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The micro-foundations of digitally transforming SMEs: How digital literacy and technology interact with managerial attributes

Nadia Zahoor [a,b,*], Anastasios Zopiatis [c], Samuel Adomako [d], Grigorios Lamprinakos [d]

[a] Department of Business and Society, School of Business and Management, Queen Mary University of London, E1 4NS, UK
[b] InnoLab, University of Vaasa, Finland
[c] Department of Hotel and Tourism Management, School of Management and Economics, Cyprus University of Technology, 30 Archbishop Kyprianos Street, 3036 Limassol, Cyprus
[d] Birmingham Business School, University of Birmingham, Edgbaston, Birmingham, UK

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ABSTRACT

Research often illustrates the importance of digital transformation for small and medium-sized enterprises (SMEs), particularly during external disruptions. However, little attention has been devoted to how SMEs' digital transformation occurs. Employing a micro-foundations perspective, this study investigates the effect of managers' digital literacy (MDL) on SMEs' digital transformation. We test a moderated mediation model using survey data from 158 SMEs operating in the United Arab Emirates. Our findings suggest that MDL impacts digital transformation through the usage of digital technologies. Moreover, the relationship between MDL and the usage of digital technologies is further moderated by managerial attributes (i.e., gender, education, and age). Theoretical and practical implications are discussed.

1. Introduction

As digitalization continues to expand across the globe, researchers have sought to understand how managers' digital literacy (MDL) affects firm outcomes, such as innovation and performance (Tortora et al., 2021; Usai et al., 2021). MDL comprises more than a manager's ability to use digital devices or software. Rather, it involves a complex set of sociological, emotional, and cognitive skills that allow managers to function effectively in the digital environment (Mohammadyari & Singh, 2015). These skills broadly include the ability to use digital tools and technologies to identify and access new knowledge (Baber et al., 2022; Cetindamar et al., 2021).

Interestingly, MDL has been identified as a crucial skill for individuals to help them transform their organizations and achieve superior performance (Garzoni et al., 2020). Indeed, the fourth industrial revolution (i.e., Industry 4.0) has led to increased patronage of digital technologies such as the Internet of Things (IoT), big data, artificial intelligence (AI), robotics, cloud computing, additive manufacturing, augmented and virtual reality, and many other related digital innovations (Cui et al., 2021; Nambisan, 2017). The diffusion of these digital technologies is radically transforming organizational processes and business models (Garzoni et al., 2020; Rodgers et al., 2021; Urbinati et al., 2020). Given the rapid and radical transformation brought about by digital technologies, it is critical for managers to embrace the digital revolution in order to innovate and grow (Matt et al., 2015; Scuotto et al., 2021). Thus, digital transformation has become an area of keen interest for researchers and practitioners alike (Garzoni et al., 2020; Li et al., 2018).

Researchers have paid substantial attention to the influence of MDL on several research outcomes, including entrepreneurship (Nambisan, 2017; Neumeyer et al., 2021), digital transformation by employees (e.g., Cetindamar et al., 2021; Kozanoglu & Abedin, 2021), individual performance (e.g., Mohammadyari & Singh, 2015), firm performance (Widiastuti et al., 2021), customers (Cui, Jiao, & Zhao, 2021), and technology adoption behaviors (Yu, Lin, & Liao, 2017). In addition, the relevance of digital technologies has been identified in organizations (Kraus et al., 2021; Oliveira et al., 2022). While our understanding of MDL and its impact has improved over the last decade due to the growing number of empirical studies, the body of evidence remains limited. Furthermore, we only have a partial understanding of the relationship between MDL and digital transformation (Appio et al., 2021; Ghosh et al., 2021). In fact, the extant literature largely ignores

* Corresponding author at: Department of Business and Society, School of Business and Management, Queen Mary University of London, E1 4NS, UK.
E-mail addresses: n.zahoor@qmul.ac.uk (N. Zahoor), anastasios.zopiatis@cut.ac.cy (A. Zopiatis), S.Adomako@bham.ac.uk (S. Adomako), g.lamprinakos@bham.ac.uk (G. Lamprinakos).

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the role of MDL in digital transformation.

In addition, while the mechanism frequently used to highlight the effect of MDL on firm outcomes is naturally appealing, our understanding of how and under which circumstances MDL drives the digital transformation of firms is lacking. Regrettably, this gap remains, despite growing calls for theoretical clarity relating to the conditions under which MDL influences firm outcomes. Filling this gap is crucial, given that managerial capability is an important driver of business success (Fernando et al., 2020; Ritter & Pedersen, 2020). A nuanced analysis is warranted to shed light on how managers' attributes may facilitate the degree to which their digital literacy boosts a small and medium-sized enterprise's (SME's) digital transformation.

Given that managers of SMEs often lack the skills and expertise to adopt advanced technologies, the usage of digital technologies has been notably slow among SMEs (Adomako et al., 2021). Ostensibly, digitally enabled organizations use various technologies to improve their business transformation efforts – for example, to improve communication, collaboration, and coordination of business activities (Hughes et al., 2020; Rodgers et al., 2020). For an SME to be digitally enabled, it is critical that it should be equipped with digital literacy skills (Deloitte Access Economics, 2016).

Thus, it is important to understand the role of MDL in the business transformation strategy of an SME. Given that the advances made by digital transformation enable both innovation and production processes (Alcácer et al., 2016), managers' inability to cope with digital transformation could have serious implications for business performance. This is an important issue, because the pace of digitalization has outstripped the skills of many managers, suggesting that MDL plays a critical role in digital transformation. The micro-foundations theory also points to the importance of individual skills and capabilities underpinning digital transformation in organizations (Scuotto et al., 2021). The same theory highlights that the skills of individuals serve as micro-foundations of organizational growth (Felin & Foss, 2005; Felin et al., 2015).

Thus, the aims of this article are to: (1) investigate the impact of MDL on the use of digital technologies; (2) examine the moderating role of managerial characteristics on the relationship between MDL and the use of digital technologies; and (3) investigate the mediating mechanism of the relationship between MDL and digital transformation. To achieve these aims, we collected survey data from SMEs based in the United Arab Emirates (UAE). The UAE is an emerging market that is broadly keeping pace with digital transformation. According to the UAE Digital Transformation Report 2020, the country is ranked first globally in 23 indicators in key sectors, including telecommunications, labor, and health. Dubai's government announced in December 2021 that the city will become the world's strongest digital economy by leveraging the advantages of digital transformation (Seedgroup, 2022). However, adopting the latest technologies at the organizational level is of no use if an SME's workforce is not prepared to handle the use of digital technologies. Hence, our study emphasizes MDL as instrumental in facilitating the digital transformation of SMEs in the UAE.

