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Quantitative exploration of digital facility management adoption among United Arab Emirates facility managers

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A B S T R A C T

In the dynamic realm of facility management in the UAE, this study investigates the uptake of digital facility management systems among managers operating locally. The study aims to uncover the influential factors affecting technology acceptance within this sector. Its primary objective is to identify and understand the determinants that impact the adoption of these systems, utilizing a structured framework to analyze influential factors and their implications. The initial phase involves a systematic review to reveal trends in integrating digital technologies, focusing specifically on digital twin technology. Subsequently, quantitative surveys are conducted with 407 facility managers, guided by the UTAUT framework, employing statistical analyses to pinpoint key factors. Notably, Effort Expectancy and Performance Expectancy emerge as significant influencers, particularly influenced by the managerial level. This study provides detailed insights into the nuanced factors that drive acceptance, emphasizing the crucial role of constructs like Performance Expectancy and Effort Expectancy moderated by managerial level, shaping Behavioral Intention and Use Behavior. These findings offer practical implications for devising strategies to encourage the adoption of Digital Facility Management Systems in the UAE, laying the groundwork for future research and industry advancements.

1. Introduction

The evolving landscape of facility management (FM) amid global digital transformation, especially in emerging markets like the UAE, presents a burgeoning demand for top-tier FM services (Nota, Peluso, & Lazo, 2021; Rizvi, Pipetti, McIntyre, Todd, & Williams, 2020). Despite its nascent state, the UAE's FM market is gaining recognition as a strategic discipline crucial for (Mawed & Al-Hajj, 2017). The integration of intelligent technologies has become pivotal for ensuring price and performance satisfaction, enhancing business continuity, productivity, and profitability (Mawed & Al-Hajj, 2017 Schulze, 2019; Trzaska et al., 2021) This technological wave also ushers in potential disruptions and the need for new skills (Schulze, 2019). This study aims to understand and promote the adoption of digitized FM services, focusing on factors influencing facilities managers' willingness to adopt digitalization and IoT initiatives (Mawed & Al-Hajj, 2017). Tracing FM's historical evolution and its crucial role in organizational support (Appleby, 2018; Becker & Steele, 1990; Tucker & Masuri, 2016), the study seeks to address modern challenges by aligning FM with current and future business landscapes (Barrett & Baldry, 2009; Becker & Steele, 1990; Trzaska et al., 2021). Facilities management (FM) entails two managerial approaches: maintenance focus and leveraging facilities to align with business objectives (Curtis et al., 2017; Goulden & Spence, 2015). It evolved from equipment upkeep to a profession that serves business goals by enhancing the built environment (Goulden & Spence, 2015). Facilities managers handle strategic planning, daily maintenance, and sustainability targets (Curtis et al., 2017;Elmualim et al., 2012). Positioned in middle management, they influence organizational behavior by navigating stakeholders (Goulden & Spence, 2015).

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The integration of technology in Facilities Management (FM) triggered a significant shift towards investigating user acceptance (Lee, Kozar, & Larsen, 2003). Technology acceptance involves continual utilization (Kollmann, 2004) and encompasses a mindset influenced by various factors (Renaud & Van Biljon, 2008). Several theoretical frameworks, including the Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), and Unified Theory of Acceptance and Use of Technology (UTAUT), have emerged to explore the human-technology relationship (Sun & Zhang, 2006). These models offer crucial insights into end-user technology acceptance needs, with UTAUT particularly relevant to this study's context. The evolution of Facilities Management (FM) has been influenced by technological advancements, transforming it into a strategic entity impacting organizational performance (Barrett & Baldry, 2003; Pathirage et al., 2008). Building technology progression has shifted from analog to digital systems, significantly influencing the FM landscape (Wong et al., 2005; Alaloul et al., 2020). Computer-Aided Facilities Management (CAFM) systems introduced in the 2000s empowered real-time work order management and mobile data solutions (Prodgers, 2014). Current FM trends emphasize data analytics within platforms, requiring novel technologies for effective utilization (Fomunyam, 2019).Digitization involves converting analog to digital, while digitalization reshapes work processes and generates revenue streams (Chapco-Wade, 2018; Atta & Talamo, 2020a, 2020b). The convergence of building technology and operations supports intelligent utilization in the built environment (Johnny Kwok Wai Wong, Ge, & He, 2018), creating a need for adaptation in FM (Kensek, 2015). Big data in FM aids real-time information dissemination, operational assessment, and portfolio optimization (Mawed & Al-Hajj, 2017). Digitized FM enhances communication, manages data efficiently, and mitigates information loss due to staff turnover (Araszkiewicz, 2017). Automation streamlines workflows, enhances transparency, and offers real-time reports, while preventive maintenance minimizes downtime and reduces repair costs (Dahanayake & Sumanarathna, 2022). Digitized systems also optimize energy usage, reduce costs, and promote environmental sustainability (Atta & Talamo, 2020b). Overall, the integration of digitized FM systems fosters operational efficiency, data accuracy, and sustainability, culminating in improved organizational performance.

