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ORIGINAL PAPER

Technological knowledge, soft skills and management & leadership skills: three pillars for the digitally competent manager

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Abstract

The rapid digitalization of organizations necessitates a re-evaluation of managerial competencies to effectively lead virtual and hybrid teams. This paper introduces the concept of Digital Managerial Competencies (DMC), a comprehensive framework delineating the specific skills and knowledge managers require to navigate the digital workplace successfully. Building on the DigComp framework and grounded in a systematic literature review of 48 peer-reviewed studies, the research identifies three core dimensions of DMC: Technological Knowledge, Soft Skills, and Management & Leadership Skills, comprising 18 specific competencies. The study employs inductive content analysis to develop and validate the model, further enriched through focus group feedback with practitioners. The findings contribute to theory by offering a multidimensional, context-dependent understanding of digital managerial effectiveness and practical guidance for developing targeted training programs. The DMC framework provides a valuable tool for scholars and organizations to assess, develop, and leverage managerial competencies in the evolving digital landscape, ultimately enhancing virtual team performance and organizational outcomes.

Keywords Systematic literature review · Digital workplace · Digital managerial competencies · Technological knowledge · Soft skills · Management skills

JEL Classification M0 · M5

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1 Introduction

The ongoing digitalization of organizations has profoundly transformed how managers and team members collaborate, communicate, and coordinate (e.g., Banks et al. 2022). While it is well established that reliance on digital media—such as email, chat systems, and online platforms—enhances flexibility and connectivity, it also increases the complexity of group processes and managerial responsibilities (Larson and DeChurch 2020). Existing research recognizes that managers serve as role models within organizations, setting behavioral standards that influence employee performance (Dirani et al. 2020). Therefore, in the modern digital workplace, it is essential for managers to establish effective structural frameworks for technology use, stay informed about evolving technological environments, and possess the appropriate competencies (e.g., Contreras et al. 2020; Cortellazzo et al. 2019).

The transformation in how managers interact with their teams—and how influence is exerted—represents a fundamental change challenging our traditional understanding of managerial roles and the competencies required for success in the digital age (Contreras et al. 2020; Tuschner et al. 2022). Understanding these competencies is crucial because they directly impact managerial effectiveness in the digital workplace, which is increasingly characterized by virtual and hybrid work arrangements (Landers and Marin 2021). I refer to the competencies of managers who predominantly depend on technology for communication and leadership activities as "digital managerial competencies". The paper's primary focus is on the specific digital managerial competencies related to technology use—rather than geographical dispersion or cultural differences (Raghuram et al. 2019)—due to their high relevance across various industries as work arrangements become more flexible and technological opportunities expand.

Digital managerial competencies combine two types of concepts: managerial competencies and digital competencies. Broadly, managerial competencies are conceptualized as the combination of knowledge, skills, and abilities of managers (e.g., Spencer and Spencer 1993). However, the term "digital competence" in organizational contexts remains inconsistently defined (Murawski and Bick 2017; Oberländer et al. 2020). Existing frameworks for digital competencies for managers (e.g., Oberländer et al. 2020; van Laar et al. 2020) often cover a wide range of skills, from basic abilities like using standard software and searching for information, to advanced skills such as digital communication and collaboration. Previous efforts to develop digital competencies for managers in virtual environments tend to be limited—they are either specific to certain management levels (e.g., Roman et al. 2019; Zeike et al. 2019), industry-specific (e.g., Claassen et al. 2021), or encompass a broad set of competencies that are not unique to virtual contexts (Roman et al. 2019; van Wart et al. 2019).

Efforts to combine all facets of digital competence have resulted in a somewhat vague and overly broad construct (Eberl and Drews 2021), which is often not specific enough to the rapidly changing technological landscape and may include knowledge and skills irrelevant to many managers (e.g., programming skills; Oberländer et al. 2020). A comprehensive framework for assessing managers' digital managerial competencies is currently lacking, hindering a holistic understanding of their characteristics, mechanisms, and outcomes. Existing measures are still in early development stages and require further refinement and validation, especially given the practical importance of

the virtual context. Thus, the existing literature often fails to address how digital technologies reshape the roles and responsibilities of managers, leaving a significant gap in our understanding of what constitutes effective managerial practice in the digital workplace. This gap is particularly problematic given the rapid evolution of digital technologies and the increasing reliance on virtual teams—phenomena that challenge traditional managerial roles and require new competencies. Without a clear conceptualization and measurement of digital managerial competencies, organizations and scholars are ill-equipped to assess, develop, and leverage these competencies effectively.

To address this gap, this study aims to identify the specific managerial competencies that are relevant and unique to the digital workplace—particularly those arising from increased technology reliance (Brasse et al. 2024; McCarthy et al. 2021). I propose a new construct called Digital Managerial Competencies (DMC). Building on the Digital Competence Framework for European Citizens (DigComp), I conduct a systematic literature review and inductive content analysis of 48 peer-reviewed publications to identify, define, and categorize the core competencies that are both relevant and unique in the virtual context. The resulting model delineates three dimensions and 18 specific competencies, providing a nuanced, operationalized framework for understanding what makes managers effective in the digital workplace.

How does this work challenge and change existing scholarship? First, it shifts the focus from generic digital competencies to a specialized set of managerial competencies that are critical for the digital workplace. Second, it offers a validated, comprehensive model that can be empirically assessed and applied across diverse industries and organizational contexts. Third, it provides a conceptual definition of DMC. Fourth, it provides a foundation for future research on how these competencies influence managerial effectiveness, team performance, and organizational outcomes in the digital age. Ultimately, this study equips scholars and practitioners with a clearer, more precise understanding of what constitutes DMC, thereby enabling more targeted development, assessment, and research in this rapidly evolving field.

2 Conceptual background

2.1 Managers and the virtual environment

In today's modern workplaces, technology and work are deeply interconnected, with technological advancements significantly shaping how tasks are organized and performed (Landers and Marin 2021). Innovations in technology have the capacity to fundamentally change the nature of work itself (Schwarzmüller et al. 2018). Digital tools are frequently employed as a means to facilitate collaboration within virtual teams, allowing members to work together toward shared goals. The success of these digital media, however, largely depends on how well they align with the specific needs of employees or teams (Larson and DeChurch 2020). This suggests that the reliance on digital communication and virtual work is not inherently good or bad but is influenced by various contextual factors, such as managerial practices (Brown et al. 2021; Purvanova and Kenda 2022). This perspective contrasts with traditional, more deterministic views that focus solely on the technical features of digital tools, such as the reduced-cues perspective (Parks and Floyd 1996), which

posit that the effectiveness of a medium is determined by its inherent capabilities. To truly understand how technology impacts work processes and outcomes, it is essential to consider not just the tools themselves, but also how they are employed (Landers and Marin 2021). Since managers are instrumental in shaping team structures, fostering understanding, and creating the appropriate environment (Schmidt 2014), their role in facilitating effective technology use is crucial. This includes their ability to promote, select, enable, and guide the utilization of digital tools.