This article contributes to digitalization literature in three ways. First, we highlight the role of MDL in digital transformation. While previous studies have attempted to explain how MDL influences the adoption of digital technologies, they failed to study MDL's relevance for digital transformation through the usage of digital technologies. In the context of SMEs, managers' ability and perception of their firm has critical managerial implications (Dess & Robinson Jr., 1984). The second contribution is the use of managerial characteristic variables as moderators of the MDL–digital technology relationship to gain a better understanding of the conditions under which MDL has a positive impact on the use of digital technologies. Thus, we investigate three moderators (i.e., the manager's age, education, and gender), which enables us to gain a deeper understanding of the managerial factors that impact the relationship between MDL and the use of digital technologies. Third, we explain the mechanism through which MDL influences a firm's digital transformation. In particular, we add to the digitalization literature (e.g., Chen & Tian, 2022; Kohtamäki et al., 2021; Ostmeier & Strobel, 2022) by highlighting that usage of digital technologies is a mediating mechanism of this relationship.

The paper proceeds as follows. It first introduces the research model to theoretically ground the study and develop the hypotheses. Next, we discuss the research design and follow it with an explanation of our data analysis and results. In the concluding section, we discuss the findings and their implications.

2. Theoretical background and hypotheses

2.1. Digital transformation

In recent years, digital transformation has emerged as an important phenomenon (Kozanoglu & Abedin, 2021; Li et al., 2018). It is an organizational improvement process that triggers changes through a combination of computing, information, communication, and connectivity technologies (Vial, 2019). Digital transformation depends on digital technologies, such as artificial intelligence, 4.0 machines, blockchain technology, big data analytics, and the IoT (Pelletier & Cloutier, 2019; Ulas, 2019), to increase SMEs' competencies of openness, inclusiveness, and generativity (Appio et al., 2021). Digital transformation is thus considered a powerful tool that improves organizational design, adopts innovative practices, designs new business models, and establishes value creation processes (Cenamor et al., 2019).

The growing importance of digital transformation has become a strategic imperative for managers (Singh & Hess, 2017), and as a result, so has the integration and exploitation of digital technologies (Cannas, 2021; Moeuf et al., 2018). In this regard, research suggests that SMEs can develop their capabilities and practices through digital transformation (Matarazzo et al., 2021). For example, it has been found that the integration of digital technologies into business models improves innovativeness (Bouwman et al., 2019). In addition, it has been suggested that dynamic capabilities, including strategic agility, digital marketing, and customer centrality, are vital in enabling SMEs' digital transformation (Matarazzo et al., 2021; Peter et al., 2020; Troise et al., 2022).

Although organization-level capabilities and practices are vital, research has, to date, broadly overlooked the micro-level elements (i.e., individuals) that are strategically important for SMEs' digital transformation efforts (Santoro et al., 2020; Zimmermann et al., 2020). In fact, drawing on Coleman's (1990) bathtub framework for macro–micro-macro-level interactions, micro-foundation research has provided theoretical foundations for understanding the development of capabilities on the organizational level (i.e., the macro level) by mechanisms on the individual level (i.e., the micro level) (Abell et al., 2008; Felin & Foss, 2005). Scholars have argued that organizational changes are rooted in the actions and interactions of individuals (Felin et al., 2015; Foss, 2010). Specifically, micro-foundations theorists look beyond the organizational drivers to ascertain how lower-level drivers, in other words, the "*actors, processes and/or structures*" (Felin et al., 2012, p. 1353), shape the actions of employees to promote digital transformation for SMEs (Felin & Foss, 2005).

Micro-foundations "*are not a theory, per se, but rather a movement and way of thinking that has spread across a broad array of macro theories*" (Felin et al., 2015, p. 577). The micro-foundations perspective emphasizes individual actors (including the competencies and practices of managers) as drivers of SMEs' digital transformation (Felin et al., 2015). Therefore, in line with the micro-foundations perspective, we argue that MDL is a crucial capability that can enable digital transformation in SMEs. More importantly, we suggest that the usage of digital technologies mediates the relationship between MDL and digital transformation. Also, we posit that the impact of MDL on the usage of digital technologies is contingent on managerial attributes, including gender, education, and age. These arguments are summarized in our conceptual model

in Fig. 1.

2.2. Digital literacy and usage of digital technologies

Digital literacy refers to "*the ability to understand and use information in multiple formats from a wide variety of sources when it is presented via computers*", particularly through the use of the internet (Pool, 1997, p. 6). It involves a variety of an individual's cognitive, emotional, and sociological skills that are required to function effectively in a digital environment (Martin & Madigan, 2006). According to Vuorikari et al. (2016), MDL includes five key skill areas: information literacy, interaction and collaboration, digital content creation, safety, and problem solving.

Information literacy concerns knowledge around browsing, searching, and filtering data and digital content; interaction and collaboration relates to communicating through digital tools and cooperating with other organizational members and external networks; digital content creation refers to the ability to develop and integrate digital content, as well as to respect copyright and licenses; safety capabilities aim to protect devices, personal data, privacy, health and well-being, and the environment; and problem solving aims to solve technical problems, as well as to identify technological responses and digital competence gaps. In technologically intense environments, these skills are labelled as "*21st century skills*" (van Laar et al., 2017) and can have a wider impact on managers' usage of digital technologies.

MDL represents the summary of skills, knowledge, and awareness that managers need to perform tasks using digital technologies like the IoT, big data analytics, artificial intelligence, and so on (Scuotto et al., 2021). Especially in the context of SMEs where the use of digital technologies is slow (Adomako et al., 2021), MDL helps firms adapt to the changing technological environment (Rialti et al., 2019). Managers confident in their own digital literacy skills tend to be better prepared and more willing to use digital technologies in performing complex job activities (Neumeyer & Liu, 2021). For example, by using interaction and collaboration skills, digitally literate managers are more likely to engage in organizational activities through digital technologies.

Also, problem solving skills can enable such managers to use digital technologies in order to communicate with colleagues and customers or resolve issues more efficiently. Therefore, developing such digitally enhanced skills promotes a digital mindset and shapes managerial pathways to use digital technologies in daily work routines (Cetindamar et al., 2021; Cetindamar & Phaal, 2021). In addition, MDL facilitates the absorptive capacity of managers to adapt to new digital technologies, as well as to assimilate and recombine new digital skills that enable the effective utilization of digital technologies (Mohammadyari & Singh, 2015; Neumeyer et al., 2021). Thus, we argue that:

H1: Managers' digital literacy is positively associated with their usage of digital technologies in SMEs.

2.3. Moderating role of managerial attributes

In addition to H1, we argue that managerial attributes play an important moderating role in the association between MDL and usage of digital technologies. Often, SMEs are supportive of digitalization, but managers might not be willing to improve MDL and adopt digital technologies due to psychological and cognitive barriers (Singh et al., 2020). As such, understanding managerial attributes in the relationship between MDL and usage of digital technologies is imperative to drive digital transformation in SMEs (Bi et al., 2019). For the purpose of this study, managerial attributes are those personal characteristics that may affect usage of digital technologies. Following previous studies (Francioni et al., 2015; Marconatto et al., 2021; Tocher & Rutherford, 2009), this study considers the attributes of gender, education, and age.