Quantitative methodology was employed to investigate the factors influencing digitization adoption in facilities management services among professionals in the UAE (Brewerton & Millward, 2001). This approach, considered fitting due to its focused objectives, utilized an online survey format to collect data from active facilities managers (Ponto, 2015). Acknowledging the practical challenges of surveying the entire population, a sample was chosen, employing the Statistical Package for the Social Sciences (SPSS) for analysis (Bryman, 2006). Quantitative research, rooted in the positivist paradigm, examines objective theories and relationships between variables (Kwadwo Antwi & Hamza, 2015). It aims to confirm predefined hypotheses using numerical data, distinguishing between descriptive (describing trends) and analytical (examining causal relationships) studies (Sukamolson, n.d.). Analytical designs further divide into experimental (where variables are controlled) and non-experimental (where the researcher is an observer) studies (Creswell & Poth, 2016). Quantitative research's strengths lie in precision, reproducibility, and statistical analysis, but limitations include minimal individual perspectives and the need for large sample sizes (Oppong, 2013); Choy, 2014). Overall, it offers a structured and objective approach to data collection and analysis but may limit subjective insights (Torrentira Jr., 2020).

The objective of this research was to examine the factors contributing to the acceptance of digital facility management services among UAE-based facility managers. This investigation aimed to address three specific research inquiries: firstly, to identify influential factors driving facility managers' acceptance of these services; secondly, to determine the key UTAUT constructs influencing facility managers' intention to adopt digital facility management services in the UAE; and finally, to assess the significance of UTAUT constructs in guiding facility managers' practical use of digital facility management services within the UAE setting.

2. Methodology

2.1 Design

This study employed a quantitative cross-sectional survey methodology to investigate digital facility management acceptance among UAE facility managers. Initially, 24 factors identified in the systematic review were grouped into 10 themes to streamline participant engagement and ensure clarity without compromising the essence of the factors. For instance, factors such as outcome improvement, user-specific configuration, and ease of use were consolidated under the Operational Efficiency theme. The grouping process, inspired by prior studies like (Khalifa, 2013, Alaboudi et al., 2016) aimed to minimize participant burden while maintaining alignment with established research.

The factors identified from the systematic review have been categorized into ten distinct themes, each contributing uniquely to the landscape of digital facility management acceptance among UAE facility managers. These themes encapsulate essential facets within the realm of facility management, ranging from Operational Efficiency (OE), which revolves around the availability of operational resources, to themes like Remote Monitoring (RM), emphasizing the necessity of qualified human resources. Predictive maintenance with IoT (PMI) underscores the significance of high-quality facility management systems and applications, while Building Information Modelling (BIM) emphasizes the adaptability of system functions according to users' needs. Energy Efficiency (EE) centers on the cost and energy reduction aspect, Communication & Collaboration (CC) highlights the connectivity of information systems, and Real-time Data Analytics (RD) focuses on technical competency and

work experience. Additionally, Prompt Maintenance (PM) points to the required education, training, and proficiency for job confidence, while Occupant Experience (OEX) delves into the positive engagement of individuals when perceiving technology's advantages. Lastly, Implementation Challenges (IC) address potential hurdles such as uncooperative behavior and resistance to change, collectively offering a comprehensive framework to comprehend the multifaceted nature of digital facility management acceptance among facility managers in the UAE.

2.2 Data Collection

For data collection, our quantitative research used structured questionnaires via online platforms, offering efficient yet potentially biased responses. These surveys gather precise data on perceptions and demographics, employing both open and closed-ended questions, notably Likert scales. The questionnaire covered demographic details through multiple-choice questions and 37 Likert-scale-based queries centered on UTAUT components. This method allowed participants to express their opinions on technology adoption. Our sampling strategy aimed for diversity, recruiting 407 participants from varied professional backgrounds to ensure comprehensive insights into the research topic. In the research targeted facility managers at all levels in the UAE. To overcome the challenge of identifying these managers across diverse backgrounds, invitations were sent to the entire potential population via Google Forms. This broad approach aimed to gather insights from facility managers across various sectors, offering a comprehensive understanding of influential factors within the UAE's facility management landscape.

2.3 Sample design

The calculation for sample size, based on a 95% confidence interval and a 5% margin of error, indicated that a representative sample size should be 384. However, the study received a total of 407 responses, surpassing the initially calculated sample size.

2.4 Questionnaire design

An online questionnaire comprising four sections was designed, drawing from two primary sources. The questionnaire integrated factors identified in the above section as pertinent to digital facility management acceptance in the UAE, sourced from multiple stakeholders, and validated questionnaire items derived from the UTAUT model (Venkatesh, Morris, Davis, & Davis, 2003). Hosted on the Online Surveys platform and accessible via a Google Forms link, the questionnaire was conducted in English and encompassed demographic queries, attitudinal scales assessing the importance of the ten themes, UTAUT-based modified items using five-point Likert scales, and an optional section for participants willing to engage in follow-up interviews. To ensure the instrument's validity, experts in UAE facility management were invited to assess its content and clarity. A pilot study was conducted to gather feedback on comprehension, questionnaire completion time, and language clarity, with comments suggesting a need for more concise language in the introduction. The estimated time for questionnaire completion ranged between 10 to 15 minutes. The study incorporated evidence-based strategies to enhance participation, aligning with recommendations by Nair et al. and Nair, (2019) emphasizing clarity about the study, underscoring the value of participation, considering questionnaire length, ensuring confidentiality, and employing reminder messages for participants.

2.5 Quantitative data analysis.

The questionnaire data underwent meticulous cleaning in SPSS after export from the online surveys platform, ensuring accuracy by checking spelling and removing extraneous spaces. The analysis unfolded across three structured steps: firstly, employing the Relative Importance Index (RII) in IBM SPSS v25 to identify significant factors influencing facility managers' acceptance in the UAE; secondly, mapping these factors against UTAUT constructs, overseen by the Principal Investigator and confirmed by a team member for accuracy; and finally, conducting comprehensive analysis encompassing descriptive statistics, Principal Component Analysis (PCA), and Logistic Regression Analysis using IBM SPSS v25. This methodological approach offered a systematic exploration of the dataset, revealing crucial insights into the influential factors shaping facility managers' acceptance within the UAE context.

