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Agile digital transformation in SMEs: a hybrid prioritization approach

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Introduction: Agile Digital Transformation (ADT) represents a new generation of digital transformation that enables small and medium-sized enterprises (SMEs) to adopt iterative and data-driven strategies, enhancing their flexibility, competitiveness, and sustainability. Despite extensive research on digital transformation (DT), few studies have explored the specific enablers of ADT tailored to SMEs.

Methods: This study employed a rigorous three-phase methodology, combining a systematic literature review, a hybrid Delphi method involving academic and industry experts, and the Best-Worst Method (BWM) for prioritization.

Results: The study identified nine key enablers of ADT, organized under four overarching themes: Strategic Capabilities, Human Capabilities, Organizational Capabilities, and Technological Capabilities. The most significant enablers include transformational leadership, agile organizational strategy, and dynamic resource management.

Discussion: These findings provide theory-informed and practical guidance for SME managers to navigate digital transformation under resource constraints. The framework aligns with Sustainable Development Goals (SDG 8 and SDG 9) by promoting economic resilience and innovation-led industrial growth.

KEYWORDS

agile digital transformation, SMEs, sustainable development, digital leadership, resource management, data-driven strategy, Delphi–BWM method

1 Introduction

The rapid evolution of the business landscape, driven by digital advancements and market uncertainty, underscores the critical role of digital transformation (DT) in ensuring organizational sustainability. DT reshapes enterprise functions, customer engagement, and market dynamics, enabling operational efficiency, adaptability, and cost-efficient innovation (Verhoef et al., 2021; Hafeez et al., 2025). Within the context of the Fourth Industrial Revolution, DT is not merely a technological upgrade but a holistic transformation of business processes and organizational models, promoting economic resilience and scalability (Fuchs and Hess, 2018). While DT has proved to be a critical growth element for small and medium enterprises (SMEs), many face serious challenges in its practical implementation due to limited financial resources, technological infrastructure, and digital expertise (Levy et al., 2023). Moreover, traditional DT strategies are often rigid, sequential, and resource-intensive, making them incompatible with the operational realities of SMEs. These methods fail to support cost-effective scalability and do not respond swiftly to evolving market demands (Fachrunnisa et al., 2024). While DT primarily focuses on leveraging digital technologies to redesign processes,

customer interactions, and business models, ADT embeds the principles of agility, iteration, adaptability, responsiveness, and resilience into this process. In other words, ADT is not merely “using agile to implement DT,” but represents a distinct paradigm that integrates technological renewal with organizational agility to address uncertainty, volatility, and resource scarcity (Chen et al., 2025; Sallam et al., 2024; Mikalsen et al., 2018). ADT can therefore be defined as a dynamic, learning-oriented form of DT that combines agile strategic alignment, adaptive leadership, and innovation-driven culture to achieve rapid, scalable, and sustainable change in resource-constrained environments such as SMEs (Fachrunnisa et al., 2024; Kausar, 2021). This distinction is especially critical for SMEs, where limited resources and market turbulence demand flexible, incremental, and cost-effective transformation pathways rather than rigid, large-scale digital programs. Unlike static long-term DT plans, ADT facilitates mini-batch innovation, rapid response to market shifts, and enhanced customer-centricity (Sallam et al., 2024). However, despite its growing importance, most existing research remains focused on large enterprises, leaving SMEs underrepresented (Palfreyman and Morton, 2022). However, research on ADT in SMEs remains underdeveloped, with limited focus on their specific constraints and few structured approaches to enabler prioritization. In particular, context-sensitive studies addressing resource-scarce environments are still limited and require further scholarly attention. The main objective of this research is to systematically identify and rank the critical enablers of ADT for SMEs. By clarifying these enablers, the study aims to provide a structured roadmap that helps SMEs adapt to changing market conditions, enhance their competitive position, and pursue sustainable growth despite resource constraints.

To achieve this objective, the research adopts a three-phase hybrid methodology that integrates systematic literature review (SLR), hybrid Delphi expert validation, and the best-worst method (BWM). This methodological innovation not only validates enablers through expert consensus but also produces an actionable prioritization rarely found in prior DT-in-SME research. The proposed approach emphasizes transformational leadership, agile organizational strategy, dynamic resource management, and an Adaptive Workforce as key enablers that foster psychological adaptability and an innovative culture. By providing an empirically validated, SME-centric framework, this study delivers actionable guidance for agile, data-driven decision-making under resource constraints, while advancing Sustainable Development Goals (SDG 8 and 9) through economic resilience and industry innovation. Accordingly, the core research questions guiding this study are:

- What are the main enablers of ADT in SMEs?
- How should these enablers be prioritized for effective ADT implementation and economic sustainability?
- How does the enablers' prioritization of ADT improve economic resilience in resource-constrained enterprises?

The outline of this paper is structured as follows. Section 2 provides a multi-dimensional literature review that examines agility in DT, its relevance for SMEs, the enabling factors of DT, and the application of decision-making methods such as MCDM. Section 3 presents the research methodology, including the SLR, hybrid Delphi expert validation, and BWM. Section 4 discusses the key findings and their implications for theory, management, policy, and practice.

Finally, Section 5 concludes the paper by summarizing contributions, acknowledging limitations, and suggesting directions for future research.

2 Literature review

To establish a clear conceptual foundation for the empirical approach of this study, the literature review is organized in three layers. The first part discusses agility in DT to provide the general theoretical basis. The second part narrows the focus to ADT in SMEs, highlighting their specific characteristics and challenges. The third part identifies key DT enablers relevant to SMEs. In line with this approach, de Mattos et al. (2024) also adopted a layered literature review moving from broad theoretical foundations to SME-specific contexts and then to enabler identification. They emphasized that such segmentation not only ensures methodological rigor but also maintains integrity across otherwise separate discussions. Following this logic, our three-part structure similarly creates a coherent narrative that integrates general agility theory, SME realities, and enabler extraction into a unified framework. This layered structure allows for a step-by-step narrowing of scope, moving from broad theoretical insights to practical SME-specific applications. It also ensures a more accurate extraction of enablers that guide the subsequent Delphi and BWM analyses.

2.1 Agility in digital transformation

Agility in DT refers to an organization's capacity to adapt quickly and flexibly to technological changes and evolving customer demands (Popoola et al., 2024). At a general level, agility is underpinned by several core principles, including iterative development, adaptability in processes, cross-functional collaboration, and continuous customer responsiveness. These principles enable firms to experiment, adjust strategies in real time, and maintain competitiveness in fast-changing environments (Fuchs and Hess, 2018). In practice, Complex problems can be divided into smaller parts and solved step-by-step. This approach offers significant advantages for SMEs undergoing DT (Malik et al., 2025). Adopting an agile approach reduces the risk of failure in DT for SMEs. This occurs by testing and refining systems in incremental stages, such as customer relationship management implementation, rather than making large-scale changes that could lead to significant issues (Cubillas-Para et al., 2024). This helps quickly identify and solve problems, minimizing disruption to business activities (Rialti and Filieri, 2024). Rigby et al. (2016) discuss the power of agile practices for improving innovation and resilience, particularly for SMEs within the uncertain conditions of DT. Agility also embraces collaboration internally within an organization and externally with partners (Zhang et al., 2024). Furthermore, agile methodologies encourage the joint working of cross-functional teams and therefore collapse silos and create a culture where the responsibility for transformation is shared (Sallam et al., 2024). Another important aspect of agile methodologies is related to empowering SMEs to iterate with new technologies and then react in the minimum time (Ghezzi and Cavallo, 2020). Sallam et al. (2024) emphasized that emerging DT promotes the development of a culture of continuous change (Sallam et al., 2024). This suggests SMEs need a

culture where employees can be driven to experiment and try new things. When occurring alongside agile methodologies, this cultural shift can lead to real change and help SMEs prosper in the long run within the digital world (Fachrunnisa et al., 2024).

2.2 Agile digital transformation in SMEs

According to Rigby et al. (2016), agile practices empower innovation and resilience, which many companies need to execute DT in an effective manner (Rigby et al., 2016). It is a catalyst to facilitate agility, enabling continuous change. Eventually, DT helps organizations become more innovative and responsive (Balasubramaniam et al., 2022). For SMEs, agility is crucial and helps them to overcome challenges in the digital era (Fachrunnisa et al., 2024). Vial (2019) defines DT as an integration of digital technologies at all levels of enterprise operations. What differentiates the best-performing SMEs is their agility in driving this transformation (Vial, 2019). It does not involve big changes all at once. Instead, it focuses on small improvements that quickly create value (Stoiko, 2024). Previously, processes that decided changes were deterministic steps. In contrast, ADT is non-deterministic and focuses on facilitating effortless transitions (Kanavittaya et al., 2020). Palfreyman and Morton (2022) emphasized that, given rapid market shifts, evolving customer needs, and technological advancements, companies must remain agile (Palfreyman and Morton, 2022). Moreover, Troise et al. (2022) noted that agility is not only related to software optimization. Today, agility has moved one level further. Agility as culture symbolizes flexibility, iterative improvement, and customer orientation (Troise et al., 2022). In this context, ADT calls for competitive options in handling customer needs, organizational flexibility, and quick decision processes to address the emergence of modern adaptive challenges in the market (Kose, 2021). Despite its advantages, adopting ADT in SMEs remains difficult due to limited funding, weak infrastructure, and a shortage of specialized resources. Hence, SMEs need to find different ways to deal with DT challenges, unlike large companies (Merdin et al., 2023). Satar et al. (2024) found that agile frameworks help SMEs overcome such barriers, allowing them to adapt more easily without straining their limited capital (Satar et al., 2024). Thus, SMEs should test new technologies and adjust their strategies based on real-world feedback, and as a result, the resource utilization will be optimized (Chen et al., 2025).