It is somewhat surprising that gender has received little attention in digitalization literature, despite its significance in psychology and organizational behavior studies (Kidder, 2002; Shan et al., 2019; Shockley et al., 2017). As the proportion of females in the workforce is gaining prominence in SMEs (Ruiz-Jiménez & Fuentes-Fuentes, 2016), particularly in emerging markets (Salloum et al., 2019), it is important to consider the effect of gender on the relationship between MDL and usage of digital technologies. Female managers have a different attitude towards changes in the technological environment, which has its own particular effect on the link between MDL and usage of digital technologies. Female managers are more receptive to change, and take a more proactive approach, too, compared to their male counterparts (Segovia-Pérez et al., 2019; Wang et al., 2019). They also tend to favor digital technologies, given their increasing participation in the field of computer science (Drabowicz, 2014).

In addition, the use of digital technologies has led to work becoming flexible (Grönlund & Öun, 2018). This offers both opportunities and challenges for female managers in terms of balancing work and family life. Female managers may adopt digital technologies to improve their work outcomes while still meeting their family responsibilities. For example, research has shown that female managers tend to use digital technologies to schedule work and manage their family duties (Roy, 2016). Therefore, female managers are more likely to be highly digitally literate, enabling them to put new technologies into practice (Ferreira et al., 2019). Thus, it is hypothesized that:

H2a. The association between managers' digital literacy and usage of digital technologies is moderated by a manager's gender, such that

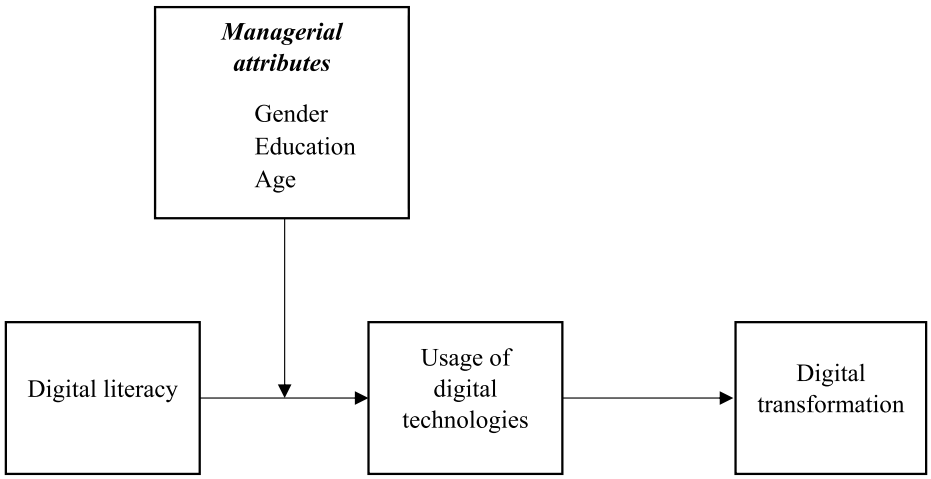

Fig. 1. Conceptual framework of the study.

the relationship is stronger for female managers than for male managers.

Further, we argue that managers' education moderates the association between MDL and usage of digital technologies. First, a manager's education level translates into greater information-processing capacity (Dollinger, 1984). A high level of education denotes elevated levels of open-mindedness, tolerance of ambiguity, and integrative complexity (Schroder et al., 1967). Second, highly educated managers tend to be less risk averse and better informed about the competitive market environment (Gaio et al., 2022). They are more open to emerging opportunities and to adopting technologies in SMEs (Jafari-Sadeghi, Garcia-Perez, et al., 2021; Scuotto et al., 2021).

Therefore, it can be argued that highly educated managers are better able to translate their digital literacy skills into usage of digital technologies. Third, highly educated managers are more likely to have enhanced digital absorptive capacity (Berrill et al., 2020), facilitating digital skills development and usage of digital technologies to complete work-related tasks. As Elena-Bucea et al. (2021) argued, "*Education can be the turning point for the digital divide, overcoming the ICT complexity, making the difference when individuals are faced with ICT, providing the opportunities to achieve digital dividends*" (p. 1010). A higher education level helps managers deal with ICT-related challenges and develop digital skills that are required to use digital technologies. Finally, highly educated managers are better able to identify opportunities and absorb new information, as well as to generate technological ideas at a faster rate (Lee & Hallak, 2018). Education therefore equips managers to develop their digital literacy and accordingly to use complex technologies for interaction, communication, and task completion. Thus, we suggest that education level reinforces the positive effect of digital literacy on usage of digital technologies, that is – a positive moderating role for a manager's education level. Therefore, the following hypothesis is proposed:

H2b. The positive association between managers' digital literacy and usage of digital technologies is moderated by a manager's level of education, such that the relationship is stronger at a higher educational level than at a lower one.

In terms of a manager's age, the decrement theory of aging suggests that physical and cognitive change co-occur with age (Giniger et al., 1983). These changes can adversely affect a manager's learning efforts and coping resources, and therefore lead to weaker MDL/usage of digital technologies' relationship with increasing age. Thus, based on this perspective, MDL is expected to have a weaker effect on usage of digital technologies among older managers, relative to their younger counterparts, due to the reduced coping and learning mechanisms among the former (Fasbender et al., 2021). Older managers become less competent and often reluctant to learn new technologies; this can reduce their usage of digital technologies (Soluk et al., 2021). In contrast, younger managers are more likely to have grown up in a digital environment that was considerably more complex and heterogenous (Choi et al., 2020). Therefore, younger managers tend to be more digitally skilled and better able to use digital technologies for performing work tasks (Nadkarni & Prügl, 2021; Oggero et al., 2020). In fact, young, digitally literate managers are at the forefront of using digital technologies, as they "*can try any tool and play around with it*" (Dittes et al., 2019, p. 660). Hence, MDL should be effective for promoting and facilitating the use of digital technologies among younger managers, compared to older ones. The above arguments lead to the following hypothesis:

H2c. The positive relationship between managers' digital literacy and their usage of digital technologies is moderated by a manager's age, such that the relationship is stronger for younger managers compared to older ones.

2.4. Mediating role of usage of digital technologies

We further argue that MDL leads to digital transformation via the usage of digital technologies. Stated differently, the usage of digital technologies serves as an intervening variable that mediates the relationship between MDL and organizational digital transformation. While MDL prepares managers to exploit emerging technologies, the actual usage of MDL converts digital literacy into digital transformation (Brock & von Wangenheim, 2019; Gfrerer et al., 2020). MDL encourages managers to embrace digital transformation in SMEs as an opportunity (Cannas, 2021; Matarazzo et al., 2021).

However, merely possessing digital literacy is not sufficient to promote digital transformation; rather, managers need to exploit their digital skills in their job by using digital technologies (e.g., artificial intelligence, data analytics, blockchain), thereby creating a positive attitude towards these technologies in SMEs, which will, in turn, facilitate digital transformation (Ghobakhloo & Ching, 2019). Digitally literate managers possess the skills that allow them to make critical and creative use of ICT in order to manage the digital transformation of their SME. Studies support that what constitutes digital skills at an individual level in SMEs involves skills, attitudes, and knowledge necessary to exploit technologies and address technological problems to the greatest extent possible (Scuotto et al., 2021; Sousa & Rocha, 2019).