A. Step 1

Determine significant factors influencing facility managers for acceptance in UAE (RII). The formula of the RII is as follows:

$$\mathrm{RII} = \frac{\sum \mathrm{W}}{\mathrm{A} \times \mathrm{N}} \tag{1}$$

$$\mathrm{RII} = \frac{\mathrm{W5} \times (\mathrm{n5}) + \mathrm{W4} \times (\mathrm{n4}) + \mathrm{W3} \times (\mathrm{n3}) + \mathrm{W2} \times (\mathrm{n2}) + \mathrm{W1} \times (\mathrm{n1})}{\mathrm{A} \times \mathrm{N}} \tag{2}$$

where, W=weights given to each factor by the respondents, Ranging from5 to 1 where ‘5’ is most important and ‘1’ least important.

A= highest weight(i.e.5),
N=total number of respondents, and n=number of respondents who selected an answer ranging from 5 to1.

B. Step 2

Map the RII identified significant factors against UTAUT constructs. Fig. 1 shows the adopted UTAUT theory with modifications for this study.

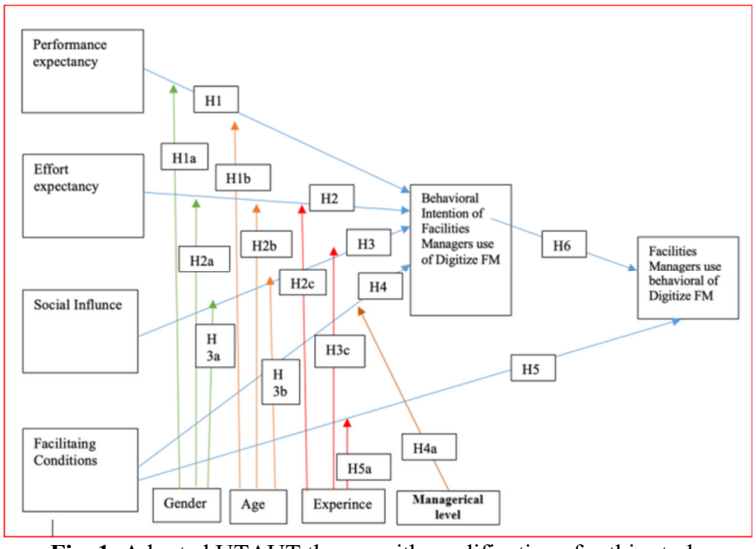

Fig. 1. Adopted UTAUT theory with modifications for this study

C. Step 3

The statistical analysis in the final step involved using the Statistical Package for Social Sciences (SPSS, v25) to conduct the following procedures:

- Descriptive Statistic.
- Principal Component Analysis (PCA).
- Ordinal Regression Analysis.

3. Results

A total of 407 responses were gathered, affirming the representation of the targeted population, primarily consisting of facility managers. Table 1 provides an overview of participants demographics, indicating that 53.1% (n=216) of participants were male. Within the sample, 48.4% (n=197) fell within the 20-25 age bracket. Approximately 27% (n=110) held mid-level managerial positions, while 53.3% (n=178) possessed managerial experience spanning less than three years, and 16% (n=65) had over 12 years of experience. A significant majority, about 65.4% (n=266), operated within facility management facilities located in urban areas across the UAE.

Table 1
Characteristics of participants:

Profile	Frequency	Percentage	Profile	Frequency	Percentage
Gender:			**Managerial level**		
Male	216	53.1	Top level	65	16.0
Female	190	46.7	Middle Level	110	27.0
Prefer not to say	1	0.2	Low level	10	2.5
Age (years):			First line	81	19.9
Under 20	49	12.0	Others	141	34.6
20-25	197	48.4	**Managerial experience (years):**		
25-30	46	11.3	< 3	217	53.3
30-35	37	9.1	3 to 6	66	16.2
35-40	24	5.9	6 to 9	40	9.8
40-45	21	5.2	9 to 12	10	2.5
45-50	14	3.4	over 12	74	18.2
Over 50	19	4.7			

2.6 RII Analysis results

The comprehensive RII analysis demonstrated the significance of all factors identified by multiple stakeholders among facility managers, each exhibiting varying levels of importance. As per Al-Saleh & Al-Kadiri, (2000); Çetin & Koyuncu, (2020), an RII value of ≥0.60 is considered significant. Within this analysis, the RII values spanned from the most pivotal theme, Implementing Challenges Resolution (IC; 0.7661), to the least prominent theme, Communication and Collaboration (CC; 0.7410) as outlined in Table 2.

Table 2
RII Analysis results

Themes	Overall RII	Rank
IC	0.7661	1
OEX	0.7553	2
BIM	0.7533	3
RD	0.7509	4
PM	0.7494	5
EE	0.7484	6
OE	0.7474	7
RM	0.7469	8
PMI	0.7430	9
CC	0.7410	10

2.7 Mapping the factors

Following the thematic definitions, the process of aligning factors with UTAUT constructs was undertaken. All established significant themes (as indicated in Table 2) were included in the mapping procedure, depicted in Fig. 2.

