

Factors and Industry 4.0 Technology Adoption among ICT Service Smes in Malaysia: A Descriptive Assessment

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DOI: <https://doi.org/10.47772/IJRISS.2026.100800735>

Received: 28 August 2026; Accepted: 02 September 2026; Published: 16 September 2026

ABSTRACT

This study provides a descriptive assessment of the factors associated with Industry 4.0 adoption and the current level of implementation of eleven Industry 4.0 technologies among ICT service Small and Medium Enterprises (SMEs) in Malaysia. Drawing upon a sample of 150 respondents from registered Malaysian ICT service SMEs, the paper presents a descriptive, mean-based analysis of eight key adoption factors and eleven technologies. The findings indicate that customer requirements recorded the highest perceived importance ($M = 4.493$, $SD = 0.610$), followed by cost reduction ($M = 4.307$) and competitors' technology practices ($M = 4.227$). In terms of technological implementation, the Internet of Things (IoT) demonstrated the highest adoption level ($M = 4.180$, $SD = 0.769$), closely followed by System Integration ($M = 4.013$) and Cloud Computing ($M = 3.953$). In contrast, physical and highly specialized technologies, such as Autonomous Robots ($M = 2.020$, $SD = 0.930$) and Additive Manufacturing ($M = 2.193$, $SD = 1.060$), exhibited the lowest levels of adoption. The overall technology adoption mean was 3.172, indicating a moderate level of Industry 4.0 maturity. The paper highlights that ICT service SMEs prioritize digital solutions that are directly relevant to service delivery, business operations, and cloud-based infrastructure, while physical automation remains less applicable. The findings offer valuable insights for managers developing digital strategies and policymakers designing targeted digital transition support programs.

Keywords: Cloud Computing, digital technology adoption, digital transformation, ICT service SMEs, Industry 4.0, Malaysia

INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are the backbone of Malaysia's economic development and transition [1]. According to official statistics from SME Corp Malaysia [2], MSMEs constitute 97.4% of total business establishments, contribute approximately 38.4% to the national Gross Domestic Product (GDP), and employ 48.2% of the national workforce. In recent years, this contribution has exhibited a steady upward trajectory, with MSME GDP growth consistently outpacing overall national GDP growth [1]. Specifically, in 2024, MSMEs recorded a robust GDP growth of 5.8%, contributing RM652.4 billion in value-added, which accounts for 39.5% of the national GDP, compared to 39.1% in 2023 and 38.4% in 2022 [2]. This expansion highlights the rising importance of smaller enterprises in anchoring economic resilience.

Structurally, Malaysian MSMEs are highly concentrated in the services sector [3]. The profile of MSMEs demonstrates that services consistently account for more than 80% of all establishments [3]. Earlier statistics

indicated that about 89.2% of SMEs operated in the services sector, representing 809,126 firms [2]. More recent Micro, Small, and Medium Enterprise profiles confirm that this dominance has continued: in the 2024 MSME profile, the services sector comprised 84.4% of total MSMEs (917,070 firms), far exceeding manufacturing, construction, and agriculture [2]. This clearly indicates that any strategic discussion of MSME development and digital adoption in Malaysia is, in practice, largely a discussion about service-based enterprises.

Within the services sector, the Information and Communication Technology (ICT) service subsector has emerged as a critical driving engine toward country sustainability and digital transformation [4]. In 2024, the digital economy comprising both the ICT industry and e-commerce activities contributed 23.4% (equivalent to RM451.3 billion) to Malaysia's national economy, where the ICT industry itself accounted for 13.9% and e-commerce activities from non-ICT industries contributed 9.5% [5]. The sector grew at a rate of 5.1% in 2024, reflecting stronger expansion compared to the 3.5% growth recorded in 2023 [5]. The total revenue for information and communication services reached RM131.4 billion in 2024, representing a 3.4% increase from the previous year, and continued rising to RM45.9 billion in the third quarter of 2025 [5]. This sustained growth highlights the strategic importance of ICT service SMEs as key providers of output, innovation, and employment.

Despite the significant macroeconomic contributions of small and medium enterprises (SMEs) and a strong policy push via national initiatives such as the Industry4WRD policy and the MyDIGITAL Blueprint, the digital adoption rate among Malaysian service-sector SMEs remains modest. Most Malaysian SMEs exhibit low technological capability and innovation performance, relying heavily on traditional service delivery models. The World Bank (2020) reported that less than 15% of Malaysian SMEs have adopted automation or data analytics tools, and even fewer have adopted advanced solutions like Artificial Intelligence (AI) or machine learning due to concerns over cost, complexity, and a lack of digital strategy. This digital divide prevents SMEs from realizing the substantial benefits of the Fourth Industrial Revolution.