Emerging research emphasizes that the impact of technology on the effectiveness of virtual teams depends heavily on how these tools are chosen, implemented, and adopted by team members (e.g., Swart et al. 2022). One of the greatest challenges for managers in virtual settings is providing clear direction and navigating the virtual environment (Morrison-Smith and Ruiz 2020). A manager's behavior regarding digital media—such as their decisions about which tools to use and the norms established for their use—can significantly influence employees' attitudes and behaviors (Braun et al. 2019; Schwarzmüller et al. 2018). Therefore, managers must intentionally select and implement technological solutions and structures that address team members' needs, ultimately aiming to achieve desired organizational outcomes (Larson and DeChurch 2020).

As managers navigating the digital age, it's crucial to recognize that the challenges associated with virtual work extend beyond individual employees' knowledge and skills; they involve managerial roles in fostering effective digital collaboration (Dirani et al. 2020). One significant challenge is ensuring effective virtual communication. While digital media can vary in their ability to transmit social cues and facilitate interaction, the key lies in selecting the appropriate media for specific tasks and contexts. Managers need to guide their teams in making these choices, especially considering issues like asynchronous communication and the reduced visibility of non-verbal cues, which can lead to misunderstandings if not properly managed. (Wang et al. 2021).

Another critical area is keeping pace with rapidly evolving technologies. Managers must be proactive in supporting their teams to adapt to new tools and technological advancements (Nowacka and Rzemieniak 2022; Zahoor et al. 2023. This requires fostering a flexible and open attitude toward learning, addressing resistance or apprehension toward technology, and encouraging continuous development. Providing the right infrastructure and promoting motivation to explore and utilize new technologies effectively is essential for maintaining productivity and innovation.

Lastly, managers play a vital role in establishing norms and structures that facilitate smooth virtual collaboration (Raghuram et al. 2019). This includes setting clear interaction rules, shared expectations, and norms for using digital media. Such guidelines help reduce communication overload, prevent misunderstandings, and improve coordination and cooperation within teams (Amankwah-Amoah et al. 2021). Overall, managers are instrumental in enabling their teams to overcome technological challenges by promoting adaptability, strategic media use, and shared collaborative standards, thereby enhancing team effectiveness in the digital work environment.

2.2 Digital competencies and the DigComp framework

In today's rapidly evolving digital landscape, managers face numerous challenges within virtual settings that necessitate the integration of new technologies into their

workflows. To effectively promote, select, and utilize these tools for interaction and leadership, managers must stay current with technological advancements, actively engage with digital tools, and develop confidence in their use (Janssen et al. 2013; Tuschner et al. 2022). This ongoing need underscores the importance of cultivating digital competencies—the combination of knowledge, skills, and abilities required to effectively identify, adopt, and leverage digital technologies within work processes (Oberländer et al. 2020). By 'effectively', it is meant that managers apply their competencies in such a manner as to achieve a desired result.

However, as highlighted by several researchers (Ala-Mutka 2011; Murawski and Bick 2017; Vieru et al. 2015), the concept of digital competence remains inconsistently applied across studies and contexts. The terminology itself is often tangled in what Ferrari (2012, p.11) describes as a "jargon jungle", with various terms conveying similar yet distinct ideas. Notably, the terms "digital skills" and "digital literacy" are frequently used interchangeably, despite their nuanced differences. According to van Laar et al. (2020), digital skills are typically conceptualized as subset of digital competencies. They refer specifically to the practical abilities to use technology (e.g., using software applications, navigating the internet, etc.) (Ala-Mutka 2011; Ilomäki et al. 2016; Iordache et al. 2017). It is more difficult to differentiate digital literacy from digital competencies (Ilomäki et al. 2016; Iordache et al. 2017). Digital literacy has its roots in the broader concept of literacy, which traditionally referred to the ability to read and write (Spante et al. 2018). It might be seen as a complementary concept focused on information processing and communication skills in digital environments.

Digital competence itself is a multi-dimensional concept, often encompassing technological, ethical, cognitive, social, and pedagogical areas, depending on the framework adopted (Calvani et al. 2008; McGarr and McDonagh 2019; Vieru and Bourdeau 2017). Despite these variations, a common thread across frameworks is the emphasis on technological understanding as a core element. Nevertheless, research on digital competencies has primarily focused on citizens—such as students and teachers—within the education sector (e.g., Krumsvik 2014; Pettersson 2017), leaving a gap in understanding the digital competencies required for managers.

Overall, competency studies of managers in virtual settings have the following limitations: First, they target specific management levels—such as frontline managers, middle managers, or senior executives. For example, Roman et al. (2019) and Zeike et al. (2019) focus on competencies relevant to upper-level managers, addressing their particular challenges in virtual settings. While valuable, this approach can overlook the unique needs of other managerial levels or fail to provide a comprehensive view applicable across the organization. Second, some of them tailor digital competency development to particular industries. For example, Claassen et al. (2021) concentrate on competencies in the healthcare sector. Industry-specific training ensures relevance within that context but limits the transferability of competencies to other sectors. This focus can impede the creation of a universally applicable framework for DMC. Third, they aim to identify a broad set of management competencies—such as communication, leadership, or decision-making—that are generally relevant across settings (e.g., Roman et al. 2019; van Wart et al. 2019). However, these competencies are often not tailored to the peculiarities of virtual environments, and may lack specificity and practical applicability.

The objective of this paper is to create a comprehensive, adaptable framework that can guide managers across various levels and industries in effectively developing digital competencies suited for virtual work settings. The DigComp framwork is used as reference model to create a model of DMC. Even though the DigComp framework is aimed European citizens, its universal and all-encompassing characteristic makes it applicable in various contexts and many authors regard it as solid base for studying digital competencies (Findeisen and Wild 2022; Khan and Vuopala 2019; Reisoğlu and Çebi 2020; Romero-Tena et al. 2020).

3 Methodology

To develop a model of DMC, I conducted a systematic literature review of relevant publications within the management and organization domain. To minimize researcher bias, enhance rigor, and address the operational needs of practitioners, it is crucial to synthesize the literature in a manner that is systematic, transparent, and reproducible (Tranfield et al. 2003, p. 207). Accordingly, this study adopts a replicable and transparent methodology, in line with best practices for conducting literature reviews.