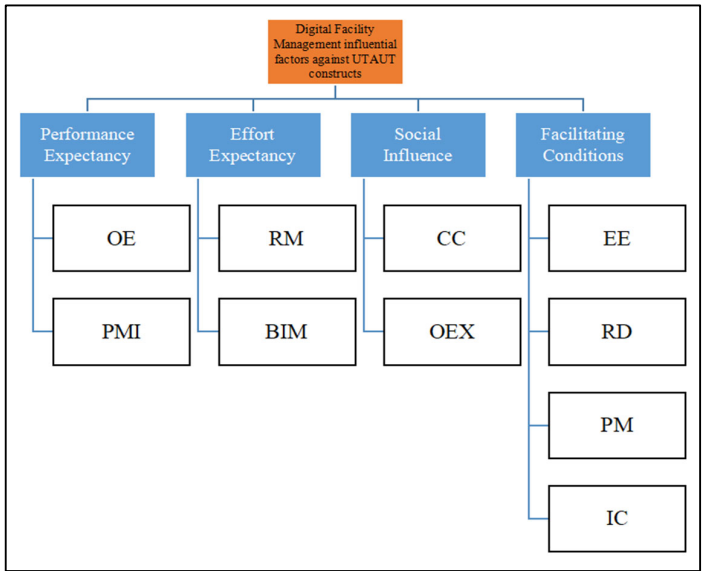

Fig. 2. Mapping Factors to UTAUT Constructs

2.8 Statistical Analysis

2.8.1 UTAUT Analysis Findings

Three UTAUT constructs potentially influence Behavioural Intention, while two affect Use Behaviour. Performance Expectancy, indicating the system's perceived enhancement in work performance, saw strong agreement, except for the statement about service user's role in promotion, garnering a neutral response from 14.3% (n=58). Effort Expectancy, representing system simplicity, received considerable agreement, especially on how system complexity impacts service utilization (68.5%, n=278). Social Influence, gauging external encouragement, recorded higher agreement for top management support (71.7%) and facility manager participation (69%). Facilitating Conditions, highlighting system support, had comparatively lower agreement, with only 69% confirming access to information resources and 70.3% (n=286) noting system use influenced by technological accessibility. Behavioural Intention, assessing future behaviour likelihood, showed consistent agreement for the first two statements (72.5% and 72%), while the third statement on continued usage demonstrated slightly lower agreement (69.2%).

2.8.2 Principal Component Analysis (PCA)

The PCA was applied to condense the numerous interconnected UTAUT variables. In social sciences, Hair et al. (1998) highlighted that accounting for 60% or even less of the total variance could be considered satisfactory due to the nature of less precise information. This statistical process becomes viable when variables display strong correlation (Kim, 1996) and are confirmed as factorable using the (Kaiser, 1974) (KMO) Measure of Sampling Adequacy, where values ideally surpass 0.5 (Kaiser, 1974). Across all UTAUT constructs, a robust correlation was evident, and KMO values ranged from 0.8753 (FC) to 0.9519 (PE). Additionally, the Bartlett's Test of Sphericity demonstrated high significance levels (sig.≤0.05).

Table 3
KMO and Bartlett's Test for all UTAUT constructs

Construct	KMO Measure of Sampling Adequacy	Bartlett's Test of Sphericity significance
Performance Expectancy	0.9519	0.0*
Effort Expectancy	0.9219	0.0*
Social Influence	0.9134	0.0*
Facilitating Conditions	0.8753	0.0*
Behavioral Intention	0.9298	0.0*

Cronbach's alpha, a measure of reliability, was employed to assess internal consistency within the UTAUT constructs. As per Gliem & Gliem (2003) values closer to 1 indicate stronger internal consistency, with 0.9 and above considered excellent and 0.7 and above considered acceptable (Gliem & Gliem, 2003). Table 4 showcases the internal consistency levels of all constructs, ranging from 0.940 (excellent) to 0.899 (good).

Table 4
Internal Consistency of UTAUT constructs

Constructs	Cronbach's alpha	Internal consistency
Performance Expectancy (PE)	.913	Excellent
Effort Expectancy (EE)	.899	Good
Social Influence (SI)	.925	Excellent
Facilitating Conditions (FC)	.940	Excellent
Behavioral Intention (BI)	.924	Excellent

Table 5 presented the examination of correlations among UTAUT constructs, indicating a significant positive correlation at a p-value of less than 0.01. The most robust correlation surfaced between FC and SI, registering a value of r=.89, demonstrating a strong positive relationship.

Table 5
UTAUT Constructs Correlation

	Mean	SD	PE	EE	SI	FC	BI
PE	3.83	1.22	1				
EE	3.71	1.15	0.79**	1			
SI	3.78	1.2	0.79**	0.84**	1		
FC	3.75	1.18	0.82**	0.88**	0.89**	1	
BI	3.84	1.22	0.8**	0.84**	0.82**	0.86**	1

**Correlation is significant at the 0.01 level (2-tailed).

2.8.3 Ordinal Regression Analysis

The Normality tests conducted on the extracted Principal Components (PC) displayed considerable deviations from a normal distribution. Consequently, ordinal regression was chosen as a statistically suitable method to derive meaningful interpretations from the final PC scores. These regression coefficients offer a probabilistic understanding of the likelihood of transitions between the three ordinal scale values. Adopting a three-fold ordinal scaling—categorized as Low, Medium, and High—for the PC scores involved dividing each score range (i.e., maximum - minimum) into three equal intervals to establish their ordinal equivalents. Subsequently, ordinal regression was applied to model both Behavioral Intention and Use Behavior. The distributional spread of the ordinal groups for each construct is outlined in Table 6.