In this complex and volatile environment, the Dynamic Capabilities framework (Teece et al., 1997) emerges as a highly useful theoretical lens to explore the organizational processes associated with technology adoption. Defined as a firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments, dynamic capabilities are essential for leveraging Industry 4.0 technologies effectively. Sensing capability enables service SMEs to recognize emerging digital trends; seizing capability involves mobilizing resources and strategic commitment for digital transformation; and transforming or reconfiguring capability helps restructure processes and systems to fit new technologies. Without developing these higher-order capabilities, technology implementation remains superficial or fragmented, failing to generate sustainable performance. Recently, Khairul Hisham et al. [37] extended the Dynamic Capabilities View (DCV) to the ICT service sector by proposing a conceptual model where Industry 4.0 adoption acts as an important mediating mechanism that translates internal dynamic capabilities—specifically technological capability, digital organizational culture, organizational readiness, and financial capability—into sustainable organizational performance.

The novelty of this study lies in addressing several critical empirical and theoretical gaps highlighted in the most recent literature. First, while previous studies have heavily focused on Industry 4.0 in manufacturing sectors, recent investigations such as Saman et al. [31] and Khairul Hisham et al. [37] emphasize that sustainability research on service SMEs remains extremely limited, highlighting a critical need for frameworks that integrate digital transformation, dynamic capabilities, and sustainable performance in a single, cohesive framework. Second, as argued by Khairul Hisham et al. [37], ICT service SMEs operate in a knowledge-intensive environment and play a strategic dual role in the digital economy: they are both users of advanced technologies and providers of digital solutions that enable other sectors to transition, which dramatically intensifies the operational complexity they face. Third, as noted by Talukder et al. [32], digital transformation should not be viewed as an isolated technological acquisition, but as an organizational process that enables firms to respond to stakeholder demands and regulatory pressures more effectively. Fourth, in dynamic emerging economies like Malaysia, Rehman et al. [33] argue that the successful deployment of Industry 4.0 technologies depends heavily on the presence of ambidextrous dynamic capabilities that balance exploration and exploitation activities. Furthermore, Ismail et al. [34] emphasize that organizational readiness, particularly top management commitment and technological preparedness, plays a decisive role in aligning technology adoption with economic and environmental sustainability goals. This is further supported by Techanamurthy et al. [35], who

identify leadership commitment, workforce skills, and digital infrastructure as the primary mitigators of strategy implementation failure during digital transformation. Lastly, as shown by Sousa et al. [36], the ultimate value of technology adoption in services is realized through enhanced operational efficiency, superior service quality, and improved quality of life at work. By focusing on the highly specialized, knowledge-intensive Malaysian ICT service subsector, this paper provides a localized, granular descriptive diagnostic map of adoption factors and actual technology implementation levels, thereby contributing a unique empirical foundation that bridges these theoretical gaps.

LITERATURE REVIEW

A. Service 4.0 and Malaysian ICT Service SMEs

Service-based ICT SMEs in Malaysia provide crucial technological solutions, such as software development, system integration, IT consulting, cloud and data center services, cybersecurity, and digital platforms [11]. They fall within the standard services classification of having an annual sales turnover not exceeding RM20 million or full-time employment not exceeding 75 employees [2]. Unlike traditional manufacturing, these firms operate in a knowledge-intensive environment where value creation is driven by intangible assets, technical expertise, and continuous technological upgrading [12]. Furthermore, ICT service SMEs play a unique dual role in the digital economy: they are both users of Industry 4.0 technologies in their own operations and providers of digital solutions that enable other sectors (such as logistics, retail, and manufacturing) to implement, integrate, and scale digital practices [13]. This dual role is further analyzed by Khairul Hisham et al. [37], who state that Malaysian ICT service SMEs are central enablers of national digital transformation goals under national programs like Industry4WRD and NIMP 2030, meaning their organizational sustainability directly influences national economic resilience. In [37], Khairul Hisham et al. emphasize that digital platforms and co-creation are key enablers of sustainable service delivery, but the adoption of these platforms must be matched by behavioral preparedness, such as digital organizational culture and leadership alignment, rather than physical infrastructure alone.