The search was carried out in the database Web of Science. As the term 'digital managerial competencies' combines 'digital', 'managerial', and 'competencies', I searched for related terms like 'manager', 'management', 'leader', 'leadership' or 'skills' to be included in the search string. In conducting the systematic search for papers, I used the search string "digital competenc*" OR "digital skill*" AND ("manager*" OR "leader*" OR "leadership skill*" OR "leadership competenc*" OR "management skill*" OR "management competenc*" OR "managerial skill*" OR "managerial competenc*").

As no interval as regards the publication period was set, the initial search resulted in 3,976 hits. I focused on journal articles, review articles, and conference papers written in English. By only including papers in the subject areas Business and Management, the number of potentially relevant papers was lowered down to 317. As indicator of the quality of Business and Management Journals, I used the 2024 version of the Academic Journal Guide (AJG). I only considered articles from journals that were at least ranked 2 for the analysis. This resulted into 91 papers that were read completely. In this way, I sorted out 48 papers that did not focus on competencies of individuals but on the organization, or only mentioned the term. The remaining 48 papers were considered relevant for the analysis. Figure 1 summarises and illustrates the systematic review flow used to finalise the dataset of 48 studies. Table 1 provides an overview of the 48 studies, showing the authors and title of each paper.

4 Findings

4.1 Descriptive analysis

To offer additional context for a better understanding of the reviewed material, the initial phase of the analysis involves a descriptive analysis. Figure 2 shows that more

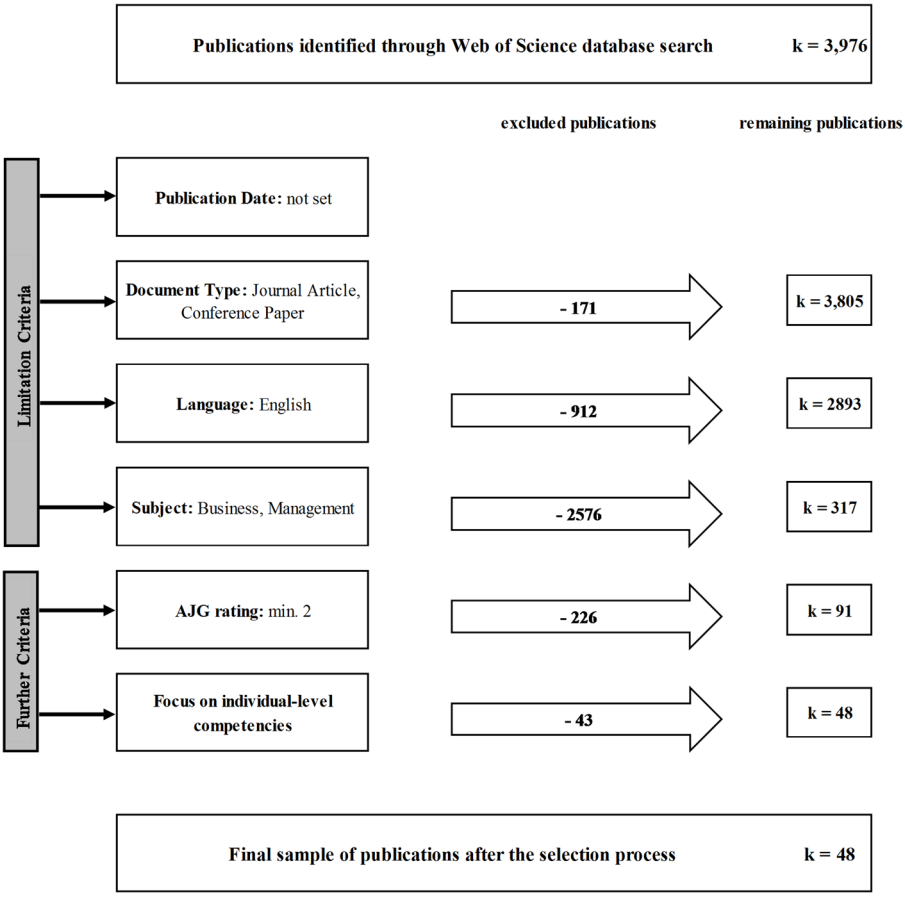

Fig. 1 Overview of the systematic literature review

than half of the 48 papers (27) were published after 2020, which expresses topicality. The interval of the papers ranges from 2000 (2 papers) to 2024 (5 papers).

Table 2 presents an overview of how the reviewed papers are distributed across different journals. With four publications, *Human Resource Development International* has the most published articles, followed by *Employee Relations*, *Journal of Business Research*, and *Journal of Organizational Change Management* with three publications each. Journals with two publications are *Academy of Management Perspectives*, *Public Administration Review*, and *Technological Forecasting and Social Change*.

Table 3 shows the distribution of the reviewed articles over approach and the research methods. 30 of the papers (63%) are empirical, indicating a strong focus on data collection and analysis to explore phenomena related to digital and virtual work, leadership, and digital competencies. Surveys are the most frequently used method, appearing in about 13 of the papers, reflecting their popularity for gathering quantitative data across diverse contexts. Interviews and case studies are also prominent, used to gain deeper insights into specific experiences or organizational contexts. Quantita-