The ordinal regression analysis of UTAUT constructs was performed across three stages. Initially, it involved examining individual constructs alongside socio-demographic factors concerning Behavioral Intention (BI) and Use Behavior (UB). Subsequently, a comprehensive analysis encompassed all constructs, including socio-demographics, concerning BI and UB. Lastly, focusing solely on the constructs validated as significant, the analysis centered on Behavioral Intention (BI) and Use Behavior (UB). These sequential rounds allowed for a nuanced exploration of the impact and significance of UTAUT constructs in relation to socio-demographics on both Behavioral Intention and Use Behavior.

Table 6
Ordinal Groups for UTAUT Constructs(N=407)

Constructs	Ordinal groups	Number of participants	Marginal %
Performance expectancy (PE)	1 - Low	30	7.4
	2 - Medium	99	24.3
	3- high	278	68.3
Effort Expectancy (EE)	1 - Low	26	6.4
	2 - Medium	118	29.0
	3- high	263	64.6
Social Influence (SI)	1 - Low	32	7.9
	2 - Medium	101	24.8
	3- high	274	67.3
Facilitating Condition (FC)	1 - Low	31	7.6
	2 - Medium	101	24.8
	3- high	275	67.6
Behavioral Intention (BI)	1 - Low	34	8.4
	2 - Medium	92	22.6
	3- high	281	69.0

Round 1-A: In the study's initial round (A), ordinal regression analyses were independently conducted for distinct UTAUT constructs concerning Behavioural Intention (BI) and their potential relationships with socio-demographic variables. Firstly, Performance Expectancy (PE) exhibited significance moderated by Age in influencing BI, indicating lower PE strongly associated with lower BI. Gender also played a role, affecting BI, alongside Managerial Level's influence, especially for middle-level managers. Effort Expectancy (EE) similarly showed significance moderated by age, with lower EE significantly impacting BI. Social Influence (SI) also played a substantial role in affecting BI, particularly lower and medium levels contributing to reduced BI. However, Facilitating Conditions (FC) showed significance in impacting BI without any socio-demographic moderation. Across these analyses, gender, managerial level, managerial experience, and age showcased varying degrees of influence on BI, emphasizing their importance in predicting behavioural intentions. Overall, these findings highlighted the significant impact of PE, EE, SI, and FC on BI, while also emphasizing the nuanced influence of socio-demographic variables on behavioural intentions.

Round 1-B: In the subsequent round (B) of the study, ordinal regression analyses examined various constructs alongside socio-demographic variables to determine their influence on Use Behaviour (UB). Results revealed distinctive impacts: both "Low" and "Medium" levels of Performance Expectancy (PE) significantly affected UB negatively, while specific age groups showed notable effects; Effort Expectancy (EE) demonstrated similar negative impacts at these levels. Social Influence (SI) at lower levels also notably affected UB negatively. Surprisingly, Facilitating Conditions (FC) showed no significant impact on UB across all levels. Behavioural Intention (BI) at “Low” and “Medium” levels significantly and negatively affected UB. Throughout these analyses, Gender, Managerial level, Managerial experience, and age exhibited minimal influence on UB, emphasizing the dominance of PE, EE, SI, and BI in shaping Use Behaviour.

Round 1-C: In the first rounds (C), the significant factors identified from both rounds (A) and (B) underwent testing against distinct moderators. The results indicated that only two moderators, Gender and managerial level, were significant in moderating the influence of Performance Expectancy (PE) and Effort Expectancy (EE) on Behavioural Intention. Consequently, a modified version of the UTAUT model was devised, as depicted in Figure 3 after the initial regression analysis. However, in collaboration with a Chartered Statistician, it was advised to conduct a second round to comprehensively consider all confirmed significant constructs for a more holistic perspective.

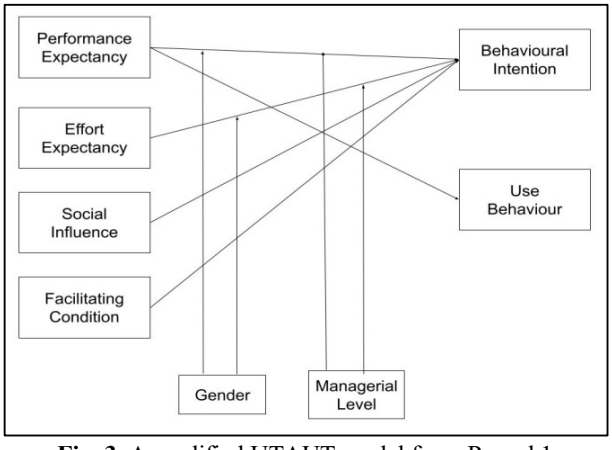

Fig. 3. A modified UTAUT model from Round 1

Round 2-A: In the second round (A) of regression analysis, a comprehensive overview of previously identified significant constructs revealed that only two, Performance Expectancy (PE) and Effort Expectancy (EE), moderated by managerial level, remained significant in influencing Behavioural Intention (BI). PE showed significance in both "low" ($p = 0.034$) and "medium" ($p = 0.028$) groups, while SI was significant solely in the "low" group ($p <= 0.05$) concerning BI. The detailed regression results illustrate that PE maintained significance in the "low" ($p = 0.101$) and "medium" ($p = 0.003$) groups, emphasizing its impact on BI, as EE's influence varied across different levels. The analysis confirmed the limited influence of constructs like Social Influence (SI) and Facilitating Conditions (FC) on BI, reinforcing the dominance of PE and EE moderated by managerial level in shaping Behavioural Intention.