B. Challenges of Service SMEs towards Business Sustainability

Achieving long-term business sustainability requires a balanced management of economic, environmental, and social responsibilities [10]. However, Malaysian ICT service SMEs face multifaceted, interconnected challenges when transitioning toward sustainable, digitalized business models. One of the most severe obstacles is financial constraints. The adoption of advanced digital technologies and sustainability practices requires significant upfront capital investments, which tight-cash-flow SMEs perceive as highly costly and risky (Indiran et al. [14]; Chong and Kaliappen [15]). Financial limitations also restrict SMEs' ability to simultaneously pursue digital transformation and sustainability initiatives, as both require substantial resource allocation (Ilias et al. [16]; Husin et al. [17]). Uncertainty regarding the return on investment (ROI) further delays strategic commitments, as owners find it difficult to quantify the long-term tangible benefits of digital transformation.

Knowledge and expertise gaps represent another critical barrier. Many SME leaders lack a comprehensive understanding of Industry 4.0 concepts, and their organizations suffer from a lack of qualified workforce with the digital competencies required to implement and manage advanced systems like big data analytics, AI, and cloud platforms (Indiran et al. [14]; Chong and Kaliappen [15]). Technological constraints, such as legacy system integration, interoperability, and cybersecurity risks, add further operational complexity (Ilias et al. [16]; Husin et al. [17]). Finally, intense market competition forces managers to focus on short-term survival and cost efficiency rather than long-term strategic sustainability, leading to sporadic and fragmented adoption (Yen et al. [23]; Minic et al. [24]). Furthermore, as noted by Khairul Hisham et al. [37], service SMEs frequently struggle with insufficient financial assets, expertise, and readiness to change. This is in contrast to larger firms that possess large budgets and dedicated IT departments, leaving smaller service firms to struggle to find resources for technology implementation [37].

C. Underpinning Theory: The Dynamic Capabilities Framework

To address high environmental dynamism and resource constraints, service SMEs must rely on more than static resource configurations [12]. While the Resource-Based View (RBV) highlights the strategic value of valuable, rare, inimitable, and non-substitutable resources, it fails to explain how firms sustain competitive advantages in rapidly changing and volatile markets [10]. The Dynamic Capabilities Theory (DCT) extends the RBV by focusing on the active, change-oriented processes of adaptation, renewal, and transformation [8]. Under Teece's [10] conceptualization, dynamic capabilities are structured around three microfoundations: sensing, seizing, and reconfiguring.

Sensing capability enables firms to detect technological opportunities and anticipate market trends [10]. Seizing capability involves mobilizing financial and human resources to exploit identified opportunities through strategic investment [10]. Reconfiguring capability involves transforming internal structures, workflows, and resource alignments to maintain strategic fit (Warner and Wäger [27]). In the context of Industry 4.0, these higher-order capabilities enable service SMEs to effectively sense digital opportunities, strategically invest in relevant technologies, and successfully restructure operations, ultimately driving balanced economic, environmental, and social sustainability.

D. Theoretical Mapping: Linking Dynamic Capabilities to Measured Variables

To establish a rigorous theoretical foundation, the relationship between the Dynamic Capabilities (DC) framework and the variables measured in our questionnaire must be made explicit. The DC framework is structured around three microfoundations: sensing, and reconfiguring (Teece, 2018)—which directly correspond to the empirical measures of adoption drivers, barriers, and technology implementation levels in our survey instrument.

Sensing Capability (Detecting opportunities & market trends): This capability is operationalized through external drivers that require active monitoring. In our survey, sensing is captured by variables measuring the perceived importance of customer requirements ($M = 4.493$), which reflect client-driven demand signals, competitors' technology practices ($M = 4.227$), which represent external technological benchmarks, and public advisory support ($M = 3.780$), which represents institutional knowledge opportunities.

Seizing Capability (Mobilizing resources and strategic commitment): This capability is operationalized through the strategic mobilization of capital and organizational commitment to exploit sensed opportunities. In our instrument, seizing is captured by variables measuring the perceived importance of cost reduction ($M = 4.307$) and time-to-market improvement ($M = 4.093$), reflecting strategic efficiency objectives. A conscious strategic orientation toward digital technology ($M = 4.080$) represents top management commitment. Conversely, human capital barriers such as a lack of qualified workforce ($M = 3.813$) measure the core resource constraints that firms must overcome when seizing opportunities.

