

# DEVELOPING A CONCEPTUAL FRAMEWORK FOR DIGITAL ECONOMY COMPETENCIES AMONG MANAGERIAL-LEVEL EMPLOYEES IN MALAYSIA'S MANUFACTURING SECTOR

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**Abstract:** *In Malaysia, the manufacturing sector, a key pillar of economic growth, faces significant challenges in digital transformation due to gaps in managerial-level digital competencies. Despite various government-led initiatives aimed at upskilling and reskilling, empirical evidence indicates that a substantial proportion of managers remain underprepared for the demands of the digital economy. This study develops a conceptual framework for digital economy competency at the managerial level within the Malaysian manufacturing sector, grounded in the Resource-Based View (RBV) and Dynamic Capability Theory. This study employed a quantitative cross-sectional survey design, and data were collected from 385 respondents using a structured questionnaire distributed to managerial employees in manufacturing firms in Sarawak, particularly those involved in digital technology adoption across subsectors such as electronics, food manufacturing, chemicals, wood-based production, and renewable energy. A simple random sampling technique was used to ensure equal selection probability and minimise bias. The findings revealed four core competency domains, which are communication, digital literacy, digital governance, and digital infrastructure, that collectively*

*underpin managerial readiness for digital transformation. Notably, the proposed framework not only offers theoretical insights by positioning digital competency as a strategic organizational capability but also enhances practical applicability through the identification of measurable indicators for each domain. By bridging global best practices with the contextual realities of Malaysia's manufacturing sector, this study contributes to the literature on digital competency development and provides a practical diagnostic tool for organizations and policymakers. This framework serves as a foundation for future empirical validation and supports workforce transformation in alignment with Industry 4.0 and Industry 5.0 agendas.*

**Keywords:** *Information Science, Humanities, Digital Economy, Competency, Managerial Levels, Manufacturing Industry*

## Introduction

The rapid evolution of the digital economy is transforming business operations worldwide, with technologies such as artificial intelligence, big data, cloud computing, and automation reshaping organisational structures and workforce requirements. In this context, digital competencies have become critical, particularly for managerial professionals who are expected to lead strategic transformation and ensure organisational adaptability in increasingly digitalised environments (Neumeyer & Liu, 2021).

In Malaysia, the manufacturing sector is a key driver of economic growth and industrial development. However, its digital transformation remains uneven, largely due to insufficient digital readiness among managerial personnel (Rodríguez-Espíndola et al., 2022). Although various national initiatives, including the Malaysia Digital Economy Blueprint, have been introduced to accelerate digital adoption, empirical evidence suggests that a significant proportion of the workforce still lacks adequate digital skills to operate effectively in a digital-first environment (Arina Sofiah, 2024; Impact Economist, 2024). This issue is particularly critical at the managerial level, where digital competence directly influences decision-making, organisational alignment, and transformation outcomes.

Despite the existence of global digital competency frameworks, there remains a lack of a context-specific, theory-driven framework that captures the digital economy competencies required of managers within Malaysia's manufacturing sector. Existing models are often general in nature and do not sufficiently reflect sector-specific demands, particularly in manufacturing environments undergoing rapid digital transformation (Yu & Moon, 2021). This gap limits the ability of organisations and policymakers to systematically assess, benchmark, and develop managerial digital capabilities in alignment with industry needs. Therefore, there is a need to develop an integrated conceptual framework that consolidates relevant competency dimensions tailored to Malaysia's industrial context.

Addressing this gap, the purpose of this study is to develop a conceptual framework for digital economy competency at the managerial level in Malaysia's manufacturing sector based on a systematic review of existing literature. By synthesising international best practices from digitally advanced economies such as Germany, Australia, China, France, and Estonia, the study identifies key competency dimensions relevant to managerial digital readiness, including digital literacy, communication, digital governance, and digital infrastructure (Sharma, 2016; Trostinskaia et al., 2017; Niu, 2022). The proposed framework aims to provide both theoretical

advancement and practical guidance for organisational development, training design, and policy formulation.

This study is grounded in Dynamic Capability Theory and the Resource-Based View (RBV). RBV posits that organisational competitiveness is driven by valuable and strategically important resources, including human capital and competencies (Barney, 1991). In contrast, Dynamic Capability Theory explains how organisations integrate, build, and reconfigure these resources to respond to rapidly changing environments (Teece, Pisano, & Shuen, 1997). In the context of digital transformation, managerial digital competencies function as strategic resources that must continuously evolve to support organisational adaptation. By integrating these two theoretical perspectives, this study conceptualises digital economy competency as both a strategic resource and a dynamic capability that enables firms to respond effectively to Industry 4.0 and Industry 5.0 demands.