Table 1 Overview of the studies identified in the systematic literature review

Authors	Title
Abalkhail J.M. (2022)	Leading through the COVID-19 crisis: a study of the public sector in the Arab Middle East
Bachmann et al. (2024)	What makes for future entrepreneurs? The role of digital competencies for entrepreneurial intention
Banerjee-Batist et al. (2022)	Leadership response to COVID-19: a comparative analysis of the education sector in USA and India
Bennett E.E. (2014)	Introducing New Perspectives on Virtual Human Resource Development
Birkinshaw et al. (2021)	The Blinkered Boss: How Has Managerial Behavior Changed with the Shift to Virtual Working?
Blanka et al. (2022)	The interplay of digital transformation and employee competency: A design science approach
Boyraz and Gilbert (2024)	Is the future of work hybrid? Examining motivations and expectations related to working from home in knowledge workers' lived experiences
Burke et al. (2006)	What type of leadership behaviors are functional in teams? A meta-analysis
Cascio, W. F. (2019)	Training trends: Macro, micro, and policy issues
Cascio, W.F. (2000)	Managing a virtual workplace
Chatterjee et al. (2022)	Digital transformation of organization using AI-CRM: From microfoundational perspective with leadership support
Chaudhary et al. (2022)	Impact of leader's e-competencies on employees' wellbeing in global virtual teams during COVID-19: the moderating role of emotional intelligence
Dirani et al. (2020)	Leadership competencies and the essential role of human resource development in times of crisis: a response to Covid-19 pandemic
Elsawah et al. (2023)	A Competency Framework for Participatory Modeling
Ferràs-Hernández, X. (2018)	The future of management in a world of electronic brains
Ferreira et al. (2023)	Business (un)usual: Critical skills for the next normal
Gong et al. (2023)	Leveraging resources to improve supervisors' vision in the remote workplace
Grant et al. (2013)	An exploration of the psychological factors affecting remote e-worker's job effectiveness, well-being and work-life balance
Gupta and Pathak (2018)	Virtual team experiences in an emerging economy: a qualitative study
Hafermalz and Riemer (2020)	Interpersonal Connectivity Work: Being there with and for geographically distant others
Harvey and Richey (2001)	Global supply chain management: The selection of globally competent managers
Hedenus et al. (2021)	Whom do you know? Recruiters' motives for assessing jobseekers' online networks
Kinkel et al. (2023)	Key competences for digital business model innovation of industrial companies
Klaus et al. (2014)	Getting in with the "In" crowd: how to put marketing back on the CEO's agenda
Kokina et al. (2021)	Accountant as digital innovator: Roles and competencies in the age of automation
Larsen and McInerney (2002)	Preparing to work in the virtual organization
Loyless L.H. (2023)	Competence in virtual communication: Remote transformational leadership
Makarius and Larson (2017)	Changing Perspectives of Virtual Work: Building Virtual Intelligence at the Individual Level
Murawski and Bick (2017)	Digital competences of the workforce–a research topic?
Müller et al. (2024)	Digital transformation leadership competencies: A contingency approach
Ngoasong, M. Z. (2017)	Digital entrepreneurship in a resource-scarce context: A focus on entrepreneurial digital competencies
Pass and Ridgway (2022)	An informed discussion on the impact of COVID-19 and 'enforced' remote working on employee engagement
Pham et al. (2023)	Improving employee outcomes in the remote working context: a time-lagged study on digital-oriented training, work-to-family conflict and empowering leadership
Roman et al. (2019)	Defining e-leadership as competence in ICT-mediated communications: an exploratory assessment.
Salah-Eddine et al. (2021)	Computerizing Technostress Management: Toward An Artificial Intelligence Assisted Support And Diagnosis System
Saner et al. (2000)	Business diplomacy management: A core competency for global companies
Sarkar and Kedas (2023)	Globally distributed talent communities: A typology of innovation problems and talent characteristics
Schiuma et al. (2024)	Transformative leadership competencies for organizational digital transformation
Shet and Pereira (2021)	Proposed managerial competencies for Industry 4.0–Implications for social sustainability
Tuschner et al. (2022)	Leading in the digital age: A systematic review on leader traits in the context of e-leadership
Ulatowska et al. (2023)	Digital transformation in HRM of the modern business service sector in Finland and Poland
van Vugt et al. (2024)	Digitally Connected, Evolutionarily Wired: An Evolutionary Mismatch Perspective on Digital Work
Verburg et al. (2013)	Getting it done: Critical success factors for project managers in virtual work settings
Vieru et al. (2015)	Digital competence: A multi-dimensional conceptualization and a typology in an SME Context
Wang and Haggerty (2011)	Individual Virtual Competence and Its Influence on Work Outcomes
Wankel, C. (2016)	Developing cross-cultural managerial skills through social media
Wuersch et al. (2023)	Digital internal communication: An interplay of socio-technical elements
Zahoor et al. (2023)	The micro-foundations of digitally transforming SMEs: How digital literacy and technology interact with managerial attributes

tive analysis techniques such as SEM, PLS-SEM, and regression analysis are prevalent for testing relationships and mediation/moderation effects.

18 of the papers are conceptual. These constitute about 38% of the papers, mainly focusing on synthesizing existing knowledge, developing frameworks, or providing theoretical overviews. This indicates a significant interest in conceptualizing models, frameworks, and theoretical discussions to guide empirical research or practice.

4.2 Inductive content analysis

In the next step, the data was analyzed by means of inductive qualitative content analysis. Previous research has shown that a systematic literature review and qualitative content analysis can be well combined (e.g. Dyckhoff and Souren 2023; Siems et al. 2023). This approach seemed particularly suitable for the purpose of this study,

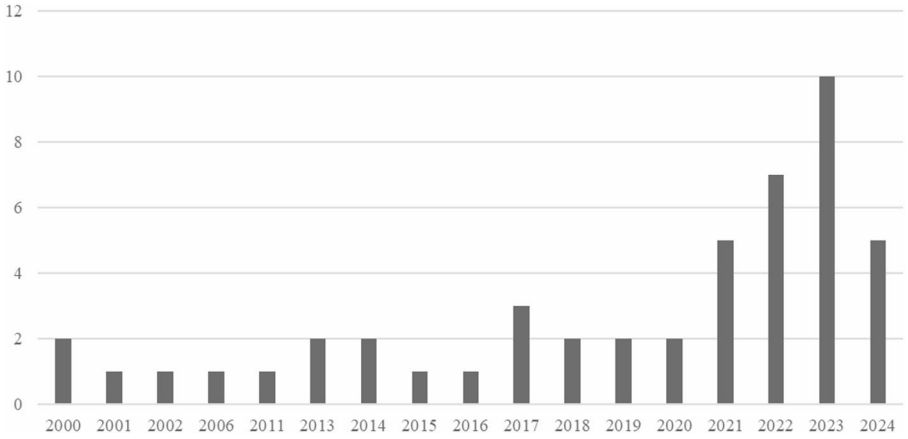

Fig. 2 Distribution of reviewed articles over time (k = 48)

Table 2 Distribution of reviewed articles over journals (k = 48)

Journal Name	Number
Human Resource Development International	4
Employee Relations	3
Journal of Business Research	3
Journal of Organizational Change Management	3
Academy of Management Perspectives	2
Public Administration Review	2
Technological Forecasting and Social Change	2
Rest appeared less than two times	

because it is recommended when former research about the phenomenon under investigation is scarce or fragmented (Vaismoradi et al. 2013), as in the case of digital competencies in the field of management. The aim of the qualitative content analysis is to produce understanding of the meaning of the content that is analyzed. This is done by conceptualizing the research data and classifying them into meaningful and relevant categories (Singh et al. 2007). Researchers use codes to label the data, compare, group, and sub-divide the codes into (content) categories. A category is a broad idea or concept in which a number of specific codes have been grouped (Vears and Gillam 2022). The inductive approach implies that all codes are developed during the coding process and do not stem from previously formulated coding lists.