With roots in the bathtub model, the micro-foundations perspective suggests that individual-level skills support routines that, in turn, translate into change at the organizational level and in business processes (Felin et al., 2012; Foss, 2010). As such, it can be argued that digital transformation is influenced by micro-foundational skills and activities in SMEs. Specifically, MDL at the individual level serves as a key enabler to develop new business models for digital transformation through the use of digital technologies (AlNuaimi et al., 2022; Verhoef et al., 2021). The efficient usage of digital technologies encourages managers to close the technological loop in SMEs and redesign internal structures to implement digitalization (Chaudhuri et al., 2022). Also, managers using digital technologies often see potential for organizational growth, which in turn facilitates technology implementation initiatives within SMEs (Adomako et al., 2021; Matarazzo et al., 2021). Digital literacy enables managers to use digital technologies ranging from basic communication tools (e.g., messaging tools or email) to complex data analytics tools for informed decision-making that can in turn shape an increasingly digital environment within SMEs. This discussion leads us to hypothesize that:

H3. The usage of digital technologies mediates the relationship between managers' digital literacy and digital transformation in SMEs.

3. Methodology

3.1. Research context

The hypothesized paths were tested using a sample of SMEs operating in the UAE. We focused on SMEs in the UAE for a number of reasons. First, like other emerging markets, the UAE is a fast-growing economy with high development potential. The country has witnessed growth in non-oil sectors like tourism, real estate, aviation, and manufacturing, which have increased the country's economic diversification.

According to the Dubai Statistics Centre (2018), the unemployment rate in Dubai was just 0.5 % in 2018, the second lowest rate across the world. Moreover, the gross domestic product of UAE was $421.14 billion and its growth rate 1.60 % in 2019 (Trading Economics, 2019). This makes the country an interesting context for the study. Second, as a mixed free economy, the UAE has developed internet and media zones that offer venture establishment with a hundred percent ownership. As such, the country has witnessed growth in privately-owned SMEs. In Dubai, SMEs account for 95 % of businesses, contributing 40 % of the

nation's GDP and employing 42 % of the workforce (UAE, 2021). Third, SMEs in the UAE have increased their emphasis on digital transformation (Cabral, 2021; Nasri, 2020). They have realized that to survive and compete in dynamic marketplaces it is vital to adopt digital technologies, including e-commerce, social media, search engine optimization, data analytics, operating business logistics, and application services. As Mohammed Alabbar, founder of Emaar Properties and Noon.com, said: "*If you are not able to dream, you'll never do it. The pandemic taught us that we will never stop and we will never close*" (Cabral, 2021). Thus, it is vital to understand how managerial abilities and characteristics drive the process of digital transformation in SMEs based in the UAE.

3.2. Sampling and data collection

We developed the sampling frame of the study from the commercial directory of the Dubai Chamber of Commerce and Industry (DCCI, 2018–19). To be eligible to participate in the study, the firms had to meet the following criteria: (1) have<250 employees; (2) be independent entities that are not part of a bigger group; and (3) the contact details of managers/employees had to be fully available. We identified 450 firms based on our selection criteria. Given the accuracy and scarcity associated with databases in developing countries (Assadinia et al., 2019; Nakos et al., 2019), we contacted all 450 firms to evaluate their eligibility, find key information, and elicit their permission; 368 agreed to participate in the study. We contacted the chief executive officers (CEOs) of the 368 firms and sent them a questionnaire, using drop-off and collection survey instrument administration procedures. The survey was administered in the English language, as this is the most commonly used business language in the UAE. 161 SMEs returned filled-in questionnaires to us. We discarded three incomplete responses and used the remaining 158 to examine our hypotheses. This represents a 42.93 % response rate. Sample characteristics of the participant SMEs are summarized in Table 1.

3.3. Measures

The measurements of the study variables were adapted from the previous literature. All the multi-item scales were measured using a seven-point Likert scale. The seven-point Likert scale provides flexibility to respondents to describe their opinions and lessen range restrictions (Allen & Seaman, 2007), thus allowing for more skewness compared to the five-point Likert scale (de Winter & Dodou, 2010). The reliability and validity estimates of our study measures are provided in Table 2.

MDL is a skill consisting of the ability of a manager to work with digital technologies in order to process and retrieve information (Cetindamar et al., 2021; Mohammadyari & Singh, 2015). It was first measured using a multi-dimensional construct developed by Vuorikari et al. (2016). The scale consists of five dimensions, including information literacy, interaction and collaboration, digital content creation, safety, and problem solving. Information literacy among our sample was measured using three items to evaluate the manager's ability to browse, to evaluate, and to manage data, information, and digital content. Four

Table 1
Firm characteristics.

Key characteristics	Range	%
Firm size (number of employees)	10–50	38.61
	51–100	30.38
	101–250	31.01
Firm age (years)	1–3	15.19
	4–9	55.06
	10–16	29.75
Industry	Industrial equipment	27.20
	Chemicals/petrochemicals	27.80
	Tourism	15.20
	Real estate	10.80
	Marketing and advertising	10.10
	Food, beverage, and consumer goods	6.30
	Pharmaceutical	2.50
Gender	Male	55.06
	Female	44.94
Education	High school	14.56
	Higher national diploma	32.28
	Bachelor's degree	33.54
	Postgraduate degree	19.62
Manager's age (years)	26–35	38.61
	36–45	29.11
	46–55	18.35
	> 56	13.92

Table 2
Measures and measurement model.

Constructs and details of measures	Standardized factor loadings
Digital literacy	
Information literacy: α = 0.89; CR = 0.89; AVE = 0.73	
I am confident in	
… browsing, searching and filtering data, information and digital content	0.88
… evaluating data, information and digital content	0.86
… managing data, information and digital content	0.81
Interaction and collaboration: α = 0.92; CR = 0.91; AVE = 0.72	
I can	
… interact through digital technologies	0.85
… share through digital technologies	0.93
… engage in citizenship through digital technologies	0.84
… collaborate through digital technologies	0.77
Digital content creation: α = 0.89; CR = 0.88; AVE = 0.71	
I can	
… develop digital content	0.78
… integrate and re-elaborate digital content	0.89
… respect copyright and licenses	0.85
Safety: α = 0.92; CR = 0.91; AVE = 0.71	
I am aware of	
… protecting devices	0.74
… protecting personal data and privacy	0.84
… protecting health and well-being	0.91
… protecting the environment	0.87
Problem solving: α = 0.93; CR = 0.93; AVE = 0.77	
I am able to	
… solve technical problems	0.85
… identify needs and technological responses	0.93
… creatively use digital technologies	0.87
… identify digital competence gaps	0.85
Usage of digital technologies: α = 0.92; CR = 0.90; AVE = 0.61	
At work, I often use	
… digital technologies to contact other people for my work.	0.70
… digital technologies to communicate with colleagues or customers in my daily work.	0.90
In terms of frequency, I use digital technologies in my daily work to	0.83
… ask questions.	0.85
… answer questions.	0.72
… share files.	0.70
… work-related socialization.	
Digital transformation: α = 094; CR = 0.94; AVE = 0.75	
Our firm is increasingly digitally interconnected with stakeholders (e.g., customers, suppliers, and partners).	0.79
Digital business transformation increasingly pervades and interconnects all areas of our firm.	0.91
Our business processes along the entire value chain are increasingly digitally interconnected.	0.94
Our firm uses digital technologies to promote products and attract customers.	0.87
Our firm uses digital technologies to handle business transactions.	0.80
Fit Statistics: $\chi 2/df = 1.16$; RMSEA = 0.03; SRMR = 0.03; NFI = 0.94; NFI = 0.94; CFI = 0.98.	