Accordingly, this study aims to identify key digital economy competency factors for managers based on literature analysis; to examine the relevance of these competencies within the Malaysian manufacturing context, and finally to develop a conceptual framework addressing gaps in managerial digital readiness. Through these objectives, the study contributes to the development of a more structured and context-sensitive understanding of managerial digital competencies in emerging digital economies such as Malaysia.

## Literature Review

### The Concept of Digital Economy

The digital economy represents a structural transformation in which economic and social activities are increasingly enabled by digital technologies such as artificial intelligence, cloud computing, big data, and advanced communication systems. Rather than being limited to technological adoption, it reflects a broader shift in how value is created, delivered, and managed across organisations and industries (Ministry of Economy Malaysia, 2021; Mottaeva et al., 2023). While definitions vary, there is consensus that the digital economy integrates digital technologies into core business and societal processes, fundamentally reshaping organisational operations and workforce requirements (Potapov, Moreva, & Latypov, 2024). In manufacturing contexts, this transformation demands a workforce capable of adapting to rapidly evolving technological environments, particularly at the managerial level where strategic decisions are made.

### Defining Digital Competencies

Digital competencies are widely conceptualised as an integrated combination of knowledge, skills, abilities, and attitudes required for effective functioning in digital environments (Helmold, 2021; Cambridge Dictionary, 2024). Rather than being limited to technical proficiency, competencies in the digital context extend to applied capabilities such as data literacy, digital tool utilisation, cybersecurity awareness, and adaptive problem-solving. For managerial roles, these competencies further encompass strategic thinking, digital decision-making, and the ability to align organisational objectives with technology-enabled processes (Wong, 2020). Although prior studies consistently highlight similar competency components, the literature remains fragmented in how these elements are structured and prioritised across different contexts. Some studies emphasise technical capabilities, while others prioritise behavioural and strategic dimensions, resulting in a lack of integrated understanding of digital competencies as a unified construct.

At a global level, disparities in digital competency development remain evident. Advanced economies such as the Netherlands and Nordic countries demonstrate high levels of digital proficiency, whereas regions including Bulgaria, Romania, and parts of Southeast Asia continue to experience significant competency gaps (Rollnik-Sadowska et al., 2024; Gayatri et al., 2024). These differences suggest that digital competency is not only a skills issue but also a contextual and structural challenge shaped by national readiness and organisational capacity. In Malaysia, this issue is particularly pronounced within sectors undergoing digital transformation, especially manufacturing, where managerial digital readiness remains limited (Tee et al., 2024; Arina Sofiah, 2024).

Although national initiatives have been introduced to enhance digital skills through upskilling and reskilling programmes, evidence indicates persistent gaps in workforce readiness. For example, while 83% of employees are reported to possess essential digital skills (Impact Economist, 2024), contrasting evidence shows that approximately 40% of employees still lack adequate digital skills, particularly in manufacturing, engineering, and consumer goods sectors (Arina Sofiah, 2024). This inconsistency suggests uneven competency development across the workforce rather than a uniform improvement. Taken together, these findings indicate that existing discussions on digital competencies remain largely descriptive and fragmented, with limited integration between conceptual definitions, global disparities, and sector-specific challenges. This highlights the need for a more structured and context-sensitive understanding of digital competencies, particularly at the managerial level in Malaysia's manufacturing sector.

### **Managerial Competencies in the Digital Age**

Managers play a central role in driving digital transformation as they are responsible for aligning technological adoption with organisational strategy. Beyond traditional leadership responsibilities, modern managers are expected to possess digital literacy, data-driven decision-making abilities, and adaptability to technology-enabled environments (Neumeyer & Liu, 2021). However, existing studies indicate that managerial competency requirements in the digital era are often inconsistently defined. Some studies emphasise technical competencies such as analytics and software proficiency (Mohamed, 2022), while others highlight behavioural competencies such as emotional intelligence and adaptability (Tovmasyan, 2022). This separation between technical and behavioural dimensions suggests a lack of integrated understanding of what constitutes effective managerial digital competency. Empirical evidence further suggests that managerial competencies are significantly linked to organisational performance and innovation outcomes (Zacca & Dayan, 2018). However, the absence of a structured competency framework limits the ability of organisations to systematically develop and assess managerial readiness for digital transformation.