Table 3 Distribution of reviewed articles over approach and research method (k = 48)

Approach		Method	
Empirical	30	Surveys	13
		Interviews	8
		Case Studies	4
		Quantitative Analysis	4
Conceptual	18	Literature Review	10
		Framework/Model Development	4
		Theoretical Analysis, Meta Analysis	4

Table 4 The development of competency statements to categories and main categories

Competency Statement	Initial Coding	Category	Main-Category
To recognize personal strengths and weaknesses in various skills	Self-Awareness of Skills		
To understand where one's own digital competence needs to be improved	Self-Awareness of Competence		
To understand how personal values align with professional goals	Values and Goals Alignment	Self-Assessment	
To assess the impact of one's behavior on team dynamics	Behavior Assessment		
To regularly assess one's own performance on key projects and tasks	Performance Assessment		
To establish clear, measurable objectives for personal and professional growth.	Objective Development		
To create a timeline for achieving specific skills or competencies	Achieving Skills		
To prioritize developmental goals based on current performance and future aspirations	Goal Prioritization	Goal Setting	
To identify resources and support systems necessary for achieving personal goals	Achieving Goals		
To regularly evaluate progress toward set goals and adjust them as needed	Evaluate and Adjust Goals		
To seek constructive feedback from peers and supervisors to enhance performance	Seeking Feedback		
To actively seek constructive criticism from colleagues and supervisors	Seeking Feedback		
To analyze feedback objectively to identify areas for improvement	Feedback Analysis		
To document feedback received to track changes in behavior and performance over time	Feedback Documentation	Feedback	
To implement suggestions from others as a means of enhancing performance	Implement Suggestions		
To analyze feedback in the context of personal goals and aspirations	Feedback Analysis		**Self-Assessment and Self-Development**
To express gratitude for feedback received, fostering a culture of open communication	Gratitude for Feedback		
To engage in peer evaluations to gain insights from colleagues' perspectives	Seeking Feedback		
To keep up to date with the digital revolution	Staying Updated		
To improve or update one's own digital competence	Competence Improvement		
To seek opportunities for self-development	Self-Development Opportunities		
To actively pursue opportunities for acquiring new skills and knowledge	Self-Development Opportunities		
To stay updated on industry trends and best practices relevant to one's field	Staying Updated	Self-Development	
To participate in professional networks and communities for shared learning experiences	Active Learning		
To conduct periodic reviews of skills and competencies to ensure relevance	Staying Updated		
To embrace challenges as opportunities for learning and development	Self-Development Opportunities		
To utilize online platforms and resources for self-paced learning opportunities	Active Learning		
To reflect on past experiences to identify patterns of success and failure	Analyzing Past Experiences		
To engage in regular self-reflection to evaluate personal growth and areas for improvement	Self-Reflection	Self-Reflection	
To maintain a journal to track personal development and insights gained	Documenting Reflection		
To analyze successes and setbacks to inform future actions and strategies	Learning from Experiences		

Given that the current research focuses on developing a model of DMC, the content analysis process model proposed by Mayring (2014, p. 63) for systematic, theory- and rule-based textual understanding and interpretation was employed in this study.

For a systematic and verifiable categorization of text segments, Mayring (2014) recommends to define content-analytical units—comprising coding units, context units and recording units—prior to analysis. In this paper, a 'clause' in the text forms the coding unit, each research paper is the context unit and the complete material comprising 48 papers constituted the recording unit.

Furthermore, category definition and level of abstraction are central for inductive category formation (Mayring 2014, p. 82). For this study, the category definition is formulated as "A descriptor of a competency element (knowledge, skill, attitude) as expressed in the literature, capturing specific aspects of digital competencies". The level of abstraction is "Categories that generalize specific competency expressions

from the literature into broader, interpretative groups, enabling the identification of overarching dimensions of digital competencies".

The content analysis commenced with a thorough reading of the entire dataset, continuing until all 48 papers had been reviewed and all relevant textual segments identified. Each paper was read from the beginning line by line, and whenever a text segment contained a competency statement or example, it was manually extracted into an Excel spreadsheet and assigned a preliminary code. A code is a short, representative label that summarized the essence of each raw data statement. The initial codes were compared and grouped into broader categories based on their similarities. The categories were constructed iteratively through coding the data and continuously comparing the categories with the data, refining the category labels as necessary (Eisenhardt 1989). All category labels were formulated as nouns with qualifiers, designed to accurately capture the semantic essence of the respective textual segments (Partington 2002). The categories were then grouped to build main categories. Overall, 19 main categories were developed in this process. Table 4 visualizes the development of the main category 'self-assessment and self-development'. For example, the competency statement 'To recognize personal strengths and weaknesses in various skills' was coded 'self-awareness of skills' and initially categorized 'self-awareness'. After coding of related statements, the category name was changed to 'self-assessment'. This category was then grouped with the categories 'goal setting', 'feedback', 'self-development' and 'self-reflection to the main category 'self-assessment and self-development'.

Using the competency statements as orientation, I formulated five to six descriptions for each main category to provide understanding of its meaning. For example, one description of the main category 'self-assessment and self-development' was 'to understand where one's own digital competencies need to be improved or updated. Through this systematic grouping and re-grouping of main categories, three dimensions emerged, which encapsulated the essential competencies identified throughout the literature. The overarching dimensions—technological knowledge, soft skills, and e-leadership skills—provided a coherent framework that effectively represented the diverse aspects of DMC. This initial framework is shown in Table 5.

To guarantee inter-coder reliability, two further researchers independently coded a portion of the competency statements, and any disagreements were addressed through collaborative discussion. This repeated refinement process enabled the categories and main categories to develop in accordance with the data, thereby strengthening the validity of the results. Following these validations, the amounts of main categories and descriptions was reduced, and the names of some categories were re-formulated. For example, in the dimension 'soft skills', the main category 'positive thinking' was renamed to 'curiosity and open-mindedness', and in the dimension 'e-leadership skills', 'technical literacy' was changed to 'data literacy'. Furthermore, we decided to merge the main categories 'face-to-face communication' and 'digital communication' to the main category 'communication' under soft skills. This resulted in a model of 18 main categories of DMC with four to five descriptions. Table 6 shows the revised model with the re-formulated main categories in italics.

To enrich and validate the results of the previous activities from a qualitative point of view, two focus groups studies with 5 participants per meeting have been conducted. The focus groups involved managers training experts, and labor market intermediar-

Table 5 The initial framework of DMC

Digital Managerial Competencies	Technological Knowledge	Knowledge about Hardware and Software
		Knowledge about Information Management
		Knowledge about Digital Content
		Advanced Technological Knowledge
	Soft Skills	Self-Assessment and Self-Development
		Positive Thinking
		Ethics and Responsibility
		Creativity and Innovation
		Problem Solving
		Face-to-Face Communication
		Emotional Intelligence
	E-Leadership Skills	Technical Literacy
		Digital Communication
		Change Management
		Self-Leadership
		Helping and Motivating Others
		Team Working
		Trust-Building
		Strategic Thinking