Notes: α = Cronbach Alpha; CR = Composite reliability; AVE = Average variance extracted; NFI = normed fit index; CFI = comparative fit index; RMSEA = root mean square error approximation; SRMR = standardized root mean squared.

items were used to measure interaction and collaboration in terms of sharing, engaging, and collaborating through digital technologies. Three items were used to measure digital content creation. Safety was assessed using four items capable of capturing the ability to protect devices, data and privacy, health and well-being, and the environment. Finally, problem solving evaluated the ability to solve technical problems, identify needs and technological responses, creatively use digital technologies, and identify digital competence gaps using four items.

Usage of digital technologies is defined as the frequency of using knowledge management systems at work for communication and socialization (Davison et al., 2013; Wong et al., 2016). We operationalized usage of digital technologies by adapting the scale from Ou and Davison (2011). Six items were used – to determine the frequency of digital technology usage to contact other people at work, communicate with colleagues, ask questions, answer questions, share information, and assess socialization related to work.

Digital transformation refers to a change in how digital technologies are employed in firms to develop new digital business models that help create more value for firms (AlNuaimi et al., 2022; Verhoef et al., 2021). The digital transformation was captured on a five-item scale adapted from prior research (Martínez-Caro et al., 2020; Racela & Thoumrungroje, 2020). The scale explored how digital transformation had impacted businesses in connecting with stakeholders, promoting products, attracting customers, and handling business transactions.

Gender was measured as a dummy variable and was assessed as follows: 0 = male and 1 = female (Fritz & van Knippenberg, 2018). *Education* was captured as follows: 1 = high school, 2 = higher national diploma, 3 = bachelor's degree, and 4 = postgraduate degree (Adomako & Nguyen, 2020). The manager's age was captured using the age of each respondent (in years) and was logarithm transformed.

We controlled for firm size, firm age, and industry to account for their effects on dependent variables. *Firm size* was measured using the number of employees and *firm age* was captured using the number of years since a firm was founded. To correct for skewness, we used the logarithm transformation of firm size and firm age. *Industry* was categorized into seven groups, including industrial equipment, chemicals/petrochemicals, tourism, real estate, marketing and advertising, food, beverage, and consumer goods, and pharmaceuticals.

3.4. Bias assessment

We assessed the non-response bias by comparing early and late respondent groups. The results of a *t*-test for the demographics and the main variables of the study indicated no significant difference between the two respondent groups (Armstrong & Overton, 1977). Hence, non-response bias was concluded not to have had any influence on our study results.

Given the cross-sectional nature of our study, common method bias emerged as a potential problem. Therefore, we followed *ex-ante* procedural remedies by counter-balancing the order of questions, ensuring respondents of confidentiality and anonymity, and avoiding double-barreled questions (Podsakoff et al., 2003). We also conducted *ex-post* statistical tests to check for potential common method bias. Specifically, we estimated three models using confirmatory factor analysis (CFA): Model 1, wherein a method-only model was estimated by loading all items on a single latent construct ($\chi 2/df = 5.53$; RMSEA = 0.20; SRMR = 0.19; CFI = 0.39; NFI = 0.32); Model 2 estimated a trait-only model by loading each item onto its respective latent construct ($\chi 2/df = 1.16$; RMSEA = 0.03; SRMR = 0.03; CFI = 0.98; NFI = 0.94); and Model 3 estimated a method-and-trait model by adding a common factor and linking with the items in Model 2 ($\chi 2/df = 1.12$; RMSEA = 0.03; SRMR = 0.03; CFI = 0.99; NFI = 0.94). A comparison of the three models suggested that Model 2 and Model 3 were superior to Model 1, whereas Model 3 was not found to be substantially better than Model 2. Thus, we concluded that common method bias did not pose a problem in this study.

4. Analyses and results

4.1. Validity and reliability assessment

Confirmatory factor analysis (CFA) was used to determine the reliability and validity of constructs in the AMOS (28.0) statistical package. We used the maximum likelihood estimation method. The results of the measurement model suggest a good model fit: $\chi 2/df = 1.16$; RMSEA = 0.03; SRMR = 0.03; CFI = 0.98; NFI = 0.94. Cronbach's alpha and composite reliability were used to determine the measures' reliability. As shown in Table 2, the values of Cronbach's alpha and composite reliability exceeded the recommended threshold of 0.70 and 0.60 respectively, thus confirming the reliability of measures (Kline, 2015). Further, all the loading factors were positive and significant in support of the convergent validity of measures (Hair et al., 2018). The discriminant validity was assessed by comparing the squared average variance extracted (AVE) and inter-construct correlations (Fornell & Larker, 1981). The results in Table 3 show that the squared AVE for each construct was greater than the corresponding inter-construct correlation. Also, in line with Anderson and Gerbing (1988), the chi-square difference results indicated a significant difference between constrained and unconstrained models ($\Delta\chi 2(1) \geqslant 2.75$, $p < 0.05$). Thus, the results confirm the discriminant validity of the study constructs. The descriptive statistics and inter-constructs correlations are also provided in Table 3.

4.2. Structural model estimation

Having established the reliability and validity of the constructs, the structural equation model (SEM) was estimated to test hypotheses using the maximum likelihood estimation method in the AMOS (28.0) statistical package. There are a number of benefits of using SEM. First, digital transformation involves a series of interconnected skills and processes (as shown in Fig. 1) that make the relationship between variables more complex. As such, simple regression analysis techniques like logistic regression and ANOVA might not help to estimate the model (Tabachnick et al., 2007). Second, while traditional methods only involve observed variables, SEM considers both observed and unobserved measurements. Using SEM, the researchers can estimate measurement errors in the data (Hair et al., 2018). Third, SEM is a broadly accepted, useful technique to test contingent and indirect effects (Bagozzi & Yi, 2012).

We used the multiplicative approach to test the moderating effects. Before conducting the analysis, we mean-centered the variables involved in the interaction analyses (Aiken et al., 2003). Specifically, we created three interaction terms: (1) digital literacy × gender; (2) digital literacy × education; and (3) digital literacy × age. To further account for multicollinearity, the variance inflation factors (VIF) were calculated, which were well below the threshold value of 10, indicating that multicollinearity was not an issue in the analysis (Aiken et al., 2003).

Hypothesis 1 argues that MDL is positively related to the use of digital technologies. As shown in Table 4, MDL is positively and significantly related to the use of digital technologies ($\beta = 0.23$; $p < 0.01$), thus supporting Hypothesis 1.