Round 2-B: In the second phase (B), the analysis focuses solely on the relationship between Performance Expectancy (PE) and Use Behaviour (UB). The ordinal regression results demonstrate a significant influence of PE on UB, with both "Low" and "Medium" levels showing substantial negative impacts on UB, reflected in p-values less than 0.001. This suggests a decrease in UB as PE decreases from "Low" to "Medium". Notably, other variables are omitted in this analysis, solely presenting parameter estimates for PE concerning UB. Overall, PE significantly influences UB, indicating lower PE levels correspond to reduced UB. This phase led to a modified UTAUT model combining two distinct parts (Fig. 4), prompting a subsequent round of analysis to uncover potential connections.

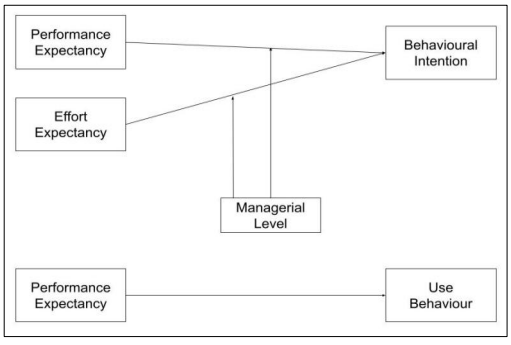

Fig. 4. An updated UTAUT Model from Round-2

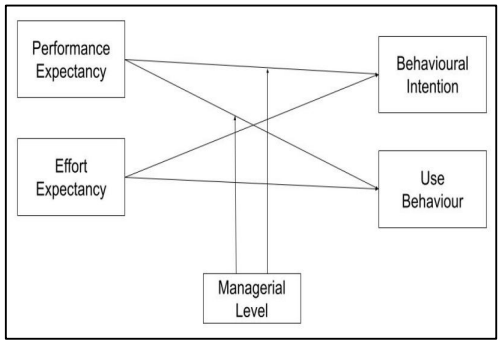

Fig. 5. Final version of UTAUT model from Round-3

Round 3: In the third phase (A), a fresh analysis was carried out to pinpoint the impact of Effort Expectancy (EE) on Use Behaviour (UB). The examination focused on EE's influence on Behavioural Intention (BI), highlighting specific findings: For EE at the "Low" level, the p-value stands at 0.891, indicating no statistically significant effect on BI, surpassing the typical significance threshold of 0.05. Conversely, EE at the "Medium" level holds a p-value of 0.048, below 0.05, signifying a significant impact on BI. This suggests that EE at the "Medium" level significantly influences Behavioural Intention. The detailed regression results also present estimates for UB categories alongside EE levels. This round's outcomes led to the final modified UTAUT model tailored to facility managers' acceptance of a digital facility management system in the UAE, as depicted in Fig. 5.

3. Discussion

This research utilizes the Unified Theory of Acceptance and Use of Technology (UTAUT) model to examine the drivers of Behavioural Intention (BI) and Use Behaviour (UB) regarding the adoption of Digital Facility Management Systems in the United Arab Emirates (UAE). Our analysis highlights key influencers and presents nuanced insights into users' attitudes and actions regarding this innovative system. The outcomes emphasize the substantial impact of Performance Expectancy (PE) on Behavioural Intention (BI). Lower PE levels are strongly linked to diminished BI, indicating that users' perceptions about the system's performance significantly influence their willingness to utilize it. Strategies aimed at bolstering acceptance should prioritize enhancing these performance expectations by showcasing the system's capabilities and advantages.

Gender dynamics play a role in BI, with both genders displaying reduced odds of lower BI. However, females demonstrate a slightly more pronounced effect, suggesting gender-specific variations in acceptance levels. Customized approaches for different gender groups could optimize the system's acceptance. Managerial Level emerges as a significant factor, notably with middle-level managers exhibiting higher BI. Understanding how organizational hierarchy influences the intention to use is crucial. Tailoring strategies and training programs for different managerial tiers becomes essential for broader acceptance within organizations.

Effort Expectancy (EE) significantly influences BI, underscoring that users' perception of the effort required to operate the system strongly affects their intentions. Streamlining system usage and minimizing perceived effort are critical for enhancing acceptance. Other factors like age, managerial experience, and social influence exhibit limited impact on BI, highlighting the dominance of PE and EE. However, considering these factors while devising user-specific strategies remains crucial.

Facilitating Condition (FC) appears to have minimal influence on BI, indicating that users' perceptions of available resources and usage conditions have little bearing on their intention to use the system. Similarly, in Use Behaviour (UB), PE and EE stand out significantly, while Gender, Managerial Level, and Managerial Experience exhibit limited influence. Social Influence (SI) significantly shapes UB, implying that peer pressure or social cues substantially impact users' actual behaviour concerning the system. Employing social influence strategies becomes critical in encouraging system usage.

PE and EE emerge as pivotal factors influencing BI and UB. Prioritizing strategies to enhance PE perception and reduce perceived effort could effectively bolster system acceptance and usage within organizations.

4. Limitations

This study's strengths rest in its use of the well-established Unified Theory of Acceptance and Use of Technology (UTAUT), providing a robust framework for interpreting findings across various domains like academia, commerce, and healthcare. Despite UTAUT's recognized efficacy in explaining technology acceptance, there's an ongoing lack of consensus regarding its standardized model, leading to variations in constructs and the omission of core moderators in different studies. This necessitates further exploration into augmenting the theory with external constructs or modifying existing ones, aligning with Williams et. al.'s recommendations. Additionally, the multidisciplinary research team contributed diverse perspectives, enhancing the outcomes. However, limitations include a focus solely on digital facility management from the perspective of facility managers, limiting generalization, and relying solely on online questionnaires due to specific objectives and resource constraints. The study's statistical analysis also faced challenges due to the primary author's limited expertise, necessitating guidance from a Chartered Statistician.