2.3 Digital transformation enablers in SMEs

DT redefines business practices, processes, capabilities, and models that incorporate agility as a core component to guide organizations through this transformation (Li et al., 2021). DT enablers are those factors that reduce the barriers to a DT and increase the chance of its success (Schallmo et al., 2017). Discovering DT enablers allows companies to prioritize the right steps on their journey toward DT's successful execution (Sinyuk et al., 2021). Research emphasizes that leadership commitment is one of the most widely cited enablers. Without good leadership, leading improvement projects like DT becomes impossible (Buonocore et al., 2024; Claro and Silva, 2025; Rialti and Filieri, 2024). Kane et al. (2015) mentioned that technology and culture are major enablers, as well as leadership

(Kane et al., 2015). More results in line with Nambisan et al. (2019) demonstrate that ecosystem externalities can be generally advantageous for SMEs with limited internal resource capabilities (Nambisan et al., 2019). Alshammari (2023) used SLR to identify enablers, comprising leadership, organizational culture, collaboration, data management, and employee skills (Alshammari, 2023). Later, Ly (2023) highlighted that other enablers, such as leadership, organizational agility, and change acceptance ability, could affect organizational DT (Ly, 2023). Another core enabler is technology infrastructure. SMEs need the appropriate tools and platforms to support their digital ambitions (Corvello et al., 2023; de Mattos et al., 2024). However, simply having the technology is not enough (Sagala and Öri, 2024). Another critical DT enabler is the neglect of workforce skills. Therefore, companies must upskill and reskill their employees to fully leverage new technologies and maximize their benefits (Muduli and Choudhury, 2024). On the other hand, SMEs struggle with some limitations in DT execution. One of them is financial management. Researchers state that even larger companies will have the capacity to dedicate a lot of money to DT, but often, SMEs have come to be very cautious and strategic with their spending (Blatz et al., 2018). Hinings et al. (2018) agreed that organizational culture has a crucial role in DT. If employees are not aligned with the organizational digital objectives, nothing will change (Mittal et al., 2018). The organizational culture dictates how individuals respond to change, and the smaller teams typically found in SMEs can be an accelerator for DT (Zhang et al., 2024). It is worth mentioning that strong leadership can shape an organizational culture and shape the workforce's readiness (Ramadan et al., 2023). This highlights the importance of prioritizing criteria. Because of limited resources in SMEs, they suffer high levels of competition and ever-changing market needs. Furthermore, agile principles help organizations launch and adjust digital strategies quickly in response to market and consumer changes (Sallam et al., 2024). Additionally, much of the literature highlights the necessity of implementing agile methodologies to achieve successful DT within organizations, particularly in SMEs (Mikalsen et al., 2018; Ngwenya et al., 2025).

2.4 Using the multi-criteria decision-making method in SMEs

Many studies have examined the application of MCDM methods in SMEs. Basuki (2016) applied the MCDM approach in prioritizing the sustainable strategies of SMEs. Furthermore, creating a platform for further research on decision-making techniques in SMEs (Omowole et al., 2024). Moreover, Enjolras et al. (2020) applied a hybrid AHP method to examine the link between innovation and export capabilities in SMEs and proposed a decision-support tool to strengthen their competitiveness (Basuki, 2016). In addition, Roy and Shaw (2021) further proposed a hybrid BWM and TOPSIS-based multi-criteria credit-scoring model in SMEs. This model evaluates credit for SMEs based on specific criteria, accelerates the decision-making process, and enhances access to finance (Roy and Shaw, 2021). In this regard, Chang et al. (2021) proposed a hybrid management strategy for the adoption assessment of Industry 4.0 technologies in SMEs by identifying related key factors (Chang et al., 2021). In another study, Garg and Kashav (2022) applied the BWM to identify supply chain financing barriers affecting Indian SMEs (Garg and Kashav,

2022). Additionally, [Khulud et al. \(2023\)](#) depicted the bibliometric mapping within the field of MCDM-based sustainable supplier selection from 2013 to 2022. Their work has thus laid the groundwork for subsequent research in suggesting the noteworthy contribution of MCDM in facilitating sustainability-driven SMEs ([Khulud et al., 2023](#)). Later, [Santos et al. \(2024\)](#) developed the MCDM model for prioritizing sustainability functions in SMEs. They applied the Fuzzy-DEMATEL method for classifying sustainability functions ([Santos et al., 2024](#)). Besides that, [Silva et al. \(2024\)](#) finally examined the BWM as a standalone analytical system to evaluate the motivators for open innovation among SMEs ([Silva et al., 2024](#)). The reviewed studies show that DT, agility, and decision-making methods like MCDM are important for SMEs. However, most of these studies focus on large companies and do not fully match the needs of smaller businesses. Based on this, the next section explains the main research gaps that this study aims to address.

2.5 Research gap

Despite the significant progress of DT research, critical gaps remain in understanding ADT for SMEs, particularly under conditions of economic sustainability and resource constraints. Much of the existing body of DT studies has concentrated on large enterprises, overlooking the specific financial and operational limitations that SMEs encounter ([Sagala and Öri, 2024](#); [Palfreyman and Morton, 2022](#)). Even in systematic reviews, such as the study of [Ramdani et al. \(2022\)](#), which analyzed 125 studies, agility-related dynamics central to ADT were not explicitly addressed. Similarly, [Dörr et al. \(2023\)](#), through their synthesis of 75 studies using the Attention-Based View, revealed conceptual fragmentation in SME–DT research and highlighted the lack of maturity-oriented models of ADT. Further, [Pelletier et al. \(2023\)](#) demonstrated that IT capability configurations can strengthen organizational agility, yet their study did not conceptualize ADT as a maturity construct. Other contributions, including those by [Troise et al. \(2022\)](#) and [Gonzalez-Tamayo et al. \(2023\)](#), framed agility as a cultural paradigm that supports flexibility and iterative improvement; however, they did not provide structured methods to identify and rank ADT enablers in SMEs. Approaches such as combining Delphi with BWM have rarely been applied in this field, with only partial use in broader DT contexts ([Jäkel et al., 2024](#); [Garg and Kashav, 2022](#)). Moreover, there is a lack of contextualized research on SMEs in emerging economies, as studies like [Alshammari \(2023\)](#) and [Fachrunnisa et al. \(2024\)](#) mainly discussed enablers such as leadership and organizational culture without focusing on agility or resource-constrained environments. In summary, existing research on DT has primarily focused on large enterprises and has paid limited attention to the specific financial and operational constraints of SMEs. Studies on ADT often remain fragmented, with little effort to consolidate and validate enablers that are most relevant to SMEs. Moreover, systematic strategies for identifying and prioritizing these enablers are largely absent, and hybrid methodological approaches such as Delphi combined with BWM have rarely been applied in this field. Finally, research contextualized for SMEs in emerging economies and resource-constrained environments is still scarce. These gaps highlight the need for more focused and context-sensitive investigations to advance the understanding of ADT in SMEs.

3 Methodology

This research was carried out in a three-phase methodology: SLR, hybrid Delphi, and BWM. BWM applied to prioritize ADT enablers, enabling SMEs to optimize their limited resources for successful ADT execution and economic sustainability.

Phase 1: SLR and thematic analysis of systematic literature

Phase 1 is initiated using SLR, in which relevant academic papers are selected based on predefined keywords related to ADT. These papers were selected based on clear rules for including or excluding studies to ensure the reliability of the results. Thematic analysis was then performed to derive common principles found in this data and identify factors influencing ADT in SMEs.

Phase 2: hybrid Delphi (expert validation)

During this stage, a hybrid Delphi method (combining qualitative and quantitative approaches) was performed to validate and justify the established criteria. This step aimed to ensure the clarity, relevance, and completeness of the proposed criteria.

Phase 3: applying the BWM method to prioritizing criteria

This study employed the BWM to prioritize the enablers of ADT in SMEs, given its advantages over alternatives such as AHP or TOPSIS. BWM requires fewer pairwise comparisons, which reduces complexity and time while improving reliability and accuracy. Unlike AHP, which is prone to inconsistency, BWM relies only on best and worst criteria, ensuring greater consistency. This makes it especially suitable for contexts with limited expert input. In this phase, experts applied BWM to rank the final set of criteria derived in the previous stage, as illustrated in [Figure 1](#).

3.1 Systematic literature review

The SLR was designed and conducted following the process model of [Tranfield et al. \(2003\)](#) and [Kraus et al. \(2020\)](#), which structures the review into planning, conducting, and reporting phases. To ensure transparency, traceability, and reproducibility, reporting was aligned with PRISMA 2020 ([Tugwell and Tovey, 2021](#)). Under this protocol, research questions, data sources, eligibility criteria, and quality-appraisal procedures were defined *a priori*, and the identification, screening, and inclusion stages were conducted in accordance with the established SLR framework. Searches targeted DT with an emphasis on organizational agility and related to SMEs. The window covered 2011–2024, and queries were executed on 09-Jan-2025 in Web of Science (Topic/TS), Scopus (TITLE-ABS-KEY), and Google Scholar as a supplementary source. A base query on DT maturity/model/framework was intersected with agility terms; database-level filters for year, Business and Management, document type (journal articles and, where applicable, book chapters), and English were applied. The corresponding query sets and fields are summarized next to [Figure 2](#).

