment framework, including defining maturity characteristics at different levels. This refinement process would necessitate gathering primary data from industry experts, including facilities managers, technology specialists and strategy managers, in order to enhance the model's sector-specific applicability. Additionally, to strengthen the model's validity and practical relevance, it would be beneficial to conduct validation studies using real-world organizational case studies within the FM sector.

Future research endeavours could involve conducting a comprehensive survey across various FM organizations to establish benchmarks and best practices for digital maturity within the FM sector. These benchmarks would provide valuable insights for FM organizations to compare their own digital maturity progress against industry standards, motivating them to strive for continuous improvement and maintain a competitive edge. Additionally, longitudinal studies tracking the digital maturity progression of FM organizations over time could offer valuable insights into the long-term impacts and benefits of adopting the FM-DMM. By monitoring the evolution of FM organizations' digital capabilities and assessing their outcomes and performance improvements, researchers can provide empirical evidence of the model's effectiveness in driving DT and achieving competitive advantages in the FM sector.

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