The study argues in Hypothesis 2a that gender moderates the effect of MDL on usage of digital technologies, such that the relationship is more positive for females than males. We found support for Hypothesis 2a, as the interaction term between MDL and gender is positive and significant ($\beta = 0.17$; $p < 0.05$), suggesting that high levels of MDL improve the usage of digital technologies for female managers compared to male managers. We argue in Hypothesis 2b that the effect of MDL on the usage of digital technologies is moderated by education. The interaction term between MDL and education is positive and significant ($\beta = 0.19$; $p < 0.01$). Our findings indicate that the beta coefficient for the impact of education on the association between managers' digital literacy and usage of digital technologies is moderated by a manager's

Table 3
Descriptive statistics, correlations, and validity.

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Firm size[#]	1.80	0.30	1												
2. Firm age[#]	0.86	0.24	0.32***	1											
3. Industry[†]	–	–	−0.04	−0.09	1										
4. Gender[†]	–	–	0.01	0.09	−0.19*	1									
5. Education[†]	–	–	−0.03	0.10	−0.01	0.23**	1								
6. Manager's age[#]	1.61	0.11	−0.01	−0.06	−0.11	−0.19*	−0.36***	1							
7. Information literacy	5.18	1.31	−0.08	−0.08	0.06	0.08	0.24**	−0.23**	**0.85**						
8. Interaction and collaboration	5.00	1.43	−0.10	−0.04	−0.08	0.19*	0.15	−0.23**	0.20*	**0.85**					
9. Digital content creation	4.52	1.56	−0.04	0.08	0.08	0.13	0.27**	−0.23**	0.32***	0.18*	**0.84**				
10. Safety	5.27	1.33	−0.01	0.00	−0.01	0.15	0.27**	−0.33***	0.35***	0.23**	0.20*	**0.85**			
11. Problem solving	5.11	1.46	−0.01	0.10	−0.17*	0.19*	0.26**	−0.17*	0.18*	0.30***	0.23**	0.29***	**0.88**		
12. Manager's usage of digital technologies	5.04	1.32	0.19*	0.21**	0.01	0.19*	0.37***	−0.22**	0.33***	0.13	0.18*	0.19*	0.10	**0.78**	
13. Digital transformation	4.71	1.53	0.30***	0.41***	0.00	0.15	0.14	−0.15	0.21**	−0.11	0.17*	0.07	0.10	0.41***	**0.86**

Note. S.D. = standard deviation; # = natural logarithm transformation of the original values; † = dummy variable; significance levels: ^p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.

Table 4
Structural model results.

Hypotheses	Independent variables	Standardized parameter estimates and t values*	
		Manager's usage of digital technologies	Digital transformation
H1	Digital literacy	0.23** (2.89)	0.07 (0.95)
H2a	Digital literacy × gender	0.17* (2.05)	–
H2b	Digital literacy × education	0.19** (2.61)	–
H2c	Digital literacy × Manager's age	−0.29*** (-3.46)	–
H3	Manager's usage of digital technologies	–	0.30*** (4.08)
	Gender	0.02 (0.29)	–
	Education	0.23*** (3.43)	–
	Manager's age	0.02 (0.22)	–
	Firm size	0.18** (2.79)	0.15* (2.01)
	Firm age	0.11^ (1.77)	0.16* (2.08)
	Industry	0.06 (0.89)	0.04 (0.54)
Total variance explained (i.e. R^2)		0.43	0.30
Fit Statistics: $\chi 2/df = 1.40$; RMSEA = 0.05; SRMR = 0.03; NFI = 0.94; NFI = 0.95; CFI = 0.98.			

Note. *T*-values are reported in parentheses; Significance levels: ^p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001; abbreviations: NFI = normed fit index; CFI = comparative fit index; RMSEA = root mean square error approximation; SRMR = standardized root mean squared.

level of education, such that the relationship is stronger for managers with high levels of education (unstandardized effect = 0.76, p < 0.01) than managers with low levels of education (unstandardized effect = 0.08, p > 0.10). The effect sizes show that the higher the education, the larger the coefficient. In support of Hypothesis 2b, we found that the effect of MDL on usage of digital technologies is stronger when managers are highly educated.

We also split the data into two categories based on the education of respondents (1 = Non-IT education, 2 = IT education). Using a *t*-test, we found no differences between managers with an IT degree and those with non-IT education (*t*-value = 0.40, p = 0.40, F = 0.70). With respect to Hypothesis 2c, the findings show that the relationship between MDL and usage of digital technologies is moderated by the manager's age (β = -0.29; p < 0.001). This finding suggests that MDL is more positively related to usage of digital technologies among younger managers than older ones. Thus, Hypothesis 2c was supported.

We argue in Hypothesis 3 that the use of digital technologies mediates the relationship between MDL and digital transformation. In support of Hypothesis 3, we found that MDL is positively and significantly related to the use of digital technologies (β = 0.23; p < 0.01). In turn, the use of digital technologies positively and significantly influences digital transformation (β = 0.30; p < 0.001), whereas the direct impact of MDL on digital transformation is insignificant (β = 0.07; p > 0.10). This confirms that the path between digital literacy and digital transformation is mediated by the usage of digital technologies.

4.3. Robustness analysis

Following the recommendations of Preacher and Hayes (2008), we conducted additional analysis in PROCESS macro to test the moderating effects of managers' gender, education, and age. The results confirm that the relationship between digital literacy and usage of digital technologies is moderated by gender (β = 0.71, 95 % lower limit confidence interval (LLCI) = 0.29, 95 % upper limit confidence interval (ULCI) = 0.71), education (β = 0.43, 95 % LLCI = 0.25, 95 % ULCI = 0.76), and age (β = -0.05, 95 % LLCI = -0.07, 95 % ULCI = -0.03). These results demonstrate a similar pattern to those in SEM, thus supporting hypotheses 2a, 2b, and 2c. Following recommendations in previous studies (Aiken et al., 2003; Cohen et al., 2003), we graphically represent the

moderation effects by plotting the interactions between: (1) MDL and gender; (2) MDL and education; and (3) MDL and age. Figs. 2a, 2b, and 2c provide the graphical representation of the moderation effects. More specifically, Figs. 2a and 2b show that values above the mean values of gender (i.e., female managers) and education (highly educated managers) are associated with a stronger positive relationship between digital literacy and usage of digital technologies. Fig. 2c demonstrates that the effect of MDL on usage of digital technologies is significantly improved for younger managers compared to older ones.

To further account for the mediation effect, we used the bootstrapping technique in PROCESS macro (Preacher & Hayes, 2004). The results confirm the mediating role of managers' use of digital technologies in the relationship between MDL and digital transformation ($\beta = 0.16$, 95 % LLCI = 0.03, 95 % ULCI = 0.34), as the CI does not include zero.

5. Discussion and conclusion

Our study was designed to investigate the relationship between MDL and digital transformation through the mediating mechanism of the use of digital technologies. Using data from a sample of 158 SME managers, we established an indirect link between MDL and the likelihood to embark on digital transformation. Specifically, our finding that MDL is positively associated with the use of digital technologies sheds light on the importance of the linkage between the digital literacy of managers and the likelihood of technology usage in SMEs. By using insights from extant studies on MDL (Garzoni et al., 2020; Li et al., 2018; Neumeyer et al., 2021), our study argues that the knowledge acquired from MDL is a vital driver of digital technology usage. The second finding of this study revealed that managerial attributes (i.e., gender, age and education) moderate the relationship between MDL and the use of digital technology; this provides new evidence that managerial attributes are important moderators of the relationship between MDL and the use of digital technology. Our third finding (i.e., the use of digital technologies mediates the link between MDL and digital transformation) provides synergy of the results related to hypotheses 1 and 2 by explaining the mechanism through which MDL influences digital transformation. Collectively, these findings have important implications for theory development in terms of improving our understanding of the role of MDL in digital transformation.