Eligibility Criteria: Studies were included if they (i) were peer-reviewed journal articles or book chapters, (ii) were published between

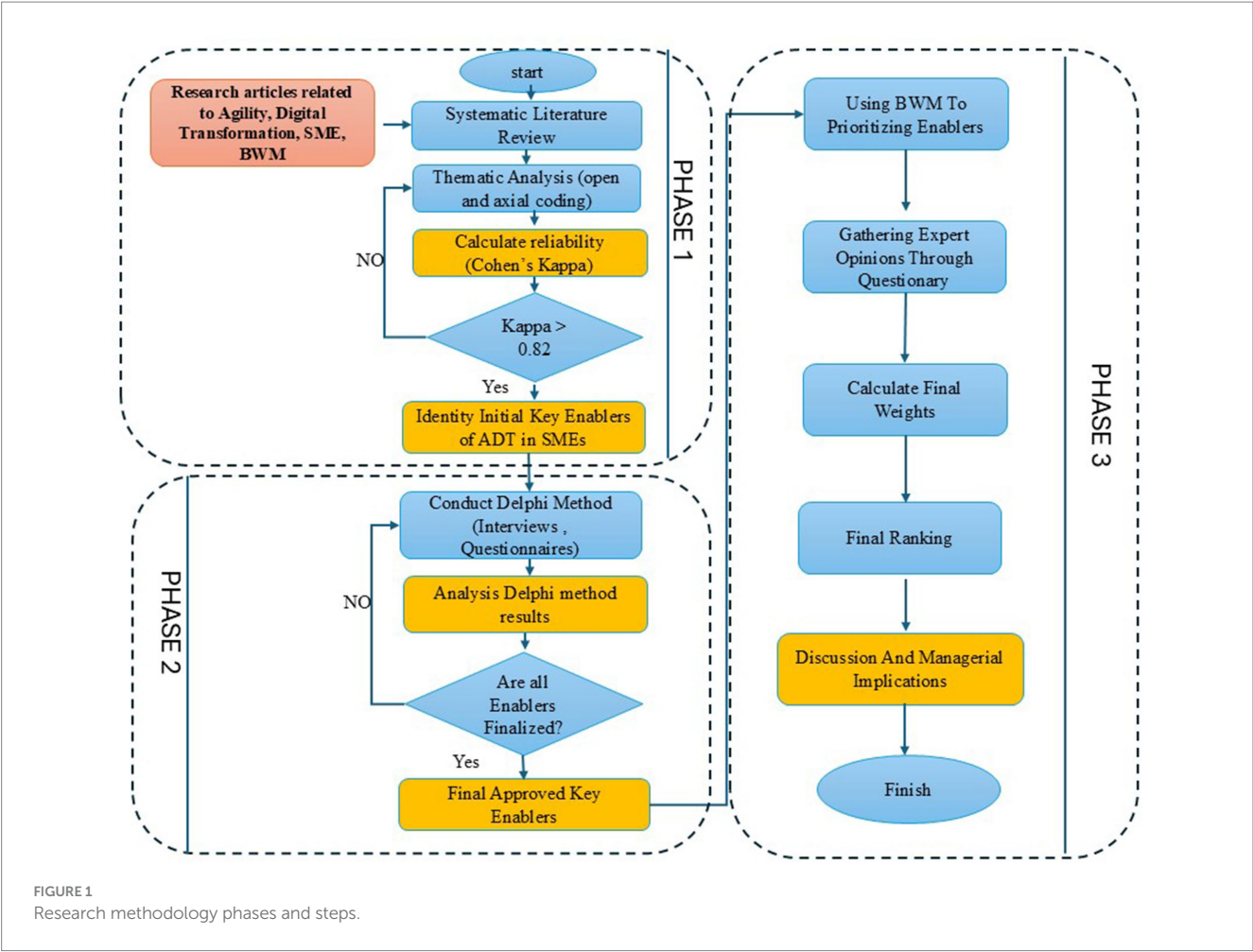


FIGURE 1
Research methodology phases and steps.

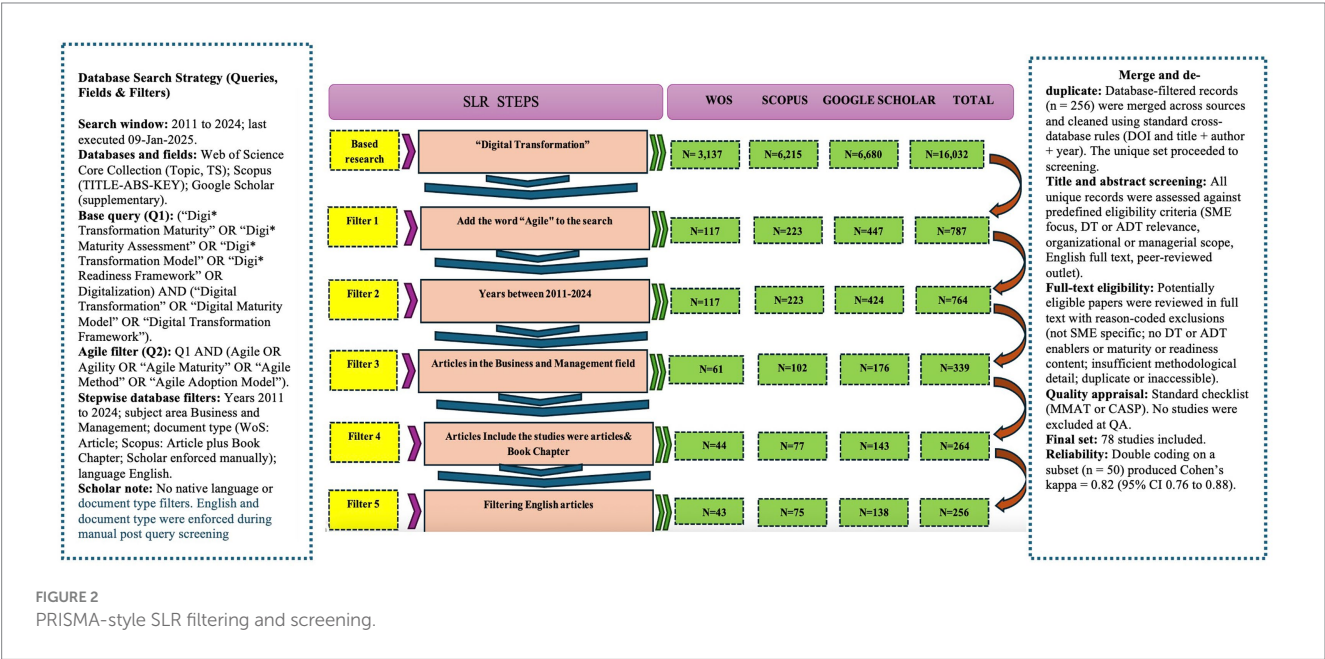


FIGURE 2
PRISMA-style SLR filtering and screening.

2011 and 2024, (iii) addressed digital or ADT constructs from an organizational or managerial perspective, and (iv) were relevant or applicable to SME contexts. Records were excluded if they (i) showed no relevance to SME applications, (ii) did not include DT/ADT-related constructs, (iii) were duplicates, or (iv) lacked actionable managerial implications.

PRISMA Flow: The PRISMA 2020 flow diagram (Figure 2) visualizes the systematic filtering and screening stages, illustrating how 16,032 initial records were refined to 256 eligible studies through database filtering, merging, de-duplication, and reason-coded exclusions (all filters are shown in Figure 2).

The diagram visualizes the PRISMA sequence from identification to inclusion. After database-level filtering (16,032 → 256).

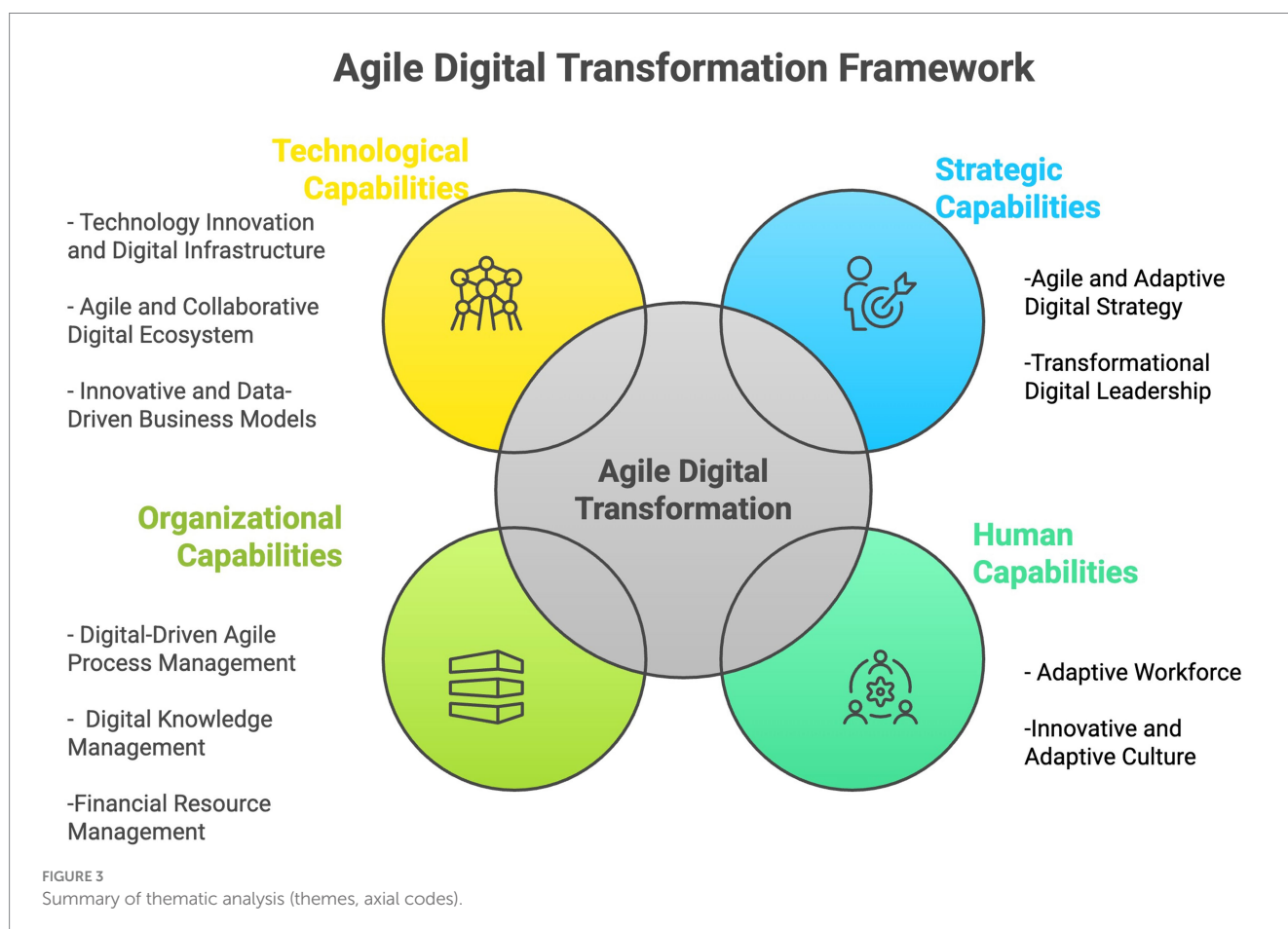
Quality Appraisal and Reliability: The methodological reliability of the included studies was assessed descriptively based on the Critical Appraisal Skills Program (CASP) method. Each study was reviewed in terms of conceptual clarity, methodological rigor, contextual relevance to DT/ADT related to SMEs, and transparency of reported findings. This qualitative appraisal ensured that all included papers met acceptable standards of credibility and reliability before thematic synthesis. In total, 78 studies were retained for synthesis. To further enhance methodological reliability, two independent coders were trained through pilot coding of five sample papers and iterative calibration sessions to harmonize code interpretations. During reliability testing, both coders independently analyzed a subset of 50 studies, yielding Cohen's $\kappa = 0.82$ (95% CI: 0.76–0.88), indicating excellent agreement (see Figure 3; Appendix A).