Reconfiguring Capability (Transforming structures & workflows): This capability is operationalized through the physical and digital reconfiguration of internal workflows, resources, and systems to support and integrate new technologies. In our research model, reconfiguring is directly reflected in the actual implementation level of the eleven Industry 4.0 technologies (overall $M = 3.172$). For service SMEs, key technological enablers such as System Integration ($M = 4.013$) and Cloud Computing ($M = 3.953$) act as the active reconfiguration of legacy software architectures into unified, agile digital systems.

METHODOLOGY

A. Research Design

This study utilizes quantitative descriptive research design. In alignment with the positivist philosophy, the study aims to capture population characteristics with statistical accuracy using empirical evidence and quantitative techniques [13]. To ensure generalizability and logical evidence collection, a cross-sectional survey design was

implemented, which gathers data at a single point in time to provide a snapshot of organizational practices and perceptions [13].

B. Sample and Data Collection

The target population of this study consists of registered Malaysian ICT service SMEs. These firms play a strategic dual role as both users of advanced technology and solution providers enabling digital transformation in other sectors. To ensure that the sample reflects the target sector with high precision, we established strict eligibility and inclusion criteria: (1) registered as a service SME with SME Corp Malaysia or the Malaysia Digital Economy Corporation (MDEC); (2) falling under the official national services definition of an annual sales turnover not exceeding RM20 million or employing no more than 75 full-time workers; (3) established and operating for at least three consecutive years; and (4) actively implementing or planning to implement digital transformation in their workflows. Geographically, the sample covers major high-tech and industrial economic zones in Malaysia, including the Klang Valley (Selangor and Kuala Lumpur), Melaka, and Johor, where ICT service clusters are highly concentrated.

To ensure that the responses reflect strategic, high-quality organizational knowledge rather than general perceptions, a non-probability purposive sampling technique was deployed, targeting exclusively managerial-level employees including general managers, directors, executives, and senior IT managers who possess direct oversight over their firms' strategic direction and technological investments. A total of 150 usable, fully completed, and verified questionnaires were retrieved. Given the purposive nature of the design where respondents were pre-screened to ensure they met all strict eligibility criteria before survey administration, the resulting sample represents a robust and highly qualified group of ICT service SMEs in Malaysia, ensuring high validity in our descriptive findings.

C. Measurement and Instrument Design

The structured research instrument was designed in a closed-ended format to capture population characteristics with high statistical precision. It is structured into two primary, conceptually distinct measurement components, which must be clearly distinguished: (1) Part A: Perceived Adoption-Related Factors, consisting of 8 latent dimensions (drivers and barriers) that reflect external pressures and internal strategies, and (2) Part B: Industry 4.0 Technology Implementation Levels, consisting of 11 distinct digital technologies. All items in Part A and Part B were measured using a 5-point Likert scale (where 1 = strongly disagree / low implementation and 5 = strongly agree / high implementation). In Part A, the eight factors measured are: customer requirements, competitive pressure, cost reduction, time-to-market improvement, legal requirements, workforce availability (measured as the constraint 'lack of qualified workforce'), public advisory support, and strategic orientation. In Part B, the eleven technologies evaluated are: Big Data Analytics, Autonomous Robots, Additive Manufacturing, Augmented Reality, Artificial Intelligence, Advanced Materials, Cybersecurity, Simulation, Cloud Computing, Internet of Things, and System Integration.

The overall technology adoption mean is calculated as the simple arithmetic average of the implementation means of all eleven individual technologies evaluated in Part B, representing a composite index of Industry 4.0 digital maturity. Mathematically, it is expressed as follows:

$$\text{Overall Adoption Mean} = (\sum \text{Mean of Tech}_i) / 11 \text{ Calculation: } (4.180 + 4.013 + 3.953 + 3.560 + 3.487 + 3.240 + 3.047 + 2.807 + 2.387 + 2.193 + 2.020) / 11 = 34.890 / 11 = 3.1718 \approx 3.172$$

D. Reliability and Validity Analysis

To establish content and face validity, ten academic and industry experts reviewed the questionnaire layout, wording, and item relevance, and revisions were made to eliminate ambiguities [13]. The reliability of the instrument was tested through a pilot study involving 50 high-level ICT SME managers [13]. The pilot test demonstrated excellent internal consistency, with an overall Cronbach's alpha value of 0.961. The individual subscales for sensing, seizing, reconfiguring, Industry 4.0 adoption, and organizational sustainability recorded

Cronbach's alpha values ranging from 0.760 to 0.801, far exceeding the acceptable academic threshold of 0.70 [13], which indicates a highly reliable measurement scale.