5. Conclusion

The quantitative survey sought to investigate the factors affecting the acceptance of digital facility management systems within UAE facility managers. Through an online questionnaire, data was collected from 407 facility managers, initiating the initial phase of a mixed methods design, followed by qualitative exploration. Utilizing a modified UTAUT framework, the study categorized identified factors into 10 themes and correlated them with UTAUT constructs. Refinement of the UTAUT model occurred via three rounds of regression analysis, pinpointing Effort Expectancy (EE) and Performance Expectancy (PE) as substantial influencers of both Behavioural Intention (BI) and Use Behaviour (UB), moderated by managerial level. The study also highlighted age as a key moderator impacting PE and Social Influence (SI) on BI. These findings carry significant implications for improving the uptake of Digital Facility Management Systems in the UAE, advocating for tailored strategies that leverage critical UTAUT constructs. Overall, this research emphasizes the relevance of the UTAUT framework in understanding technology acceptance, aligning identified factors with its constructs, and offering valuable insights for future studies.

In further research on exploration in diverse cultural contexts, long-term observations of system evolution, user-driven design, age-related factors, and understanding resistance are key areas for advancing digital facility management acceptance.

References

Alaboudi, A., Atkins, A., Sharp, B., Balkhair, A., Alzahrani, M., & Sunbul, T. (2016). Barriers and challenges in adopting Saudi telemedicine network: The perceptions of decision makers of healthcare facilities in Saudi Arabia. *Journal of Infection and Public Health*, 9(6), 725–733.

Alaloul, W. S., Liew, M. S., Zawawi, N. A. W. A., & Kennedy, I. B. (2020). Industrial Revolution 4.0 in the construction industry: Challenges and opportunities for stakeholders. *Ain Shams Engineering Journal*, 11(1), 225–230. Retrieved from https://doi.org/10.1016/j.asej.2019.08.010

Al-Saleh, M. F., & Al-Kadiri, M. A. (2000). Double-ranked set sampling. *Statistics & Probability Letters*, 48(2), 205–212.

Appleby, P. (2018). *Sustainable facilities management* (2018th ed.). Retrieved from https://www.google.co.in/books/edition/Routledge_Handbook_of_Sustainable_Real_E/PmgPEAAAQBAJ?hl=en&gbpv=1&dq=Appleby%2C%20T.%20(2018)%20facility%20management&pg=PA253&printsec=frontcover

Araszkiewicz, K. (2017). Digital Technologies in Facility Management - The state of Practice and Research Challenges. In *Procedia Engineering* (Vol. 196, pp. 1034–1042). Elsevier Ltd. Retrieved from https://doi.org/10.1016/j.proeng.2017.08.059

Atta, N., & Talamo, C. (2020a). Digital transformation in facility management (FM). IoT and big data for service innovation. In *Digital Transformation of the Design, Construction and Management Processes of the Built Environment* (pp. 267–278). Springer, Cham.

Atta, N., & Talamo, C. (2020b). facility management services in smart cities: trends and perspectives. In *Smart Innovation, Systems and Technologies* (Vol. 177 SIST, pp. 220–230). Springer. Retrieved from https://doi.org/10.1007/978-3-030-52869-0_19

Barrett, P, & Baldry, D. (2003). Total facilities management towards best practice. *Malden: Blackwell Science Inc*.

Barrett, P., & Baldry, D. (2009). *Facilities management: Towards best practice*. John Wiley & Sons.

Becker, F., & Steele, F. (1990). The total workplace. *Facilities*.

Brewerton, P. M., & Millward, L. J. (2001). *Organizational Research Methods: A Guide for Students and Researchers* (unabridged). SAGE, 2001.

Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done? *Qualitative Research*, 6(1), 97–113. Retrieved from https://doi.org/10.1177/1468794106058877

Çetin, A. E., & Koyuncu, N. (2020). Estimation of population mean under different stratified ranked set sampling designs with simulation study application to BMI data. *Communications Faculty of Sciences University of Ankara Series A1 Mathematics and Statistics*, 69(1), 560–575.

Chapco-Wade, C. (2018). Digitization, digitalization, and digital transformation: What's the difference. *URL: Https://Medium. Com/@ Colleenchapco/Digitization-Digitalization-and-Digital-Transformation-Whats-the-Difference-Eff1d-002fbdf (Дата Звернення: 01.02. 2020)*.

Choy, L. T. (2014). *The Strengths and Weaknesses of Research Methodology: Comparison and Complimentary between Qualitative and Quantitative Approaches*. *IOSR Journal Of Humanities And Social Science (IOSR-JHSS* (Vol. 19). Retrieved from www.iosrjournals.org

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

Curtis, J., Walton, A., & Dodd, M. (2017). Understanding the potential of facilities managers to be advocates for energy efficiency retrofits in mid-tier commercial office buildings. *Energy Policy*, 103, 98–104. Retrieved from https://doi.org/10.1016/j.enpol.2017.01.016

Dahanayake, K. C., & Sumanarathna, N. (2022). IoT-BIM-based digital transformation in facilities management: a conceptual model. *Journal of Facilities Management*, 20(3), 437–451. Retrieved from https://doi.org/10.1108/JFM-10-2020-0076

Elmualim, A., Valle, R., & Kwawu, W. (2012). Discerning policy and drivers for sustainable facilities management practice. *International Journal of Sustainable Built Environment*, 1(1), 16–25.