Figure 3 illustrates the four main themes and 10 axial codes derived from the thematic analysis. The detailed list of 135 open codes (refined after removing overlaps and duplicates from the initial 149

codes), together with the 10 axial codes and four themes, is presented in “Appendix A.”

3.2 Thematic coding and coder calibration

The thematic synthesis was manually conducted in three sequential stages: open, axial, and selective coding. In the open coding stage, key phrases and recurring concepts were extracted line by line from the textual content of the 78 eligible studies, yielding a total of 135 open codes. During the axial coding phase, conceptually similar open codes were merged into 10 axial categories through iterative comparison and researcher consensus. The selective coding stage subsequently combined these axial categories into four overarching themes representing the foundational dimensions of ADT in SMEs. Two independent coders, both experienced in qualitative research, participated in pilot calibration sessions using five representative studies to match interpretations and ensure consistency before the main coding process. Coding was performed manually to enable deeper interpretive engagement with the data, in line with the interpretivist logic of thematic analysis proposed by Braun and Clarke (2021). Any divergences were discussed and resolved through consensus. Reliability was ensured through double-coding by two trained coders; details of the reliability test are reported in Section 3.2. Conceptual saturation was confirmed when no new codes emerged after analyzing the final 10 studies. The complete manual coding



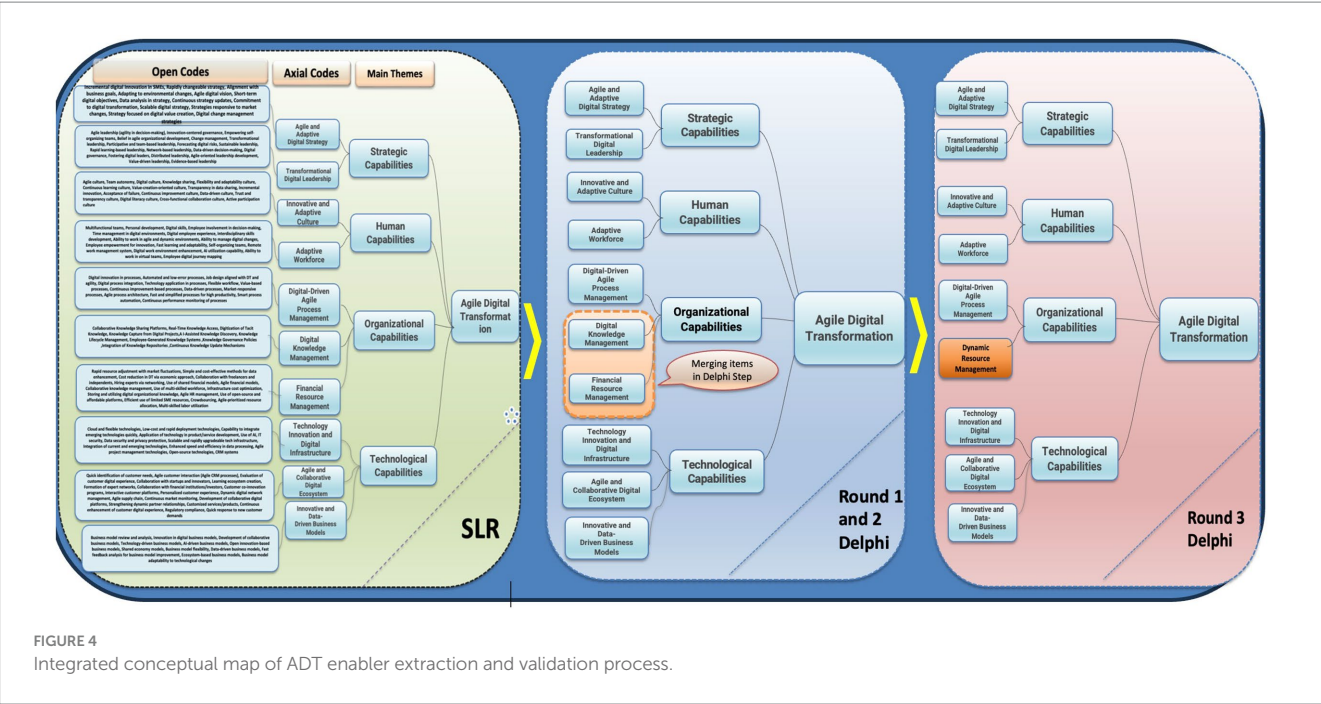


FIGURE 4 Integrated conceptual map of ADT enabler extraction and validation process.

framework, including open, axial, and thematic layers, is provided in “Appendix A” and Figure 4.

3.3 Hybrid Delphi method

After developing the initial coding framework based on the literature (Appendix A), the hybrid Delphi method was performed to refine the preliminary ADT enablers in SMEs. The main goal was to validate and consolidate the four main themes and 10 identified axial codes (Figure 3). At first, the Semi-structured interviews were conducted with eight experts from both academia and industry (Table 1).

3.4 Expert selection

The Delphi process involved eight experts selected for their seniority and extensive experience in DT, agility, and SME management. Selection criteria included at least 10 years of professional involvement, demonstrated expertise through leadership, consulting, or publications, and holding senior academic or industry roles. The panel consisted of five academics and three industry professionals, providing a balanced mix of theoretical and practical perspectives.

In Table 1, additional details are provided on the expert panel, including industry sector, region, and SME category. While the panel reflected diversity in professional roles and backgrounds, all experts were from the ICT sector in the Middle East. This contextual focus enriches insights for resource-constrained SMEs in emerging economies but may limit the transferability of findings to other industries or regions. This study involved minimal-risk expert interviews (Delphi). All participants gave informed consent; responses were anonymized and analyzed in aggregate. Ethical review was waived

per institutional guidance. The evaluations of these experts, summarized in Table 2, formed the basis for deriving the finalized criteria used in subsequent analysis and prioritization. This ensured that the study outcomes are both academically rigorous and practically relevant for SMEs pursuing sustainable competitive advantage through ADT.

As shown in Table 1, the Delphi panel included experts from both academia and industry within the ICT sector across the Middle East. Their profiles covered diverse professional roles, industry experience, and SME categories. This regional focus offers valuable insights for resource-constrained SMEs in emerging economies, while the transferability of results to other sectors or regions may be limited.

3.5 Expert interviews process

This three-round Delphi process was conducted to validate 10 axial codes identified as the main factors influencing ADT in SMEs. The process began with Round 1, during which semi-structured interviews (45–60 min, video-conducted and recorded with participants’ consent and archived securely) were used to assess the relevance and clarity of the 10 codes on a 5-point Likert scale (1 = Not Important, 5 = Very Important). Qualitative feedback was also collected through open-ended questions such as “How does this code contribute to ADT?” In Round 2, an email-based questionnaire presented anonymized ratings and feedback from Round 1, inviting experts to reconsider and re-rate their assessments. In Round 3, a final questionnaire was distributed to confirm agreement on the refined codes, with consensus quantified using Kendall’s coefficient of concordance (W). All rounds were conducted anonymously. Detailed transcripts and questionnaires were archived for analytical transparency. All experts provided informed consent, participation was voluntary, responses were anonymized, and the study complied with institutional ethical guidelines. No identifying data were collected.

TABLE 1 Characteristics of the experts.