RESULTS AND DISCUSSION

A. Factors Associated with Industry 4.0 Adoption

The descriptive analysis of the eight factors associated with digital adoption provides crucial baseline insights into what is perceived as key drivers or constraints among Malaysian ICT service SMEs. As detailed in Table I, the empirical findings indicate that customer requirements recorded the highest mean score ($M = 4.493$, $SD = 0.610$), indicating that client-driven demands are perceived as the most influential external force associated with digital transitions. This result aligns with Teece's (2018) dynamic capabilities view, which emphasizes that sensing customer needs is a fundamental microfoundation for business sustainability. In service contexts, client expectations force firms to adapt rapid service delivery models to avoid obsolescence (Chong & Kaliappen, 2025). Cost reduction emerged as the second-highest factor ($M = 4.307$, $SD = 0.590$), highlighting that operational efficiency is heavily prioritized by these resource-constrained SMEs, as process automation and cloud-based systems can directly mitigate high administrative overheads (Ilias et al., 2025).

Competitors' technology practices also recorded a high mean ($M = 4.227$, $SD = 0.625$), reflecting strong associative pressures from industry peers, which is highly consistent with competitive mimicry and rivalry dynamics in knowledge-intensive service sectors (Al-Khatib, 2024). In contrast, legal requirements and changed legislation recorded the lowest mean score ($M = 3.600$, $SD = 0.927$). This suggests that formal regulatory compliance mandates represent a relatively weaker external driver of digital change compared to direct, immediate market and commercial forces, which is acceptable and logical in the flexible, non-coercive Malaysian services sector (Ratana Singaram et al., 2023).

Table I Factors Associated With Industry 4.0 Adoption

Rank	Adoption Factor	Mean	SD
1	Customer requirements	4.493	0.610
2	Reduce costs	4.307	0.590
3	Competitors practice new digital tech	4.227	0.625
4	Improve time-to-market	4.093	0.717
5	Conscious strategy around digital tech	4.080	0.650
6	Lack of qualified workforce	3.813	0.727
7	Public advisor/business support	3.780	0.722
8	Legal requirements/changed legislation	3.600	0.927

B. Level of Industry 4.0 Technology Adoption

The assessment of actual technology implementation levels across the eleven advanced technologies reveals a moderate but highly uneven digital maturity profile, with an overall technology adoption mean of 3.172. The highest implementation level was recorded for the Internet of Things (IoT) ($M = 4.180$, $SD = 0.769$), which is consistent with its role as a core connectivity enabler for smaller service enterprises, allowing real-time data linkages with minimal capital expenditure (Jayashree et al., 2022). System Integration was the second-most adopted technology ($M = 4.013$, $SD = 0.882$), which represents a vital operational capability for ICT service SMEs, as connecting diverse software interfaces and databases is essential to support operational continuity and

digital flexibility (Saman et al., 2025). Cloud Computing followed as the third-highest implemented technology ($M = 3.953$, $SD = 0.771$), proving that cloud infrastructure is heavily favored by service-sector SMEs due to its low upfront cost, scalability, and ease of maintenance, enabling firms to transition from heavy physical infrastructure to agile virtual architectures (Chong & Kaliappen, 2025).

Conversely, specialized physical and hardware-heavy technologies such as Additive Manufacturing/3D Printing ($M = 2.193$, $SD = 1.060$) and Autonomous Robots ($M = 2.020$, $SD = 0.930$) recorded the lowest adoption scores. This pattern is highly logical and acceptable, as knowledge-intensive ICT service firms have almost no physical manufacturing assembly or raw material handling workflows, rendering physical robotics operationally irrelevant to their business models (OECD, 2020).

Table Ii Industry 4.0 Technology Adoption Level

Rank	Technology	Mean	SD
1	Internet of Things (IoT)	4.180	0.769
2	System Integration	4.013	0.882
3	Cloud Computing	3.953	0.771
4	Cybersecurity	3.560	0.959
5	Artificial Intelligence (AI)	3.487	1.035
6	Simulation	3.240	0.932
7	Big Data Analytics	3.047	0.985
8	Advanced Materials	2.807	1.047
9	Augmented Reality	2.387	0.947
10	Additive Manufacturing / 3D	2.193	1.060
11	Autonomous Robots	2.020	0.930

IMPLICATIONS AND RECOMMENDATIONS

A. Managerial Implications

For SME managers, the findings suggest that digital strategy must be aligned with actual operational needs rather than driven by technological trends. Given that customer requirements ($M = 4.493$) represent the primary adoption driver, managers should prioritize digital investments that directly enhance customer experience, service delivery speed, and customizability. Building solid capabilities in cloud computing, IoT, and system integration provides a stable digital foundation before venturing into highly complex or specialized technologies.