Table 6 The revised framework of DMC

Digital Managerial Competencies	Technological Knowledge	Knowledge about Hardware and Software
		Knowledge about Information Management
		Knowledge about Digital Content
		Advanced Technological Knowledge
	Soft Skills	Self-Assessment and Self-Development
		Curiosity and Open-Mindedness
		Ethics and Responsibility
		Creativity and Innovation
		Problem Solving
		Communication (face-to-face & digital)
		Emotional Intelligence
	E-Leadership Skills	*Data Literacy*
		Change Management
		Self-Leadership
		Inspiring and Motivating Others
		Managing Teams
		Trust-Building
		Strategic Thinking

ies from Finland. They were shown the model and asked their opinion regarding the architecture as well as types and names of the competencies, e.g., do you observe any missing competencies? All the participants believed that the overall architecture is fine and agreed on the three competency dimensions identified, but suggested to name the third dimension 'management & leadership skills' instead. In the section 'technological knowledge' they suggested to include aspects about AI and cybersecurity in the competency descriptions. Moreover, they recommended to change the main category 'data literacy' to 'data-driven decision making' and add a further main category 'strategic vision and planning' which they considered relevant for managers nowadays. Considering these validations, the final model of DMC is shown in Tables 7 and will be

discussed in more detail in the next section. A detailed presentation of the model with its' competency descriptions can be found in the attachments (Tables 8, 9, 10).

5 Discussion and conclusion

The proposed model delineates three core dimensions of DMC: Technological Knowledge, Soft Skills, and Management & Leadership Skills. Each dimension encapsulates specific, critical competencies that collectively underpin a manager's ability to navigate, leverage, and innovate within digital workplaces.

Technological Knowledge forms the foundation of DMC, emphasizing the importance of understanding and operating digital systems, tools, and applications. This dimension underlines the necessity for managers to be well-versed in hardware and software fundamentals, as well as information management and digital content creation. Beyond basic operational skills, it encompasses advanced technological insights, such as customizing digital environments and developing AI-related expertise. This broad technological literacy enables managers to leverage digital resources effectively, ensure cybersecurity, and address technical issues proactively, which are vital for maintaining organizational efficiency and security (Ferràs-Hernández 2018; Schiuma et al. 2024; Shet and Pereira 2021).

Soft Skills complement technological understanding by focusing on personal and interpersonal skills that facilitate effective digital management. Self-assessment and a commitment to continuous learning allow managers to stay abreast of rapid technological changes (Burke et al. 2006; Cascio 2019). Curiosity and open-mindedness foster adaptability and innovation, encouraging managers to experiment with new tools and practices (Kinkel et al. 2023; Tuschner et al. 2022). Ethical considerations and social responsibility are integral, guiding managers to act responsibly in digital environments, safeguarding privacy, and considering the societal impacts of technology (Hedenus et al. 2021). Creativity and problem-solving skills enable managers to innovate and address challenges dynamically, while effective communication and emotional intelligence underpin successful collaboration and conflict resolution in diverse digital contexts (Chaudhary et al. 2022; Loyless 2023; Wuersch et al. 2023). These soft skills collectively support a resilient, ethical, and innovative managerial approach in the digital workplace.

Table 7 The final model of DMC

Digital Managerial Competencies		
Technological Knowledge	**Soft Skills**	**Management & Leadership Skills**
• Knowledge about Hardware and Software	• Self-Assessment and Self-Development	• Data-driven Decision Making
• Knowledge about Information Management	• Curiosity and Open-Mindedness	• Strategic Vision and Planning
• Knowledge about Digital Content	• Ethics and Responsibility	• Change Management
• Advanced Technological Knowledge	• Creativity and Innovation	• Self-Leadership
	• Problem Solving	• Inspiring and Motivating Others
	• Communication	• Managing Diverse Teams
	• Emotional Intelligence	• Trust-Building

Management and Leadership Skills constitute the third dimension, highlighting the strategic and operational skills necessary to steer organizations through digital change. Data-driven decision making emphasizes the importance of analytics and evidence-based strategies, while strategic vision and planning provide direction aligned with organizational goals (Banerjee-Batist et al. 2022; Birkinshaw et al. 2021). Change management skills are essential for facilitating the adoption of new technologies and overcoming resistance, especially in diverse and evolving workplaces (Chaudhary et al. 2022; Tuschner et al. 2022). Self-leadership fosters personal resilience and motivation, which are critical for inspiring teams (Bachmann et al. 2024). The ability to motivate others, manage diverse teams, and build trust is fundamental for cultivating a collaborative and inclusive organizational culture (Cascio 2000; Grant et al. 2013; Verburg et al. 2013). These competencies ensure that digital initiatives are effectively implemented, monitored, and sustained, ultimately driving organizational growth and adaptation.

Synthesizing these dimensions, DMC refer to the integrated set of knowledge, skills, and abilities that enable managers to effectively lead, innovate, and adapt in digitally driven organizational contexts. DMC embodies not only technical knowledge but also the soft skills and strategic management and leadership qualities necessary to harness digital opportunities while managing associated risks and challenges. It signifies a holistic competency framework that prepares managers to operate at the intersection of technology, people, and strategy.

Distinctive from existing competency frameworks, this model advances the understanding of DMC by explicitly integrating three interrelated dimensions—technological knowledge, soft skills, and management and leadership skills—into a cohesive, comprehensive structure. Many prior models tend to emphasize either technical skills or leadership qualities separately (e.g., Spencer and Spencer 1993; Tett et al. 2000); this model underscores their interconnectedness, highlighting that effective digital management requires a seamless blend of technological literacy, interpersonal skills, and strategic acumen.

One of the model's innovative contributions is its emphasis on advanced technological knowledge, such as AI-specific competencies, application modification, and digital environment customization. Unlike traditional models that focus primarily on basic ICT literacy (e.g., Kurz and Bartram 2002), this framework recognizes the importance of technical adaptability and continuous learning to keep pace with cutting-edge digital developments.

Furthermore, the model integrates soft skills that are often overlooked in purely technical frameworks, such as emotional intelligence, problem-solving, and creativity. These soft skills are crucial for fostering a healthy digital work culture, managing change, and encouraging innovation—elements vital in digital workplaces.

The inclusion of management and leadership skills tailored to digital contexts—like data-driven decision making, change management, managing diversity, and trust building—adds strategic depth. These skills reflect the realities of leading in complex, globalized digital environments and prepare managers to navigate uncertainty, foster inclusive teams, and build trust in virtual settings.

Another significant added value is the model's focus on the interplay between these dimensions, emphasizing that technical skills alone are insufficient without soft skills and management and leadership skills. This holistic approach encourages organiza-

tions to develop well-rounded managers who can not only operate digital tools but also inspire teams, drive innovation, and embed digital strategies into organizational vision.

Moreover, by explicitly addressing ethical considerations and social implications, the model aligns managerial competencies with broader societal values, promoting responsible digital leadership. This ethical lens is increasingly vital as organizations grapple with issues related to data privacy, misinformation, and social inclusion.