### **Digital Competency Challenges in the Manufacturing Sector**

The manufacturing sector has been identified as one of the primary drivers of digital transformation through the adoption of Industry 4.0 technologies such as IoT, artificial intelligence, and automation (Kraus et al., 2021). Despite the potential benefits, including improved productivity, efficiency, and operational accuracy, the adoption of these technologies in Malaysia remains relatively low (Rodríguez-Espíndola et al., 2022). A key limitation identified in the literature is that digital transformation success is not solely dependent on technological infrastructure but also on managerial readiness. In particular, insufficient managerial digital competencies have been found to hinder effective technology integration and decision-making processes in manufacturing organisations (Patrick, 2023). Moreover, existing studies often treat digital competencies and soft skills separately, despite evidence suggesting

that successful digital transformation requires an integrated combination of both. Skills such as critical thinking, adaptability, and problem-solving are equally important as technical digital capabilities in navigating complex manufacturing environments (Obermayer et al., 2023). This indicates a clear gap in the literature: while digital transformation in manufacturing has been widely studied, there remains limited focus on how managerial competencies should be systematically structured to support both technological and organisational adaptation.

### **Positioning the Proposed Framework within Existing Models**

Several established digital competency frameworks, such as the European Digital Competence Framework (DigComp) and OECD skill frameworks, provide important foundations for understanding digital literacy and workforce readiness. However, these frameworks are largely designed for general populations or macro-level policy evaluation, rather than sector-specific managerial application. A critical limitation of existing frameworks is their lack of contextual specificity. Most models do not differentiate between employee-level competencies and managerial-level strategic competencies, nor do they account for sectoral differences such as those present in manufacturing environments. As a result, their applicability in guiding managerial development within specific industries remains limited. Furthermore, existing frameworks tend to treat digital competency as a static set of skills rather than a dynamic capability that evolves alongside technological change. This creates a misalignment between theoretical models and the real-world demands of Industry 4.0 and Industry 5.0 environments. To address these limitations, this study proposes a context-specific and theory-informed framework that integrates communication, digital literacy, digital governance, and digital infrastructure as interrelated dimensions of managerial digital competency. This approach extends existing literature by shifting from generic competency classification toward a more integrated, sector-specific, and strategically oriented model tailored to the Malaysian manufacturing context.

### **Research Methodology**

This study adopted a quantitative research design using a cross-sectional survey approach. Data were collected through a structured questionnaire distributed to managerial and technical employees in manufacturing firms in Sarawak. The study population comprised manufacturing organisations in Sarawak that had adopted or were in the process of implementing digital technologies. These included subsectors such as wood-based production, electronics, food manufacturing, chemical products, and renewable energy. The selection of this population was justified by Sarawak's strategic emphasis on industrial digital transformation and the importance of workforce readiness in supporting this agenda. A probability sampling technique, specifically simple random sampling, was employed to ensure equal selection probability among respondents and to minimise selection bias. The required sample size was determined using the Raosoft Sample Size Calculator at a 95% confidence level and a 5% margin of error, resulting in a recommended sample of approximately 385 respondents. This sample size was considered adequate for conducting reliability tests and regression analyses.

### **Discussion**

This study identifies four critical components contributing to digital economy competencies at the managerial level, namely communication, digital literacy, digital governance, and digital infrastructure. These domains were consistently highlighted across international literature as foundational to digital transformation, and their relevance is particularly significant for the Malaysian manufacturing sector, which is in the midst of transitioning toward Industry 4.0 and 5.0 environments.

### Communication

The relationship between communication and digital economy competencies is a crucial area of study, especially when digitalization transforms the functions of businesses and educational entities. Active communication skills are regarded as essential for success in the digital economy. Effective communication is crucial for competitiveness in the digital economy, impacting both individuals and organizations. According to Trostinskaia et al. (2017) and Smyrnova (2021), for overseeing organizational procedures and facilitating international collaboration, this competence must be implemented. To integrate marketing, production, and research and development for new products, the invention of modern business must emphasize parallel digital communication (Smyrnova, 2021).