B. Workforce Implications

The persistent challenge of a 'Lack of qualified workforce' ($M = 3.813$, $SD = 0.727$) highlights that technological adoption is inextricably linked to human capital. Managers must actively invest in upskilling programs to build internal digital competencies in critical areas such as AI integration, cybersecurity protocols, and advanced data analytics. Establishing a learning-oriented organizational culture can mitigate workforce resistance to technological changes and enhance dynamic absorptive capacity.

C. Policy Implications

Policymakers and development agencies (e.g., MDEC and SME Corp) should design targeted, multi-tiered support programs based on technology maturity levels rather than a single generic blueprint. Early-stage service SMEs require financial and advisory support for adopting standard cloud services and integrating their systems. In contrast, digitally mature SMEs should be supported with advanced R&D grants and specialized technical training to adopt AI, simulations, and big data systems, bridging the skills gap and enhancing national competitive advantages.

CONCLUSION AND FUTURE RESEARCH

A. Adjusted Theoretical Conclusions

This study has successfully provided a descriptive, mean-based assessment of Industry 4.0 adoption factors and implementation levels among 150 Malaysian ICT service SMEs. The empirical findings show that the perceived drivers and actual technology implementation levels are highly uneven, and that the strategic value of Industry 4.0 is heavily shaped by sector-specific operational relevance. Customer requirements ($M = 4.493$) and cost reduction ($M = 4.307$) represent the most prominent factors associated with adoption, while the Internet of Things ($M = 4.180$), System Integration ($M = 4.013$), and Cloud Computing ($M = 3.953$) are the most widely implemented technologies. The overall technology adoption mean of 3.172 confirms a moderate maturity profile, with highly specialized physical automation systems like Additive Manufacturing ($M = 2.193$) and Autonomous Robots ($M = 2.020$) being secondary due to their low operational applicability.

While these findings depict an important baseline ‘descriptive diagnostic map’ of technology practices, we must emphasize that the descriptive nature of this study precludes the drawing of causal inferences. The findings represent key associations and perceived weights at a specific point in time, and are not intended to establish predictive models or causal paths. This descriptive assessment, however, serves as a vital foundation for strategic planning and institutional policymaking in the Malaysian digital economy.

B. Limitations and Directions for Future Research

While this study provides a highly granular descriptive diagnostic map of the Malaysian ICT service subsector, several methodological and analytical limitations must be acknowledged. First, the study relies on a cross-sectional survey design, which captures data at a single point in time. This design prevents the establishment of temporal order or the testing of true causal relationships between dynamic capabilities and technology adoption. Future research should implement longitudinal research designs to track how technological maturity levels change and how dynamic capabilities evolve over time as market conditions shift. Second, our sampling was restricted to a non-probability purposive sample of 150 registered Malaysian ICT service SMEs. Although purposive sampling was necessary and highly effective to target specific, qualified respondents with managerial-level expertise, it limits the statistical generalizability of the findings to the broader population of services or other sectors. Future studies should utilize probability-based, random sampling techniques across a larger sample size to improve generalizability.

Third, this paper is intentionally limited to descriptive, mean-based analysis. While this is highly useful for diagnostic mapping, it does not statistically test whether specific capabilities predict adoption. Future research should employ inferential statistical techniques, such as correlation analysis, multiple regression, exploratory or confirmatory factor analysis, and Structural Equation Modeling (such as PLS-SEM) to empirically test the hypothesized relationships within the Dynamic Capabilities framework. Finally, future studies should conduct comparative investigations across other service subsectors (e.g., logistics, retail, tourism, or financial services) to identify unique technological barriers and further refine the dynamic capabilities framework in diverse service contexts.

ACKNOWLEDGMENT

The authors wish to express their profound gratitude and appreciation to the Fakulti Pengurusan Teknologi dan Teknousahawanan, Universiti Teknikal Malaysia Melaka (UTeM) for providing the intellectual and administrative support necessary to complete this research. The authors also gratefully acknowledge that this research is fully funded by the Ministry of Higher Education, Malaysia (KPT) through the Fundamental Research Grant Scheme (FRGS) with reference code, FRGS/1/2024/SS02/UTEM/02/1.

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