The model's broad scope makes it highly applicable to sectors where digital transformation plays a pivotal role, such as Information Technology, Finance, Healthcare, Education, and Professional Services. For example, in healthcare, managers must navigate digital health records, telemedicine platforms, and data privacy concerns (Claassen et al. 2021), aligning well with the model's focus on technological knowledge and ethics and responsibility. The model is equally applicable to public sector organizations, including government agencies, educational institutions, and non-profit organizations. These entities require managers to effectively leverage digital tools for service delivery, stakeholder engagement, and policy implementation (Abalkhail 2022) The emphasis on strategic planning, change management, and trust-building is particularly relevant for fostering transparency, inclusivity, and adaptability in public services. In addition to sectoral applicability, the model applies to diverse groups of people within organizations. Digital managers, team leaders, project coordinators, and HR professionals can all benefit from its insights, as it provides a structured approach to developing essential competencies in digital workplaces. It is particularly valuable for individuals in leadership roles responsible for guiding digital transformation initiatives, managing remote or hybrid teams, and fostering inclusive, innovative workplaces.

5.1 Theoretical contribution

This paper introduces DMC as a new construct that offers valuable insights into managerial effectiveness within virtual environments. This research contributes to the existing literature by addressing the need for a more systematic examination of managerial competencies in the digital age, a gap often hindered by the absence of a reliable and valid measurement tool. Drawing on the DigComp framework, which emphasizes that technology does not have uniform effects on outcomes but is influenced by user characteristics and situational factors (e.g., Centeno et al. 2019; Khan and Vuopala 2019; Kluzer and Priego 2018), I argue that it is crucial to focus research on how managers utilize and promote technology. Consequently, DMC provides a foundational basis for further exploring the dynamic relationship between managers and technology adoption over time (Larson and DeChurch 2020).

The present studies yield three key conclusions. First, DMC is a multidimensional construct comprising three closely related competencies designed to meet the challenges of the virtual environment. These three dimensions indicate that digital managers need: (a) a thorough understanding of digital tools, systems, and processes essential for effective digital management (Technological Knowledge); (b) interpersonal and intrapersonal skills that facilitate effective communication, teamwork, problem-solving, and ethical decision-making within digital contexts (Soft Skills); and (c) strategic and organizational capabilities necessary for guiding teams and organizations successfully through digital transformation (Management & Leadership Skills).

Second, the integration of these three dimensions underscores the importance of a holistic approach to digital managerial competence, whereby technological knowledge, soft skills, and leadership capabilities are viewed as interconnected and mutually reinforcing. This multidimensional framework recognizes that technical knowledge alone is insufficient for effective digital management; rather, it must be complemented by interpersonal skills and strategic leadership to navigate the complexities of virtual environments successfully. By delineating these dimensions, the DMC model advances existing conceptualizations of managerial competencies in the digital age, offering a nuanced understanding that emphasizes the interplay between technical, human, and strategic factors.

Third, the DMC model contributes to the theoretical discourse by proposing that digital managerial effectiveness is context-dependent and shaped by both individual characteristics and situational variables. This perspective aligns with the broader literature on technology acceptance and organizational change (e.g., Kotter 1996; Venkatesh et al. 2003), suggesting that managers' ability to adapt, learn, and lead in digital contexts hinges on their mastery of the three competencies identified. Moreover, by framing DMC as a dynamic construct, the model emphasizes the importance of continuous development and adaptation, encouraging future research to explore how these competencies evolve over time and influence organizational outcomes.

5.2 Practical implications

Given that many managers today report feeling inadequately prepared to confidently lead in virtual environments (Development Dimensions International Inc. 2023), it is crucial to provide practitioners with evidence-based insights on how managers can effectively influence employees amidst increasing digitalization. I contend that simply focusing on acquiring knowledge and skills related to specific digital tools is not enough. Truly digitally competent managers go beyond this by creating supportive conditions for employees, encouraging enthusiasm for new technologies, and establishing reliable structures.

One key practical implication is the emphasis on the synergy between technological knowledge and soft skills. For example, understanding digital tools (Technological Knowledge) combined with emotional intelligence and communication skills (Soft Skills) enables managers to foster more inclusive, transparent, and adaptive digital work environments. This integrated perspective equips managers to better navigate the complexities of remote or hybrid teams, ensuring that technological implementation is complemented by empathetic leadership and effective communication strategies.

Moreover, the model's inclusion of management and leadership skills tailored to the digital era offers actionable insights for designing targeted training and development programs. Organizations can leverage this framework to identify specific competency gaps—whether in data-driven decision making, change management, or trust building—and develop customized interventions that address these areas holistically. This ensures that digital transformation initiatives are not solely driven by technological upgrades but are supported by capable leaders who can motivate, manage diversity, and build trust in digital settings.

The model of DMC is a practical, hands-on framework that highlights essential managerial competencies needed to fully leverage the growing reliance on digital technologies. In this context, the framework developed in this article can guide prac-

titioners in identifying the most relevant actions when designing development initiatives for digital managers.

5.3 Limitations and future research directions

Overall, this study has provided a significant foundation for understanding digital managerial competencies through a systematic literature review and the development of a comprehensive model, but it is essential to acknowledge its limitation.

First, the systematic review primarily relies on publications available in the Web of Science database and within journals ranked at least 2 in the 2024 Academic Journal Guide. While this ensures a focus on higher-quality sources, it may inadvertently exclude relevant insights from emerging or less prominent journals, gray literature, or industry reports that could provide valuable practical perspectives on digital competencies.

Furthermore, the model delineates three dimensions (technological knowledge, soft skills, and management & leadership skills) and 18 specific competencies. This structured approach may overlook other relevant competencies or skills that are crucial in a digital managerial context. It is possible that emergent competencies related to digital innovation, data analytics, or regulatory compliance were not captured in this study.

Finally, the model of DMC reflects the current state of literature and expert validation but may require further refinement. The dynamic and rapidly changing digital environment suggests that the competencies defined in this study may become outdated as new technologies emerge and the demands of managers evolve.

While the findings of this research contribute to the current body of knowledge, several avenues for future research can be proposed to further explore and enhance the understanding of digital managerial competencies.

First, it would be beneficial to conduct empirical studies that test the validity and applicability of the proposed model in real-world settings. Qualitative and quantitative studies involving managers and leaders across various organizations could provide insights into how these competencies manifest in practice. Longitudinal studies could track the development of these competencies over time and their correlation with organizational performance.