5.1. Theoretical implications

This study contributes to the existing literature in three ways. First, our findings expand our understanding of the impact of MDL in facilitating digital technology usage. This is important, given that digital literacy literature has predominantly focused on barriers to technology adoption (Duan et al., 2002; Neumeyer et al., 2021). Particularly, literature on digital literacy has yet to examine outcomes such as digital technology usage and digital transformation. In contrast, our study expands our knowledge by highlighting MDL as a driver of digital transformation. Not only do we propose the effect of MDL on digital transformation, we also explain the mechanism through which MDL influences digital transformation in SMEs. This extension contributes to digitalization literature (Amankwah-Amoah et al., 2021; Bartikowski et al., 2018; Kraus et al., 2021). In this way, we further efforts towards a solid understanding of MDL, something that has been called for in extant literature (Bartikowski et al., 2018; Roth et al., 2013).

Second, given that our sample comes from SME managers, our findings contribute to digital transformation literature by showing that the use of digital technology is a mediator of the relationship between MDL and digital transformation in SMEs. Extant research using SME managers is quite limited. Our study shows that MDL is critical for SMEs' digital transformation through digital technology usage.

Third, this study improves our understanding of the boundary conditions of the effect of MDL. Although existing digitalization literature has examined the role of digital literacy (e.g., Cetindamar et al., 2021; Kozanoglu & Abedin, 2021; Mohammadyari & Singh, 2015), it has yet to explain the conditions under which MDL is effective in driving technology usage. Our study adds to the existing digitalization literature (Cui et al., 2021; Yu et al., 2017) by highlighting three conditions under which MDL could drive technology usage. In particular, our findings of the moderating hypothesis show that managers' gender, age, and education are boundary conditions of MDL.

Finally, digitalization in emerging economies remains extremely under-researched (Caputo et al., 2021), particularly for countries from the Middle East. The UAE as an emerging market is, therefore, an interesting context in which to study the digital transformation of SMEs. The UAE context is significantly different from developed countries in terms of economic, financial, and infrastructure development. This suggests that our dependent variable, digital transformation, is appropriate for our study context.

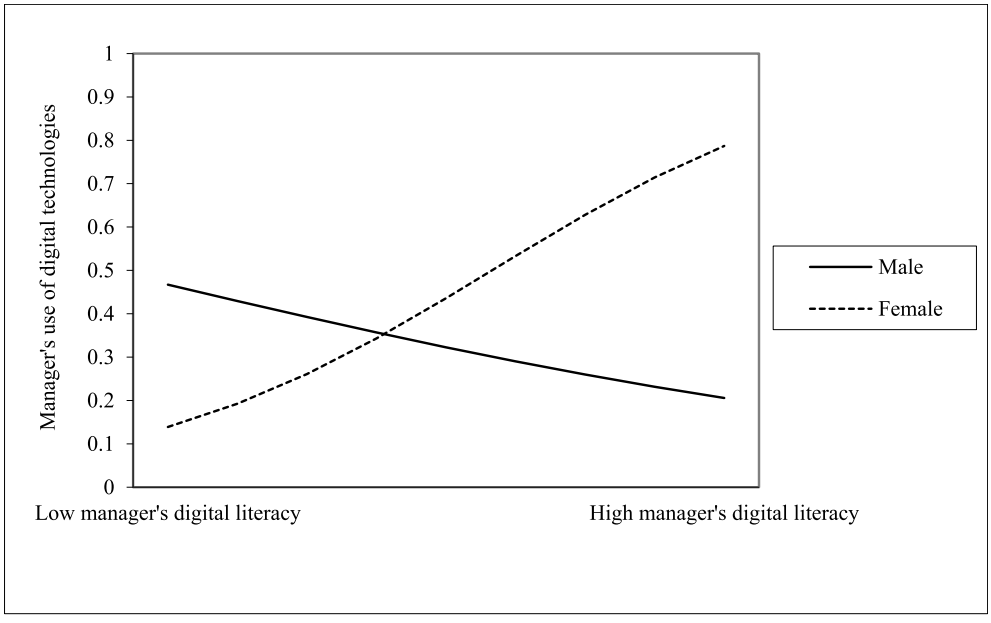

Fig. 2a. Moderating impact of gender.

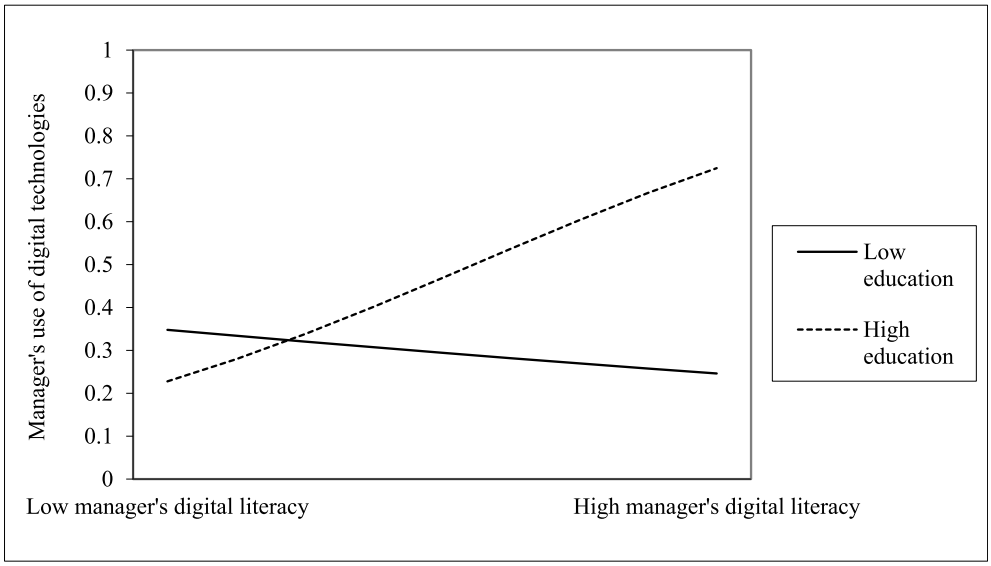

Fig. 2b. Moderating impact of education.