Expert	Role	Field of expertise	Experience	SME segment	SME type	Region	Type
1	Full Professor	Information Technology (IT) Management	20 + years	*	*	Middle East (Emerging Economy)	Academic
2	Full Professor	IT Management	18 + years	*	*	Middle East (Emerging Economy)	Academic
3	Associate Professor	IT Management	12 + years	*	*	Middle East (Emerging Economy)	Academic
4	Associate Professor	Industrial Management and Technology	10 + years	*	*	Middle East (Emerging Economy)	Academic
5	Associate Professor	IT Management	14 + years	*	*	Middle East (Emerging Economy)	Academic
6	Industry Expert	Executive Manager of SME company	16 + years	ICT-based SME	Small	Middle East (Emerging Economy)	Industry
7	Industry Expert	CEO of SME company	20 + years	ICT-based SME	Medium	Middle East (Emerging Economy)	Industry
8	Industry Expert	Top Manager of an SME company	15 + years	ICT-based SME	Medium	Middle East (Emerging Economy)	Industry

Note: The asterisk indicates that the SME segment is not applicable for academic experts.

3.6 Delphi analysis: refining ADT enablers in SMEs

In Round 1, experts evaluated the relevance of each axial code and its corresponding theme. In Round 2, experts proposed merging “Digital Knowledge Management” and “Financial Resource Management” due to their conceptual overlap (75% agreement). This integration is theoretically grounded in the dynamic capabilities perspective, which emphasizes the orchestration of knowledge and financial resources as interdependent assets that SMEs must continuously reconfigure to maintain agility and competitiveness. In addition, this merger was intended to establish a more comprehensive resource-oriented dimension that holistically encompasses organizational resources, including financial, human, and knowledge assets, within a unified construct. Recent studies further support this rationale, showing that integrating knowledge and financial capabilities strengthens SMEs’ ability to sustain DT under resource constraints (Li, 2025; Valdez-Juárez et al., 2024). Round 3 subsequently confirmed nine final factors. Kendall’s coefficient of concordance ($W = 0.85$) indicated a strong level of agreement among experts ($W > 0.7$). Kendall’s W was computed using a tie-corrected formula to account for potential rank equivalences across experts, which improves the accuracy of the agreement statistic in panels with small size.

Through this Delphi process, 10 initial codes were refined to nine, as “Digital Knowledge Management” and “Financial Resource Management” were consolidated into “Dynamic Resource Management,” based upon 75% expert agreement in round 2 and connotation in round 3. These nine finalized enablers form a conceptually grounded foundation for understanding ADT in SMEs. They represent the key dimensions of ADT derived from both literature and expert validation. The step-by-step process from thematic analysis of the selected SLR studies to the identification of the nine final criteria is illustrated in Figure 4. Moreover, the nine finalized enablers are summarized in Table 2 and depicted in Figure 5.

Figure 4 illustrates the sequential methodological process that begins with the thematic analysis of selected studies from the SLR and progresses through three Delphi rounds to refine and validate the identified dimensions.

While the nine dimensions of the ADT framework are interrelated, each construct represents a conceptually distinct domain within the transformation process. Agile and Adaptive Digital Strategy (N1) defines the flexible planning and alignment of digital initiatives, whereas Transformational Digital Leadership (N2) refers to the behavioral and visionary capacity to guide and empower change. Dynamic Resource Management (N3) operationalizes agility through resource (financial, human, and knowledge) optimization, while Adaptive Workforce (N4) focuses on human agility and digital skill renewal. Technology Innovation and Digital Infrastructure (N5) concerns the technological foundation that enables scalability and integration, contrasting with Innovative and Adaptive Culture (N6), which emphasizes shared values, experimentation, and openness to change. Digital-Driven Agile Process Management (N7) captures process-level agility through automation and flexibility. Innovative and Data-Driven Business Models (N8) relate to the reconfiguration of value creation mechanisms, while Agile and Collaborative Digital Ecosystem (N9) extends agility beyond firm boundaries through partnerships and digital networking. Together, these constructs form a coherent yet non-overlapping structure, spanning strategic, organizational, technological, and ecosystemic layers of SMEs’ digital transformation. This theoretical separation enhances construct validity and prevents redundancy among leadership-, strategy-, and culture-related dimensions. Figure 5 shows enablers that affect ADT in SMEs.

3.7 Best-worst method

The Best-Worst Method is a relatively new technique of MCDM formulated by Rezaei to select the best alternative. This approach requires fewer comparisons of criteria compared to other MCDM

TABLE 2 Enablers of ADT in SMEs with definitions.

Number	Criteria	Description	Conceptual distinction	References
1	Agile and Adaptive Digital Strategy (N1)	Agile and Adaptive Digital Strategy is the planning and implementation of digital initiatives in SMEs, which is highly flexible, customer-centric, and quick to evolve in line with changes in the market and technology. It involves having scalable digital goals, ongoing revisions of the planning, and leveraging new technologies (like the use of Blockchain) in order to create a competitive edge.	Focuses on direction-setting and strategic adaptability, how the organization formulates and aligns its plans to achieve agility; distinct from leadership (who drives) and culture (how people behave).	Reascos et al. (2023); Li et al. (2018); Pieretto and Hinterhuber (2021); Naskali et al. (2018); Levy et al. (2023); Carli et al. (2023); Teng et al. (2022); Zhang et al. (2023); Luu (2024); Özkan Alakaş (2024); Kanavittaya et al. (2020); Denning (2017); Fachrunnisa et al. (2024); Miharja and Muhammad (2023); Satar et al. (2024)
2	Transformational Digital Leadership(N2)	Transformational Digital Leadership is the ability of SMEs' leaders to guide and control DT by creating a vision of the digital, empowering employees, building a digital innovation culture, and utilizing advanced technologies (such as Artificial Intelligence) to support rapid and data-driven decision-making. This type of leadership is focused on flexibility, management of digital risk, and generating sustained change in the company.	Centers on vision, influence, and empowerment. Who guides transformation and motivates others; distinct from strategy's planning focus and culture's behavioral focus.	Ly (2023); Ramadan et al. (2023); Delioglu and Uysal (2023); Buonocore et al. (2024); Stoiko (2024); Satar et al. (2024); Esamah et al. (2023); Özkan Alakaş (2024); Leso et al. (2023); Chen (2024)
3	Dynamic Resource Management (N3)	This enabler refers to the strategic distribution and optimization of resources (financial, human and knowledge) in a cost-effective way to achieve maximum operational efficiency and sustainability. For SMEs, using low-cost, technology-driven solutions such as data-driven decision-making and automation tools is crucial for minimizing overhead while enhancing responsiveness. This approach not only promotes transformation in a lean manner while conforming to budget constraints but also strengthens the company's resilience by reducing risk exposure and increasing the return on digitally deployed investments. SMEs that adopt smart, flexible resource allocation are more likely to achieve digital maturity at an appropriate pace without overextending their capabilities.	Represents the operational allocation layer. How tangible resources are mobilized to enable agility; distinct from leadership (intangible influence) and process (workflow execution layer).	Chen (2024); Reis and Melão (2023); Thomas (2020); Williams et al. (2019); Petzolt et al. (2022); Toomsalu et al. (2019); Kyurova (2022); Indriasari et al. (2020); Omrani et al. (2024); Levy et al. (2023)
4	Adaptive Workforce(N4)	For Digital Distinction, create an Employee Agility Workforce that can quickly adapt to changing processes and tools to achieve faster productivity gains. Reskilling employees to the fullest extent is essential for SMEs when creating functional collaboration and an idea-focused culture. Employees must adapt to digitization, prototype new technologies and tools, and get involved in transformational initiatives to reduce training costs. Digital readiness harnesses the potential for SMEs to resources, fuel adoption, and unlock digital innovation through employee-centered strategies for economic competitiveness.	Emphasizes individual-level agility and capability development, focusing on personal adaptability rather than collective culture or strategic intent.	Brown and Brown (2019); Teng et al. (2022); Thomas (2020); Petzolt et al. (2022); Muduli and Choudhury (2024); Varshney (2020); Ben Slimane et al. (2022); Philbin et al. (2022); Chonsawat and Sopadang (2021)

(Continued)

TABLE 2 (Continued)