Second, the interplay between the identified competencies invites exploration. For instance, it is not yet clear how the different areas of the model are interrelated. Future empirical research needs to address this question to reveal the underlying factor structure of digital managerial competencies in an organization. Through factor analysis, similar areas can be merged and improve the structure of the model. However, a model with more areas has the advantage of highlighting more varied facets of digital managerial competencies. Each management position necessitates a particular set of knowledge and skills suggested from the model, but there is probably no job position that requires the maximum of all 18 areas. Furthermore, the current model treats all 18 areas as equally important for managers. Future research could conduct a survey in business universities and in organizations to investigate if some areas are more relevant than others, or, if important types of soft and e-leadership skills that are not yet included should be considered in the model as well.

Third, future studies could explore how the model applies across various sectors such as healthcare, finance, education, and technology. By identifying industry-spe-

cific competencies or variations in the importance of certain skills, researchers can provide tailored recommendations for training and development initiatives within various organizational contexts.

Similarly, the impact of cultural and regional factors on the perception and application of digital managerial competencies deserves further examination. Different cultures may prioritize certain competencies, and investigating how cultural differences shape perceptions of technological knowledge, soft skills, and e-leadership skills could enhance understanding of global management practices in digital contexts. Comparative studies across countries and cultures would be particularly illuminating in this regard.

Finally, given the rapid technological advancements and shifts in workplace dynamics, ongoing research into emerging competencies is essential. Future studies should explore how new technologies, such as artificial intelligence, machine learning, and virtual reality, impact the skill sets required for effective management in a post-digital age. Additionally, research could delve into the implications of remote work on the development and application of these competencies, especially concerning team dynamics and communication.

Appendix

See Tables 8, 9 and 10.

Table 8 The dimension 'technological knowledge'

TECHNOLOGICAL KNOWLEDGE	
Knowledge about Hardware & Software	To understand the basic ICT concepts of hardware and software
	To be able to operate the fundamental software needed for work
	To understand the most common digital tools and applications used at work
	To select appropriate digital resources for working
	To protect devices and digital systems against external threats
Knowledge about Information Management	To search for digital information in databases and search engines and be aware they use AI algorithms
	To recognize common cybersecurity threats (e.g., malware, phishing, hacking) and how to prevent them
	To analyze and interpret digital data and information in a systematic manner
	To critically examine digital information and be aware that data based on AI may include biases
	To use strong, unique passwords and multi-factor authentication to secure digital accounts
Knowledge about Digital Content	To create textual, numerical, and/or audiovisual information and content using the most common tools
	To edit digital content
	To be aware of author rights and different forms of digital content diffusion
	To be able to protect one's own digital identity
	To know how to protect personal data that could be compromised in digital environments
Advanced Technological Knowledge	To modify applications that are relevant for work
	To develop specific knowledge about AI-technologies
	To recognize and address technical issues when using digital technologies
	To tailor digital environments to individual needs
	To know how to set up online work platforms to support remote work

Table 9 The dimension 'Soft skills'

SOFT SKILLS	
Self-Assessment and Self-Development	To recognise where one's own competencies needs to be improved or updated
	To use various resources to stay informed about new trends and advancements
	To actively search for opportunities for training and development
	To continuously expand and enhance one's repertoire of digital and business knowledge
Curiosity and Open-Mindedness	To develop self-efficacy when dealing with goals, tasks, and challenges
	To be ready to learn new things about one's work and technological trends
	To be patient in exploring new methods, pursue goals perseveringly and be ready to make an effort
	To experiment with new management practices and digital tools
Ethics and Responsibility	To consider the consequences of one's actions in real-life and in a digital context
	To act responsibly in dealing with others and with private and corporate data
	To have due regard to reliability and privacy in all matters
	To understand the role of digital technologies for social well-being and social inclusion
Creativity and Innovation	To use digital technologies to create new knowledge for the organization
	To incorporate innovative technologies when completing tasks at work
	To employ strategies to deal with the dynamic digital environment
	To creatively address issues and opportunities
Problem Solving	To recognise issues, analyse them, and provide a rational assessment
	To take advantage of digital tools when addressing an issue and searching for a solution
	To investigate what causes the problem to understand the situation
	To interact with digitally available resources to acquire meaningful knowledge
Communication	To strive for transparency and clarity in all interactions to prevent misunderstandings
	To pay attention to the message's content while listening effectively without visual cues
	To offer timely, insightful feedback and activeley engage colleagues and subordinates
	To use digital tools to share information, collaborate, and build professional networks
	To be mindful of behavioural norms and cultural and generational diversity in all communication
Emotional Intelligence	To be aware that (online) interactions might affect other people's feelings
	To discuss problems with others and assess various viewpoints to find solutions that satisfy everyone
	To be open to shifting priorities in order to find a solution
	To manage emotions in (online) conversations
	To gather as much information as possible and maintain open communication

Table 10 The dimension 'management & leadership skills'

MANAGEMENT & LEADERSHIP SKILLS	
Data-driven Decision Making	To collect, analyze, and interpret relevant data to inform decision-making processes
	To develop metrics to evaluate the success of initiatives and make adjustments based on data insights
	To integrate qualitative and quantitative data sources for a holistic view of performance
	To apply statistical methods to identify trends, patterns, and correlations that guide strategic choices
Strategic Vision and Planning	To define a clear vision and mission that align with organizational goals and values
	To establish measurable objectives and long-term goals to direct the organization's priorities
	To engage stakeholders in the planning process to incorporate diverse perspectives
	To regularly review and adjust the strategic plan based on market trends and performance
Change Management	To organize, track, and improve the use of digital technologies at work
	To take into account the generational differences of employees when it comes to technology adoption
	To persuade employees to welcome change and support innovation
	To strike a balance between old and new technologies and anticipate potential conflicts
Self-Leadership	To be aware of one's identity, emotions, motivations, strengths, and weaknesses
	To exert personal self-control over feelings, thoughts, and actions in order to achieve goals
	To recognize others' feelings and emotions and respond to them appropriately
	To maintain motivation to finish tasks and persevere through challenges
Inspiring and Motivating Others	To recognize areas where the skills of others need to be strengthened and assist them in developing skills
	To acknowledge and value each person's performance
	To foster a sense of community and healthy relationships among employees
	To encourage cross-border communication, idea sharing, and opportunity creation
	To demonstrate passion, commitment, and resilience in your own actions
Managing Diverse Teams	To understand and respect the cultural, linguistic, and individual differences within a team
	To implement inclusive leadership practices that value diverse perspectives and experiences
	To use digital tools that facilitate effective communication and collaboration among diverse team members
	To encourage open dialogue and mutual understanding to address potential conflicts arising from diversity
	To develop skills in managing and negotiating team dynamics to foster an inclusive work environment
Trust Building	To give followers freedom and respect them as individuals
	To make clear expectations known and keep their promises
	To keep a work-life balance despite having constant access to technology
	To build an engaging, effective, and relevant digital learning environment
	To value and accept the perspectives of people from various backgrounds and cultures

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