The author also referred to the transition to digital communication networks involving increased communication intensity, real-time automation, and online information processing to enhance economic efficiency. On the other hand, higher education systems must adapt to the digital economy by including professional collaborations, flexible instructional tools, and curricula that meet the needs of future employers. This technique accelerates the acquisition of critical communication skills for future professionals. Trostinskaia et al. (2017) and Joglekar et al. (2022) assert that digital communication skills have become crucial for success in the digital economy. Consequently, educational institutions and corporations must prioritize developing and integrating these competencies to guarantee competitiveness and efficiency in implementing the digital economy. Educational institutions must adapt to reconcile perceived and actual competencies, while organizations must appropriately refine their communication frameworks to capitalize on digital economy adaptability.

### Digital Literacy

The correlation between digital literacy and digital economy proficiency is a vital subject of investigation, particularly as economies become further dependent on digital technologies. Digital literacy encompasses the competencies and understanding necessary to navigate and effectively utilize digital environments, which is crucial for participating in and contributing to the digital economy. According to Dmitry (2021) and Sharma (2016), digital literacy is crucial for navigating the digital landscape and is vital for the contemporary economy and scientific and technical advancement. Digital literacy efforts serve as instruments for attaining sustainable growth and development within knowledge societies rather than being objectives in their own right. (Sharma, 2016). Meanwhile, digital education models augment digital competencies, advancing the digital economy (Buhaichuk et al., 2023). Universities are vital in cultivating digital literacy in students, encompassing abilities such as digital writing, reading, and database use, all of which are essential for the digital economy (Gutierrez-Angel et al., 2022). On the other hand, cultivating digital capabilities, encompassing the utilization of big data, artificial intelligence, and digital platforms, is vital for the workforce in the digital economy (Barykin et al., 2020).

Digital competency, encompassing information literacy, security, and digital content management, enhances the competitiveness of human capital (Marlina et al., 2023). According to Mancha et al. (2020), digital literacy is also related to digital economy competency, which is significant for making new goods and services in the digital economy implementation. Moreover, people who are not as tech-savvy can experience the digital economy by learning how to use technology better when the organisation exposes them to the technologies (Sharma, 2016). Furthermore, digital literacy is a crucial element that underpins competence in the digital economy, which enables persons to effectively engage with digital technologies, fostering

innovation and inclusive economic advancement. Therefore, the complex nature of digital literacy highlights the need for wide-ranging initiatives in education and training to properly utilize its potential for helping economic development in the organisation. Hence, educational institutions and workforce development programs are encouraging the enhancement of digital literacy in their fields, and they support firming up the overall digital economy environment implementation.

### Digital Governance

The relationship between digital governance and digital economy competencies is an important field of research as digital transformation persistently alters the global economy's atmosphere. This paper indicates that digital governance positively impacts digital economy competencies by boosting corporate governance, nurturing social reforms and economic policies, and increasing organizational performance and modernization. Effective digital governance can enhance digital economy proficiency by fostering innovation, improving organizational performance, and ensuring sustainable economic development. Effective governance enhances the sustainable digital economy, social reforms, and economic policies, fostering a sustainable digital economy (Tang et al., 2021; Niu, 2022). To enhance organizational performance and competitiveness, digital governance has to be adapted to the needs of the digital economy (Polidi et al., 2019; Sama et al., 2021). According to Yuan (2023), implementing the digital economy helps the organizational revolution by improving an organization's digital governance. Meanwhile, as highlighted by the G20, international collaboration and governance are critical for integrating the benefits and risks of the digital economy, ensuring cybersecurity and equitable development (Lanshina et al., 2017). National governance frameworks that include leadership and constant monitoring may reduce risks while encouraging private-sector innovation (Linkov et al., 2018; Sama et al., 2021).

According to Yu et al. (2021) and Tiwari et al. (2021), digital competency, which includes digital infrastructure, integration, and management, is critical for enhancing corporate efficiency and competitiveness in the digital economy. Social reforms and economic policies facilitate the relationship between effective governance and a sustainable digital economy, underscoring the interdependence of governance, social, and economic elements (Tang et al., 2021; Niu, 2022). Furthermore, effective digital governance is essential for improving digital economic competency. These approaches enhance the digital economy by promoting innovation, refining digital governance, and guaranteeing sustainable economic growth. Global and national governance frameworks are essential in balancing the advantages and hazards of digital change. Moreover, digital competency at the organizational level is crucial for enhancing performance and competitiveness. Social changes and economic policies further influence the relationship between governance and a sustainable digital economy, highlighting the necessity of a comprehensive approach to digital governance.