Number	Criteria	Description	Conceptual distinction	References
5	Technology Innovation and Digital Infrastructure(N5)	This dimension refers to leveraging emerging technologies and developing flexible and scalable infrastructures to support ADT. This enabler includes cloud solutions, artificial intelligence (AI), the Internet of Things (IoT), and low-cost, open-source technologies that can be rapidly upgraded to meet customer needs. SMEs' digital infrastructure should be affordable, easy to implement, and scalable to enable continuous innovation. Moreover, it should accelerate business processes and make data-driven decisions. Furthermore, information security is also an integral part of this dimension to enable sustainable and secure DT in the context of SMEs.	Concerns the technological foundation—what tools and systems make agility possible; distinct from culture (behavioral readiness) or processes (operational routines).	Teng et al. (2022); Merdin et al. (2023); Carli et al. (2023); Naskali et al. (2018); Gollhardt et al. (2020); Mikalsen et al. (2018); Li et al. (2018); de Mattos et al. (2024); Ngo et al. (2023); Wimpertiwi et al. (2024); Omowole et al. (2024); Chonsawat and Sopadang (2021); Philbin et al. (2022); Omrani et al. (2024)
6	Innovative and Adaptive Culture (N6)	This enabler is about a digitally oriented, experimentation-friendly, and information-sharing-based culture, coupled with agile decision-making. Employees are encouraged to generate new ideas and contribute to digital initiatives. In this flexible framework, transformation is easier and causes fewer disruptions, since the employees themselves eliminate change resistance by participating in ongoing learning processes. This lowers the cost of adaptation and accelerates cultural convergence. SMEs thus gain improved responsiveness to change and enhanced competitiveness, along with firm support of long-term financial sustainability in rapidly changing markets.	Defines the collective mindset and behavioral readiness enabling transformation; distinct from leadership's top-down influence and process management's structural mechanisms.	Reascos et al. (2023); Li et al. (2018); Pieretto and Hinterhuber (2021); Hie (2019); Philbin et al. (2022); Liborio Zapata et al. (2021); Gonzalez-Tamayo et al. (2023); Sallam et al. (2024); Alam et al. (2022); Amaral and Peças (2021); Straková et al. (2022); Leso et al. (2023); Satar et al. (2024); Ahamed (2024); Chen (2024)
7	Digital-Driven Agile Process Management (N7)	It involves automating and digitizing business processes to enhance quality, speed, and efficiency while reducing costs for financial viability. Streamlining processes improve workflow for SMEs. Real-time information querying and process optimization facilitate operational flexibility, allowing for fast decision-making at minimal costs and increased productivity for better profitability. Lean and agile process implementation maintains flexibility for SMEs against quick changes in volatile environments for resilience to competition.	Concerned with workflow flexibility and process optimization mechanisms; distinct from strategy (planning) and culture (values and behaviors).	Teguh Setiawan Wibowo (2022); Kausar (2021); Barann et al. (2019); Alexopoulos et al. (2022); Höhnigsberg et al. (2021); Indriasari et al. (2020); Younus and Abumandil (2021); Chen (2024); Toomsalu et al. (2019); Marino-Romero et al. (2024); Ko et al. (2022); Ramadan et al. (2023); Ahamed (2024); Troise et al. (2022); Levy et al. (2023)
8	Innovative and Data-Driven Business Models (N8)	This enabler refers to Data and artificial intelligence that enhance revenue streams and customers' experiences in regard to scalable financial sustainability through digital platforms. Real-time data insights facilitate personalization and decision support in virtual space, actively contributing to the development of a scalable, technology-enabled business model. This creates long-term competitiveness in the digitized economy for SMEs through creating sustainable growth while enabling adaptability in traditional frameworks, ultimately creating new revenue opportunities.	Focuses on the economic logic of digital value creation and revenue generation; distinct from the operational processes that deliver it.	Reis and Melão (2023); Sinyuk et al. (2021); Omrani et al. (2024); Thomas (2020); Williams et al. (2019); Carli et al. (2023); Sagala and Öri (2024); Alexopoulos et al. (2022); Straková et al. (2022); Ramadan et al. (2023)
9	Agile and Collaborative Digital Ecosystem (N9)	This enabler refers to every other collaboration in the wider digital economy that engages partnerships, online platforms, and industry interaction in developing market capacity and economic sustainability. Digital technology providers, suppliers, and consumers partner with SMEs in developing industry knowledge, minimizing expense, and enhancing innovation, offering a cost-sharing advantage. A networked digital economy creates industry scalability, market expansion, and competitive innovation for SMEs to unlock wider revenue streams.	Extends agility beyond firm boundaries, emphasizing external collaboration and inter-organizational adaptability rather than internal strategy or culture. Extends agility beyond firm boundaries, emphasizing external collaboration and inter-organizational adaptability rather than internal strategy or culture.	Cubillas-Para et al. (2024); Carroll et al. (2023); Chen (2024); Corvello et al. (2023); Han and Trimi (2022); Sagala and Öri (2024); Aslanova and Kulichkina (2020); Pelletier et al. (2021); Ngo et al. (2023); Li et al. (2018); González-Varona et al. (2021); Prihandono et al. (2024); Levy et al. (2023)

methods like the Analytic Hierarchy Process and Analytic Network Process. This method can be used by individual decision-makers or groups. It is increasingly adopted due to its key features: minimal matrix data required for comparisons, high consistency among alternatives, and the use of only integer values in the comparison matrix (Rezaei, 2015). For n criteria, a pairwise comparison matrix is shown in Equation 1.

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ \vdots & \ddots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \quad (1)$$

It should be mentioned that a_{11} to a_{nn} is reflected as a_{ji} , which represents the importance of criterion i to j . $a_{ij} > 1$ denotes that i is more important than j , and $a_{ij} = 9$ reveals the extreme importance of i to j . It is possible to make a comparison between i and j into two categories: reference comparison and secondary evaluation (Rezaei, 2015). The noted comparison definition is explained:

Definition 1. When i is the best criterion and/or j is the worst criterion, the comparison between a_{ij} is referred to as a reference comparison, and vice versa.

Definition 2. If i or j is the best or worst criterion and $a_{ij} \geq 1$, then the comparison between the two is referred to as a secondary comparison.

The comparison between a_{ij} and i or j , which represent the best and worst criteria, respectively, is referred to as a secondary comparison. All possible comparisons for n criteria in Equation 1 are n^2 . It concludes that n comparisons are $a_{ii} = 1$ and that the remainder is $n(n-1)$, of which half have $a_{ij} \geq 1$ and the other half are the reciprocal of 1. Reference comparisons come from the first $n(n-1)/2$ comparisons, while the remaining comparisons are secondary (Rezaei, 2015).

3.8 BWM application

The current study aims to enable SMEs to perform effective adoption of ADT. This research seeks to identify and rank the critical determinants of ADT, enabling SMEs to allocate resources effectively and strengthen competitiveness under financial constraints.

Step 1: Determine a set of decision enablers.

A set of nine criteria was identified as the most important ADT enablers in SMEs (refer to Table 2).

Step 2: Determine the best and worst enablers.

In this step, selected experts are going to select the most important and least important of the enablers. It is shown in Table 3.

Step 3: Select the best enabler over all other enablers using a scale of 1–9.

In this section, the experts present their preference for the best enabler over all other enablers, and the best-to-other vector is shown in Equation 2.

$$Ab = (ab_1, ab_2, ab_3, \dots, ab_j). \quad (2)$$

In this context, ab_j denotes the preferential assessment of the best enabler b concerning the enabler j .

Step 4: Determine the preference of all other enablers over the worst enabler using a scale of 1–9.

In this section, the experts reveal their preference for the worst enabler over all other enablers as shown in Equation 3.

$$Aw = (a_{1w}, a_{2w}, a_{3w}, \dots, a_{jw})^T. \quad (3)$$

Here, a_{jw} indicates the preference of enabler j over the worst enabler. The vector represents the preference of all enablers over the worst enabler. Table 4 shows the pairwise comparisons between the best criterion selected by each expert with the other criteria, and comparisons of the other criteria with the worst criterion.

Step 5: Determine the optimal weights.

The optimal weights for criteria (w_1^* , w_2^* , w_3^* , ..., w_n^*) are calculated. It should be mentioned that these criteria, optimal weights, will fulfill the following requirements:

For each pair of w_B/w_j and w_j/w_w , the standard situation is where: As shown in Equations (4) and (5), α and β represent the ratios of the best and worst criteria weights used to derive the optimal weight vector.

$$\alpha_j = \left(\frac{w_B}{w_j} \right) \quad (4)$$

$$\beta_j = \left(\frac{w_j}{w_w} \right) \quad (5)$$

To estimate the optimal criteria weights, the maximum absolute difference of all sets of j criteria should be minimized, as shown in Equation 6

$$\text{Maximum Absolute Difference} = |\alpha_i - \alpha_{Bj}| - |\beta_j - \alpha_{jw}| \quad (6)$$

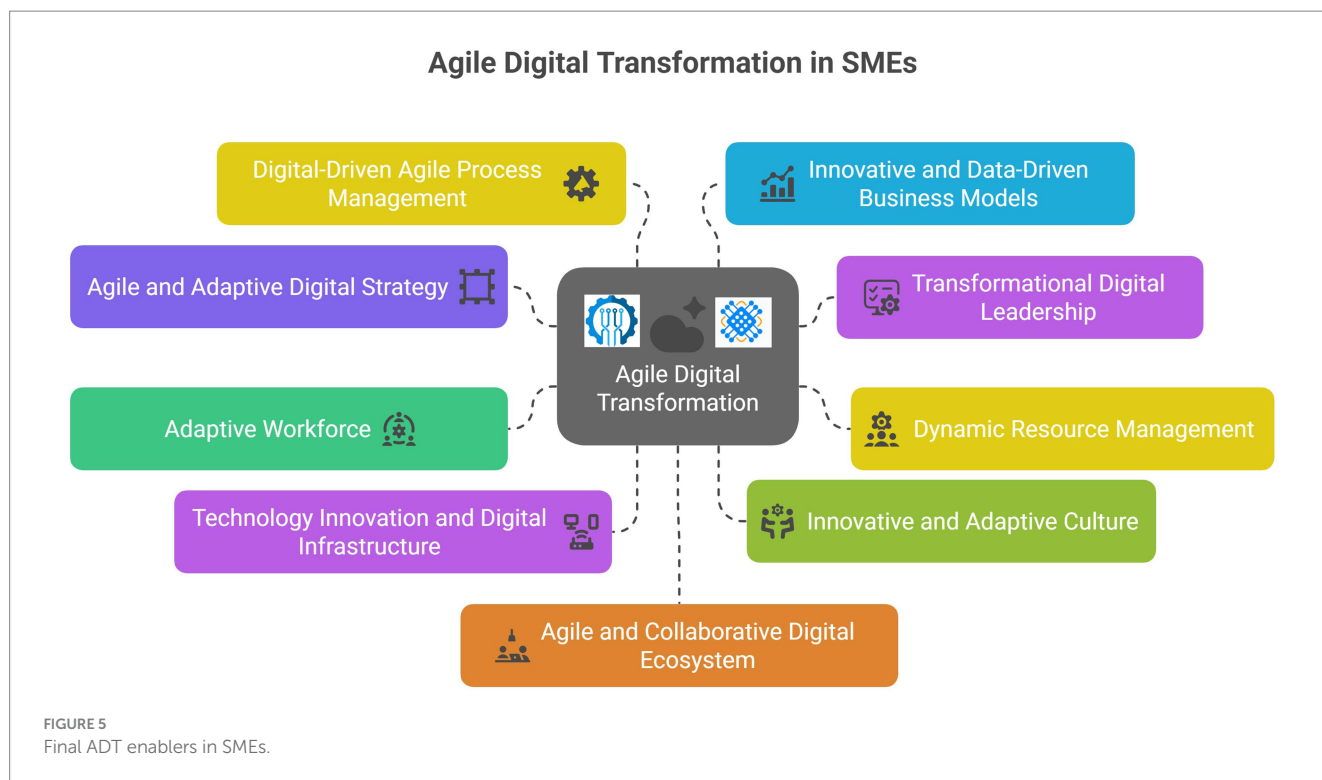
Equation 6 is represented in the form of a min-max model as explained in Equation 7.