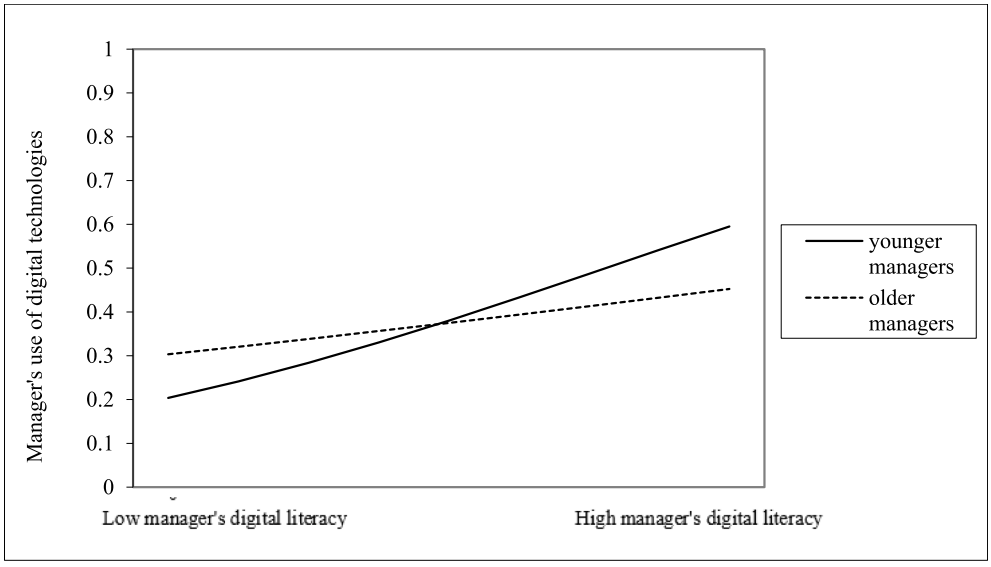

Fig. 2c. Moderating impact of manager's age.

5.2. Practical implications

Given the fact that individual-level factors drive digital transformation in SMEs, it is not appropriate for SMEs to focus only on developing organizational resources and capabilities. Instead, SMEs must extend their efforts to managerial competencies and practices in order to embrace technological change and transform organizational structures. Specifically, SMEs need to invest resources to develop MDL in order to be prepared for challenges (such as COVID-19). While managers can at times show a high level of digital literacy with respect to using digital technologies, they may nevertheless lack the experience of contextualizing it within their organization. In this regard, SMEs should provide appropriate training and experiential mental opportunities to managers to help them become digitally competent. Also, managers should be committed to self-learning and organizational training efforts for using digital technologies, as well as enabling digital transformation. This is particularly relevant for male managers, as our findings suggest that male managers – as compared to their female counterparts – are reluctant to exploit MDL for usage of digital technologies.

Further, we found that the relationship between MDL and usage of digital technologies is moderated by the managerial attributes of gender, education, and age. This suggests that SMEs must consider the attributes of their managers when seeking digital transformation. For example, younger female managers with a high education level are better able to exploit their digital literacy for using digital technologies to perform job duties and interact with colleagues or networks. Therefore, SMEs should pay attention to recruiting young talent, encouraging gender diversity, and promoting the educational attainment of managers who can make better use of digital technologies and ultimately drive digital transformation.

6. Limitations and future research directions

Along with its significant contributions, our study has a number of limitations that warrant future scholarly attention. First, our study collected cross-sectional data from single respondents. Future studies could use longitudinal financial data to estimate an overall research model. This approach could help researchers to develop causality.

Second, our data stem from SMEs operating in the UAE (i.e., an emerging market) and our findings are contingent on the particularities of this market context. While we controlled for these particularities in our research model, future studies could consider how internal or external contingencies act as boundary conditions amongst the micro-foundations of digital transformation. Relatedly, attention could be directed to comparative studies by exploring relationships in the context of two or more emerging economies with dissimilar infrastructural and cultural systems. Third, our study emphasized micro-foundations and considered MDL, usage of digital technologies, and managerial attributes as determinants of SMEs' digital transformation. There might be other moderating and mediating mechanisms that future studies could consider – for example, the behavioral integration of managers who can drive explorative and exploitative ICT capabilities for digital transformation (Venugopal et al., 2020). Also, researchers could consider the dynamic managerial capabilities (e.g., sensing, seizing, and transformation) and decision-making approaches that might promote digital vision in SMEs (Degbey & Pelto, 2021; Jafari-Sadeghi, Amoozad Mahdiraji, et al., 2021).

Finally, managerial cognitive capabilities and managerial experience (Ferraris et al., 2022) can be important micro-foundational determinants that are likely to moderate the association between managers' digital literacy and usage of digital technologies. Thus, we call for future research to investigate how managerial cognitive capabilities and managerial experience could serve as moderators of the link between managers' digital literacy and usage of digital technologies.

CRediT authorship contribution statement

Nadia Zahoor: Data curation, Writing - original draft, Visualization, Investigation, Validation, Formal analysis, Methodlogy, Resources. **Anastasios Zopiatis:** Writing – review & editing, Project administration, Software. **Samuel Adomako:** Conceptualization, Writing - original draft, Writing - review & editing, Supervision, Methodology, Project administration, software. **Grigorios Lamprinakos:** Writing – review & editing, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Nadia Zahoor is a Senior Lecturer at the Queen Mary University of London, UK. She completed her PhD in Management at University of Huddersfield, UK. Her research interests are strategic alliances, global strategy, innovation, and organizational resilience. She is particularly interested in the context of small and medium-sized enterprises in emerging markets. Her research has been published in mainstream journals, including *Journal of World Business, British Journal of Management, International Marketing Review*, *Journal of Business Research*, *Business Strategy and the Environment*, *International Small Business Journal*, *International Journal of Management Reviews*, *International Business Review*, among others. She is serving as a guest-editor for the special issues at such leading journals as *R&D Management Journal* and *European Management Journal*.

Anastasios Zopiatis, a Hospitality Management Professor at the Cyprus University of Technology (CUT), holds a BSc degree in Hotel, Restaurant and Travel Administration from the University of Southern Illinois at Carbondale (USA), an MSc degree in Hotel Administration from the University of Nevada at Las Vegas (USA), and a Doctorate in Professional Studies from Middlesex University, United Kingdom. Prior to joining CUT, he worked in private tertiary education in Cyprus, both as a hospitality and tourism educator and program coordinator. He has also worked in Las Vegas, Nevada as a Human Resources Specialist and Beverage Manager. His research is related to human resources development, tourism destination/ operations management, hospitality education, and ethics in the academic environment. His work has been published in top tier international journals such as *Tourism Management*, *Journal of Travel Research*, *the International Journal of Hospitality Management*, *the International Journal of Contemporary Hospitality Management*, and the *Journal of Business Ethics*.

Samuel Adomako, PhD., is an Associate Professor of Strategy and Innovation at the University of Birmingham. Prior to joining the University of Birmingham, he held teaching and research positions in King Fahd University of Petroleum and Minerals, and University of Bradford, UK. His research examines the nexus of Strategy, and Innovation. His research has appeared in leading journals including *British Journal of Management, International Small Business Journal, International Business Review, Journal of International Management, Journal of Business Research, Management International Review, Business Strategy and the Environment, Journal of Institutional Economics,* and many others. He received his PhD from the University of Warwick. He is a Fellow of the Higher Education Academy, UK.

Grigorios Lamprinakos is an Assistant Professor of Marketing at Birmingham Business School. The main focus of Grigorios' research is to examine the cognitive and meta-cognitive processes that drive responsible behaviour.