### Digital Infrastructure

Given the growing dependence of global economies on digital technology for development and expansion, examining the relationship between digital infrastructure and proficiency in the digital economy is imperative. Through strengthening strategy orientation and resource reconfiguration, digital competency, which includes digital infrastructure, has significantly boosted organizational performance (Yu et al., 2021). Digital infrastructure, together with digital industry and integration, significantly increases the total factor productivity, emphasizing its critical role in economic growth (Daojiong & Dong, 2022; Mao, 2023). Innovation and entrepreneurship have been transformed by the development of digital

infrastructure, which has improved value generation and capture and created new opportunities (Nambisan et al., 2019).

In order to sustain long-term growth and align with overall economic objectives that can contribute to high-quality economic development, digital infrastructure is essential for the best possible advancement in the implementation of the digital economy (Chen, 2023 & Wei et al., 2023). Strong digital infrastructure supporting the digital economy improves urban resilience's social, economic, and ecological aspects (Shi et al., 2023). According to Zhang et al. (2023), investing in IT infrastructure is crucial for digital transformation strategies, improving business performance, and digital competency to enable digital transformation. Digital infrastructure needs to be built to become competent in the digital economy. It increases economic production, fosters creativity and entrepreneurial behaviour, increases organizational performance, and promotes resilient cities and high-quality economic growth. Investments in digital infrastructure are significant in enabling digital transformation and achieving long-term growth in the digital economy.

### Findings: Proposed Research Framework

The competency gap is a significant challenge managers encounter when encouraging their personnel to utilize digital abilities. There is a demand for employees proficient in traditional business practices and digital technology tools as the economy transitions to a digital environment. Advancing the training of current staff and recruiting individuals proficient in technology is crucial for the organisation. Furthermore, instruction in digital literacy, digital infrastructure, digital governance, and communication skills is essential to workforce development programs. The difference can also be moderated through collaborations between the public and private sectors and partnerships with academic institutions that develop curricula aligned with the demands of a progressively digitalized array of industries. Digital economy competency is no longer optional for the organisation, and it is an essential element for success in a globally competitive and rapidly changing landscape. Building these competencies will require a concerted effort across the industry, from workforce training and education to adopting new technologies and developing forward-looking strategies. Companies that prioritize developing digital skills and embracing innovation will be better positioned to lead in the future of manufacturing.

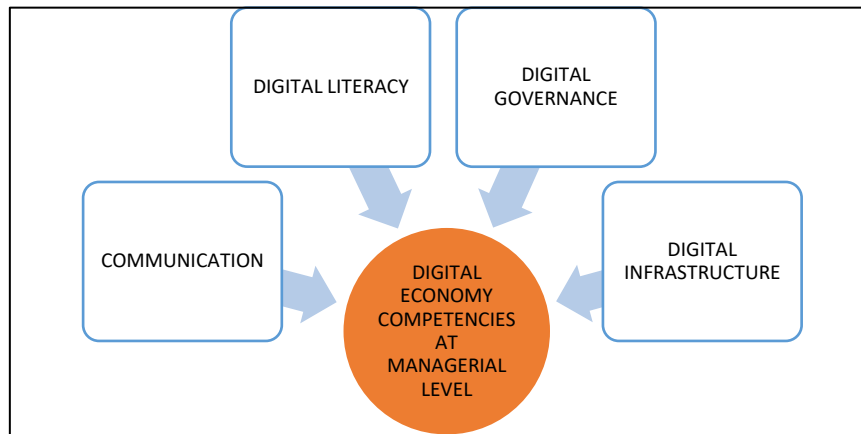
### Operationalisation of Digital Economy Competency

To enhance the practical applicability of the proposed framework, this study further outlines potential measurement indicators for each competency domain. These indicators can serve as a foundation for future empirical validation and organisational assessment tools.

- **Communication:** digital collaboration, virtual communication effectiveness, cross-functional information sharing (Joglekar et al., 2022)
- **Digital Literacy:** data analysis capability, use of digital tools, AI and big data awareness (Sharma, 2016; Barykin et al., 2020)
- **Digital Governance:** understanding of digital policies, cybersecurity awareness, ethical use of digital technologies (Sama et al., 2021; Niu, 2022)
- **Digital Infrastructure:** ability to leverage digital platforms, understanding of IT systems, integration of digital technologies into operations (Yu et al., 2021; Zhang et al., 2023)

These indicators demonstrate how the conceptual framework can be translated into measurable constructs, thereby increasing its utility for organisational diagnostics, training development,

and policy implementation. This operationalisation also provides a pathway for future quantitative studies using techniques such as Structural Equation Modelling (SEM) to test the relationships between competency domains and organisational performance outcomes.