$$\left\{ \begin{array}{l} \min \max(j) \{ |\alpha_i - \alpha_{Bj}|, |\beta_j - \alpha_{jw}| \} \\ \sum_{j=0}^n w_j^* = 1 \end{array} \right\} \quad (7)$$

In Equation 7, n denotes the number of alternatives. This can be converted into a linear programming model, as presented in Equation 8

$$\left\{ \begin{array}{l} \text{formin } |\alpha_i - \alpha_{Bj}| \leq \theta, |\beta_j - \alpha_{jw}| \leq \theta \\ \sum_{j=0}^n w_j^* = 1, w_j^* \geq 0 \end{array} \right\} \quad (8)$$

By solving the second model through Lingo18, optimal weights are calculated. The final weights are shown in Table 5. It is worth mentioning that final group weights were calculated as the



arithmetic mean of the individual expert weight vectors, consistent with practices reported in prior BWM studies (Salimi and Rezaei, 2016).

$(w_1^*, w_2^*, \dots, w_n^*)$ at the optimal value of ξ^* as depicted in Table 5. Furthermore, the maximum value of the consistency index according to a_{BW} is considered in Table 6. With the assistance of the consistency index and ξ^* value, the consistency ratio could be calculated by applying Equation 9.

$$\text{Consistency Rate (CR)} = (\xi^*) / (\text{Consistency Index}). \quad (9)$$

Consistency ratio $\in (0,1)$ shows that a value close to 0 possesses more consistency and close to 1 possesses less consistency. In this study, CR is 0.030. The final ranking of ADT enablers is depicted in Figure 6. Furthermore, a leave-one-expert-out sensitivity test confirmed the robustness of the results: the top three enablers remained unchanged across eight runs.

As shown in Figure 6, Transformational Digital Leadership is the most important and effective enabler, while the Data-Driven, Innovative Business Model is the least important enabler in implementing ADT in SMEs.

4 Discussion of findings

This study identified and prioritized nine critical enablers of ADT in SMEs using a validated hybrid Delphi and BWM methodology. The most influential drivers are Transformational Digital Leadership (0.2255), Agile and Adaptive Digital Strategy (0.1786), and Dynamic Resource Management (0.1730). Together,

TABLE 3 The main identified enabler as the best or the worst by experts.

Row	Expert	Best (most important criterion)	Worst (least important criterion)
1	Expert 1	N1	N9
2	Expert 2	N2	N7
3	Expert 3	N1	N9
4	Expert 4	N3	N8
5	Expert 5	N2	N9
6	Expert 6	N3	N7
7	Expert 7	N4	N8
8	Expert 8	N2	N8

these enablers may support organizational adaptability, inform efficient resource allocation, and conceptually guide strategic alignment for SMEs pursuing ADT. Although the Adaptive Workforce ranked fourth, its role as a connector between strategic direction and operational implementation underscores its importance in sustaining agility over time. Collectively, these factors may facilitate behavioral readiness for digital change by fostering autonomy, adaptability, and a more efficient use of limited resources. This finding aligns with Ramdani et al. (2022) and Sagala and Öri (2024), who emphasized leadership and organizational readiness as key elements of SME digitalization. However, unlike these studies, this research provides a structured prioritization of enablers, offering SMEs a clearer roadmap for action. Agile strategy and resource management enable SMEs to respond quickly and reallocate resources effectively. This supports earlier arguments by Troise et al. (2022) and Gonzalez-Tamayo et al. (2023) that agility supports

TABLE 4 Best-to-others (BO) and others-to-worst (OW) pairwise comparisons by experts.

Expert	Best/worst criteria	N1	N2	N3	N4	N5	N6	N7	N8	N9
Expert 1	Best (N1)	1	3	4	5	6	7	7	8	9
	Worst (N9)	2	2	3	2	2	2	2	2	1
Expert 2	Best (N2)	2	1	4	3	6	5	9	7	8
	Worst (N7)	5	2	3	3	2	2	1	2	2
Expert 3	Best (N1)	1	2	3	3	4	5	7	6	9
	Worst (N9)	6	3	4	2	2	2	3	2	1
Expert 4	Best (N3)	2	2	1	3	5	4	7	9	6
	Worst (N8)	6	4	3	2	3	2	2	1	2
Expert 5	Best (N2)	3	1	2	4	6	6	5	7	9
	Worst (N9)	4	5	2	2	2	3	2	2	1
Expert 6	Best (N3)	5	2	1	3	4	7	9	8	6
	Worst (N7)	2	5	3	2	2	2	1	2	2
Expert 7	Best (N4)	4	2	3	1	6	5	7	9	7
	Worst (N8)	3	5	3	2	2	2	2	1	2
Expert 8	Best (N2)	4	1	3	2	4	7	6	9	8
	Worst (N8)	2	3	2	3	2	3	2	1	2

competitiveness, but diverges from their descriptive accounts by delivering an empirically validated prioritization. The role of an Adaptive Workforce further highlights the importance of cross-functional skills and reduced training costs, extending prior insights from [Walsh et al. \(2023\)](#). Among the intermediate enablers, Technology Innovation and Digital Infrastructure (0.0739) and innovative and adaptable culture (0.0654) allow SMEs to adopt scalable, low-cost technologies and reduce resistance to change, consistent with [de Mattos et al. \(2024\)](#). Digital-Driven Agile Process Management (0.0519) streamlines workflows and enhances productivity, in line with [Chan et al. \(2019\)](#), who emphasized the role of agile processes in enhancing SME competitiveness. Business model innovation (0.0458) contributes by strengthening internal efficiency, paving the way for sustainable growth. Finally, an Agile and Collaborative Digital Ecosystem (0.0460) becomes particularly valuable after internal digital capabilities are established, echoing [Pelletier and Cloutier \(2019\)](#) and [Hafeez et al. \(2025\)](#). Although Innovative and Data-Driven Business Models (0.0458) and the Agile and Collaborative Digital Ecosystem (0.0461) ranked lowest among the enablers, their position does not indicate irrelevance. Rather, it reflects a sequencing logic in which SMEs initially prioritize leadership, strategy, and resource capabilities before leveraging external collaboration and new business models. In this regard, our findings complement [Pelletier et al. \(2023\)](#), who highlighted the role of IT capabilities, but advance beyond their descriptive scope by providing an empirically validated prioritization tailored to SMEs. Similarly, they converge with the SLR of [Perera and Razi \(2025\)](#), which emphasized leadership and resources as central, yet differ by offering a structured hierarchy that integrates ecosystem collaboration and business model innovation within the broader ADT framework. Overall, the sequential prioritization presented in this study may serve as a theory-informed reference framework for managers, suggesting a conceptual order of focus: beginning with

leadership and strategy, followed by the consolidation of resource and workforce capabilities, and subsequently emphasizing technology, culture, processes, ecosystem collaboration, and business model innovation. This conceptual ordering strengthens the theoretical contribution by clarifying the hierarchy of enablers and provides interpretive, theory-informed guidance by outlining how SMEs might sequence their DT efforts under resource constraints.

4.1 Theoretical implications

This study contributes to the DT literature by identifying and prioritizing nine key enablers of ADT in SMEs through a hybrid Delphi-BWM approach. It introduces a theory-driven framework integrating Strategic, Human, Organizational, and Technological Capabilities, extending the dynamic capability view to the SME context. By weighting expert-validated constructs, the study provides conceptual clarity on how agility-oriented capabilities interact under resource constraints. The framework reflects validated theoretical alignment, advancing understanding of agility, adaptability, and resource efficiency in small enterprise environments.

4.2 Management and practical considerations

For SME managers, the findings highlight Transformational Digital Leadership as a strategic priority supported by agile decision-making and digital literacy. Building adaptable processes and managing scarce resources efficiently can help ensure that DT remains both affordable and scalable. Adopting cost-effective technologies such as cloud solutions, automation, and basic AI, evaluated through systematic cost-benefit analysis, can further enhance operational

TABLE 5 The final weights of key enablers of ADT in SMEs.

Criterion	Description	E 1	E 2	E 3	E 4	E 5	E 6	E 7	E 8	W	R
N1	Agile and Adaptive Digital Strategy	0.395	0.182	0.309	0.163	0.120	0.073	0.090	0.097	0.1786	2
N2	Transformational Digital Leadership	0.121	0.340	0.172	0.147	0.332	0.182	0.180	0.331	0.2255	1
N3	Dynamic Resource Management	0.107	0.091	0.114	0.303	0.180	0.340	0.120	0.129	0.173	3
N4	Adaptive Workforce	0.086	0.121	0.114	0.109	0.090	0.121	0.340	0.137	0.1399	4
N5	Technology Innovation and Digital Infrastructure	0.072	0.061	0.086	0.065	0.060	0.091	0.060	0.097	0.0739	5
N6	Innovative and Adaptive Culture	0.061	0.073	0.069	0.082	0.060	0.052	0.072	0.055	0.0654	6
N7	Digital-Driven Agile Process Management	0.061	0.035	0.049	0.047	0.072	0.035	0.051	0.065	0.0519	7
N8	Innovative and Data-Driven Business Models	0.054	0.052	0.057	0.031	0.052	0.046	0.036	0.040	0.0458	9
N9	Agile and Collaborative Digital Ecosystem	0.044	0.046	0.031	0.054	0.034	0.061	0.051	0.048	0.0461	8
C. R.		0.033	0.024	0.034	0.023	0.028	0.024	0.019	0.056	0.030	

E, Expert; R, Rank; W, Weight.