Fomunyam, K. G. (2019). Education and the fourth industrial revolution: Challenges and possibilities for engineering education. *Int. J. Mech. Eng. Technol.(IJMET)*, 10, 23–25.

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. Midwest Research-to-Practice Conference in Adult, Continuing, and Community ….

Goulden, M., & Spence, A. (2015). Caught in the middle: The role of the Facilities Manager in organisational energy use. *Energy Policy*, 85, 280–287. Retrieved from https://doi.org/10.1016/j.enpol.2015.06.014

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, 39(1), 31–36.

Kensek, K. (2015). BIM Guidelines Inform Facilities Management Databases: A Case Study over Time. *Buildings*, 5(3), 899–916. Retrieved from https://doi.org/10.3390/buildings5030899

Khalifa, M. (2013). Barriers to health information systems and electronic medical records implementation. A field study of Saudi Arabian hospitals. *Procedia Computer Science*, 21, 335–342.

Kollmann, T. (2004). Attitude, adoption or acceptance? Measuring the market success of telecommunication and multimedia technology. *International Journal of Business Performance Management*, 6(2), 133–152.

Kwadwo Antwi, S., & Hamza, K. (2015). *Qualitative and Quantitative Research Paradigms in Business Research: A Philosophical Reflection*. *European Journal of Business and Management www.iiste.org ISSN* (Vol. 7). Retrieved from Online: www.iiste.org

Lee, Y., Kozar, K. A., & Larsen, K. R. T. (2003). The Technology Acceptance Model: Past, Present, and Future. *Communications of the Association for Information Systems*, 12. Retrieved from https://doi.org/10.17705/1CAIS.01250

Mawed, M., & Al-Hajj, A. (2017). Using big data to improve the performance management: a case study from the UAE FM industry. *Facilities*, 35(13/14), 746–765. Retrieved from https://doi.org/10.1108/F-01-2016-0006

Nair, J., Chellasamy, A., & Singh, B. N. B. (2019). Readiness factors for information technology adoption in SMEs: testing an exploratory model in an Indian context. *Journal of Asia Business Studies*, 13(4), 694–718. Retrieved from https://doi.org/10.1108/JABS-09-2018-0254

Nair, K. (2019). Overcoming today's digital talent gap in organizations worldwide. *Development and Learning in Organizations*, 33(6), 16–18. Retrieved from https://doi.org/10.1108/DLO-02-2019-0044

Nota, G., Peluso, D., & Lazo, A. T. (2021). The contribution of Industry 4.0 technologies to facility management. *International Journal of Engineering Business Management*, 13, 184797902110241–184797902110241. Retrieved from https://doi.org/10.1177/18479790211024131

Oppong, S. H. (2013). The problem of sampling in qualitative research. *Asian Journal of Management Sciences and Education*, 2(2), 202–210.

Pathirage, C., Haigh, R., Amaratunga, D., & Baldry, D. (2008). Knowledge management practices in facilities organisations: a case study. *Journal of Facilities Management*.

Ponto, J. (2015). Understanding and Evaluating Survey Research. *Journal of the Advanced Practitioner in Oncology*, 6(2), 168–171.

Prodgers, L. (2014). International trends and developments in FM. *Facility Management Journal, International Facility Management Association*.

Rizvi, S., Pipetti, R., McIntyre, N., Todd, J., & Williams, I. (2020). Threat model for securing internet of things (IoT) network at device-level. *Internet of Things*, 11, 100240.

Schulze, E. (2019). Everything you need to know about the Fourth Industrial Revolution. *CNBC, Cnbc. Com*.

Sukamolson, S. (n.d.). *Fundamentals of quantitative research*.

Sun, H., & Zhang, P. (2006). The role of moderating factors in user technology acceptance. *International Journal of Human-Computer Studies*, 64(2), 53–78.

Torrentira Jr., M. C. (2020). ONLINE DATA COLLECTION AS ADAPTATION IN CONDUCTING QUANTITATIVE AND QUALITATIVE RESEARCH DURING THE COVID-19 PANDEMIC. *European Journal of Education Studies*, 7(11). Retrieved from https://doi.org/10.46827/ejes.v7i11.3336

Trzaska, R., Sulich, A., Organa, M., Niemczyk, J., & Jasiński, B. (2021). Digitalization Business Strategies in Energy Sector: Solving Problems with Uncertainty under Industry 4.0 Conditions. *Energies*, 14(23), 7997. Retrieved from https://doi.org/10.3390/en14237997

Tucker, M., & Masuri, M. R. A. (2016). The rationale to integrate facilities management into the development process. *Property Management*, 34(4), 332–344. Retrieved from https://doi.org/10.1108/PM-08-2015-0040

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), 425. Retrieved from https://doi.org/10.2307/30036540

Wong, J. K., Li, H., & Wang, S. W. (2005). Intelligent building research: a review. *Automation in construction*, *14*(1), 143-159. Retrieved from https://doi.org/10.1016/j.autcon.2004.06.001

Wong, J. K. W., Ge, J., & He, S. X. (2018). Digitisation in facilities management: A literature review and future research directions. *Automation in Construction*, *92*, 312-326. Retrieved from https://doi.org/10.1016/j.autcon.2018.04.006