**Figure 1. Proposed Conceptual Framework for Digital Economy Competencies at Managerial Level**

### Conclusion and Implication

Through this study, four interrelated domains were identified as foundational to managerial digital competency: communication, digital literacy, digital governance, and digital infrastructure. These competencies were consistently reflected in international scholarly literature and are particularly relevant in guiding Malaysia's transition toward a digitally driven industrial landscape. The findings indicate that these competencies are not only individually essential but also function synergistically to shape effective managerial decision-making and organizational transformation. Digital infrastructure provides the foundational technological layer that enables connectivity, data exchange, and automation. However, without digital literacy, managers may lack the capability to effectively leverage these systems. In parallel, digital governance ensures the ethical, legal, and policy-aligned deployment of digital technologies, which is increasingly critical amid rising cybersecurity threats and data privacy concerns (Sama et al., 2021; Niu, 2022). Communication, meanwhile, serves as the integrative mechanism that facilitates collaboration, strategic alignment, and organizational agility across digitally enabled environments (Trostinskaia et al., 2017; Joglekar et al., 2022). By integrating these domains, the proposed framework advances the theoretical understanding of digital competency in managerial roles, particularly within emerging economies such as Malaysia. While existing competency models often emphasize general workforce capabilities, this study refines the focus to managerial-level competencies within the manufacturing sector, offering a more context-specific and application-oriented model.

Theoretically, this study contributes to the digital competency literature by presenting a structured and context-sensitive framework tailored to managerial challenges in Malaysia's manufacturing sector. It bridges global digital competency models with localized industrial realities, thereby enriching scholarship on digital transformation, leadership development, and organizational change in emerging economies. The framework not only identifies key competency domains, which are communication, digital literacy, digital governance, and digital infrastructure, but also organizes them into a coherent structure that can support future hypothesis-driven research as well as cross-sectoral and cross-national comparative studies within the broader digital economy.

Practically, the framework serves as a diagnostic and developmental tool for multiple stakeholders. For organizations, it can be used to assess digital readiness and identify competency gaps among mid- and senior-level managers. For educational institutions and training providers, it informs the design of executive education and professional development programs aligned with the evolving needs of digital industries. For policymakers, it supports the formulation of sector-specific upskilling strategies aligned with Malaysia's Digital Economy Blueprint (Ministry of Economy Malaysia, 2021). Strategic investment in these four competency domains is expected to enhance organizational efficiency, foster innovation, and strengthen long-term competitiveness in the digital economy. Overall, this study moves beyond conceptual development by offering a theoretically grounded and operationally defined framework, enhancing its applicability for both academic research and practical implementation. The inclusion of measurable indicators further strengthens its potential for empirical validation and real-world adoption.

### **Recommendations and Future Research**

Based on the findings of this study, it is recommended that targeted training and reskilling programs be developed to address the four core digital economy competencies, such as communication, digital literacy, digital governance, and digital infrastructure, that are specifically tailored to the managerial context within Malaysia's manufacturing sector. Strengthening collaboration between academia, industry, and government is also essential to ensure that competency-based frameworks are co-created and aligned with evolving industrial demands and educational outcomes. Organizations should implement formal mechanisms for assessing managerial digital readiness, such as standardized competency assessments, digital leadership indices, and performance dashboards, to monitor progress and inform development initiatives. Furthermore, greater investment in digital infrastructure, particularly for small and medium-sized enterprises (SMEs), should be prioritized alongside the parallel development of human capital through digital literacy programs.

Besides, ethical and governance-focused training should also be embedded within digital transformation strategies to ensure responsible and sustainable technology adoption. While this study provides a strong conceptual foundation, its reliance on secondary data presents limitations. Future research should aim to empirically validate the proposed framework through surveys or interviews with managerial professionals in Malaysia's manufacturing sector to assess the relevance and applicability of each competency domain. Comparative studies across different sectors or countries could explore the universality or variability of digital competency needs in diverse contexts. Longitudinal research may also be valuable in tracking the evolution of these competencies over time, particularly in response to ongoing technological changes and policy developments. Finally, quantitative approaches such as structural equation modelling (SEM) or factor analysis could be used to examine the causal relationships among the competency domains and their influence on organizational performance. Collectively, such studies will enhance the robustness, adaptability, and practical application of the framework presented in this paper.

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