TABLE 6 Consistency index value (Rezaei, 2015).

a_{Bw}	1	2	3	4	5	6	7	8	9
Consistency index	0.00	0.44	1.00	1.63	2.30	3.00	3.73	4.47	5.23

efficiency. By aligning digital initiatives with market and community expectations, SMEs can make a conceptual contribution to sustainable and inclusive digital growth. Overall, the study provides theory-informed managerial guidance that helps SMEs enhance their leadership, process agility, and resource optimization under constrained conditions.

4.3 Policy aims

To facilitate agile DT among SMEs, governments could strengthen national digital ecosystems by investing in digital skills programs and providing targeted incentives for technology adoption. Technology finance schemes such as low-interest digital loans and IT adoption grants may help overcome financial barriers and support digitization, particularly in underserved rural and semi-rural regions. Policymakers could also promote digital leadership capacity through publicly funded managerial training programs, while encouraging public-private partnerships and open innovation platforms to reduce transformation costs and improve knowledge exchange. These policy recommendations are indicative rather than prescriptive and should be tailored to each country's institutional context and economic priorities.

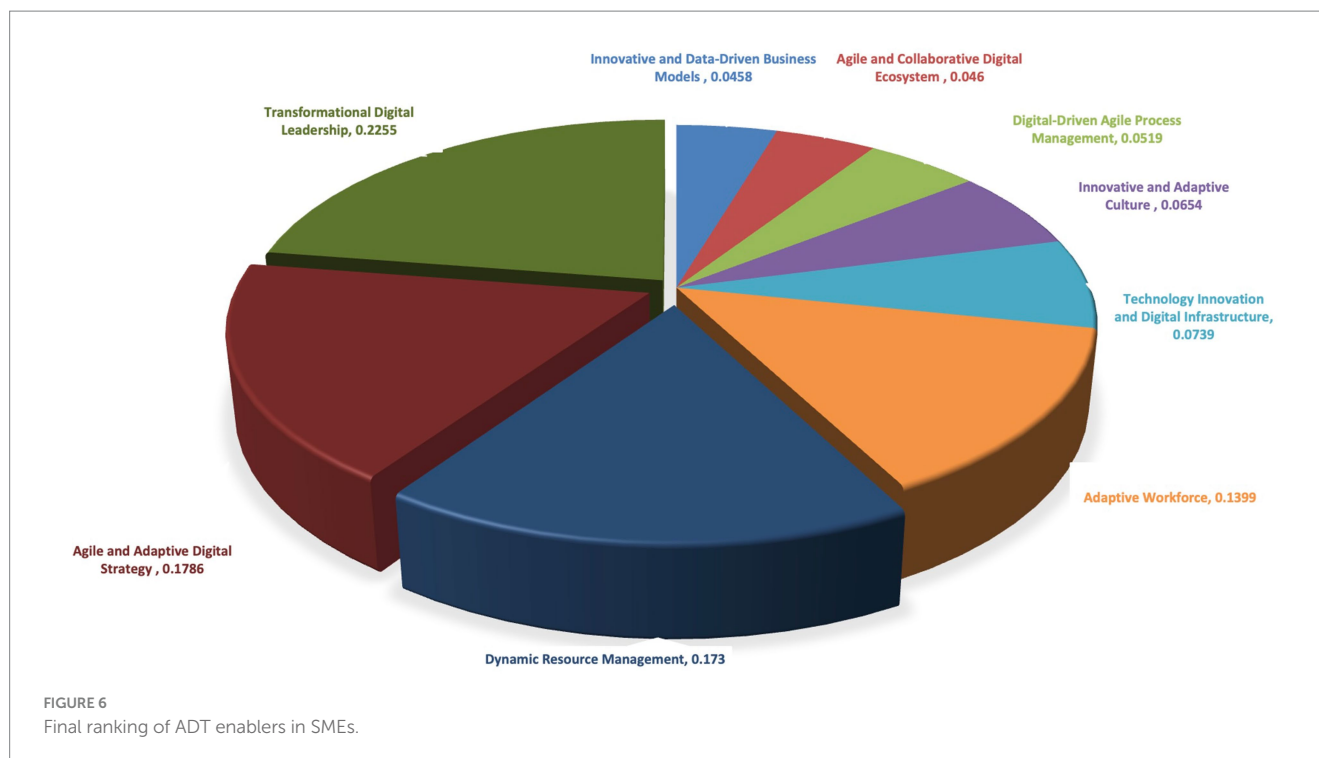
4.4 Strategic implications

At the strategic level, SMEs are encouraged to adopt dynamic and iterative approaches that remain responsive to evolving market

demands. Managers should integrate feedback mechanisms to align digital strategies with shifting business goals, optimize resource utilization, and maintain agility in decision-making. This continuous adjustment helps sustain long-term competitiveness by enabling flexible responses to uncertainty rather than focusing solely on short-term outcomes. Overall, these strategic insights provide a theory-informed, non-causal perspective that guides SMEs toward resilience and sustained performance in rapidly changing digital environments.

4.5 Limitations of the present study

Although this study provides a systematic investigation of ADT enablers in SMEs, several limitations should be acknowledged. The Delphi panel was relatively small ($n = 8$) and context-specific, comprising ICT-sector SME experts from the Middle East. Consequently, the findings rely on expert judgment rather than observed data, which may introduce judgment bias and constrain external validity. Moreover, the cross-sectional design limits the ability to infer long-term economic outcomes of ADT. The exclusive focus on SMEs restricts generalizability to larger or structurally different firms. Additionally, long-term outcomes such as profitability or cost efficiency were not examined. In addition, the absence of industry-specific or cross-cultural perspectives may obscure contextual variations in digital agility and resource deployment. Although this study prioritized high-level enablers, a detailed evaluation of related sub-criteria for economic impact assessment was not undertaken. Moreover, broader social implications such as



inclusive value creation or poverty reduction were beyond the study's scope. Finally, inter-organizational pathways that enable agility across networks were not thoroughly investigated, leaving opportunities for further ecosystem-level research. Therefore, the findings should be interpreted as theory-informed decision-support insights, since the study did not empirically validate whether the BWM-based prioritization of enablers leads to measurable improvements in ADT outcomes.

4.6 Future research scope

This study opens several directions for future research. First, longitudinal and multi-phase studies are needed to examine the long-term effects of ADT on SMEs' performance, resilience, and maturity progression. Expanding the research population to include larger enterprises, public organizations, and startups would also enhance the generalizability of findings. Second, cross-industry and cross-cultural replications could clarify how institutional, regulatory, and technological environments shape transformation pathways. Third, empirical validation should assess whether the prioritization of enablers derived from BWM corresponds to measurable improvements in digital maturity, innovation, and cost efficiency. Such validation may be achieved through case studies, longitudinal observations, or mixed-method triangulation using performance data. Fourth, fine-grained analyses of sub-criteria within each enabler could generate practical insights for improving the economic and sustainability dimensions of ADT. Future studies may also investigate how ADT enablers contribute to social value creation, including community engagement, inclusive development, and regional competitiveness. Finally, researchers are encouraged to explore how SMEs evolve from internal agility to ecosystem-level collaboration through shared digital platforms and open innovation networks. Collectively, these directions could refine

and extend the current framework into an empirically validated and generalizable model of ADT in SMEs.

5 Conclusion

This study proposed an integrated and systematic approach to identify and prioritize the key enablers of ADT in SMEs. It addressed major gaps in previous research, including the lack of clear priorities for SMEs and weak connections to broader development goals such as SDG 8 and SDG 9. Using a hybrid methodology that combines SLR, expert-supported Delphi rounds, and the BWM, the study identified nine conceptual enablers that inform ADT planning in SMEs. The resulting indicators represent expert-validated theoretical dimensions, offering theory-informed insights into cost-effective and sustainable transformation pathways. Transformational Digital Leadership emerged as a central enabler, promoting adaptability, collaboration, and alignment between business goals and digital ecosystems. In parallel, agile digital strategy and Dynamic Resource Management were found to support rapid market responsiveness and efficient resource allocation. These enablers collectively provide SMEs with a conceptual roadmap for enhancing competitiveness and long-term sustainability under resource constraints. References to SDG 8 and SDG 9 are presented as conceptual alignments, not causal claims. Future research should empirically validate these findings through longitudinal and cross-industry analyses to establish the broader applicability and practical robustness of the proposed ADT framework.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

All expert participants in this study provided written informed consent, and verbal consent was also obtained and recorded before each interview session.

Author contributions

MB: Formal analysis, Writing – review & editing, Methodology, Conceptualization, Writing – original draft, Investigation, Visualization. AH: Data curation, Conceptualization, Methodology, Writing – review & editing. AS: Writing – review & editing, Formal analysis, Conceptualization, Methodology. BO: Writing – original draft, Data curation, Visualization. HH: Visualization, Writing – review & editing, Formal analysis.

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Conflict of interest

HH was employed by company PETRONAS Sdn Bhd.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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