

Bridging the AI Readiness–Capability Gap: Manufacturing SME Transformation in the GCC

Hussain Mohammed Hassan Mohammed Alredha¹, Samer Ali Alshami²

¹Universiti Teknikal Malaysia Melaka

²Institute of Technology Management and Entrepreneurship

DOI: <https://doi.org/10.51584/IJRIAS.2026.11090031>

Received: 12 September 2026; Accepted: 17 September 2026; Published: 05 October 2026

ABSTRACT

Manufacturing small and medium-sized enterprises (SMEs) are central to economic diversification, industrial development, and employment creation across Gulf Cooperation Council (GCC) countries, particularly the United Arab Emirates (UAE). At the same time, these firms face persistent constraints related to finance, digital infrastructure, skills, managerial capability, data readiness, and organizational resistance, which may limit their ability to realize value from artificial intelligence (AI). This review examines how manufacturing SMEs can move beyond AI adoption toward the development of organizational AI capabilities. Drawing on the literature, AI capability is discussed through three dimensions: AI infrastructure capability, AI business-spanning capability, and proactive AI stance. The review synthesizes the opportunities, challenges, and policy implications associated with these capabilities in the GCC and UAE contexts. It further proposes a future research agenda emphasizing capability development, strategic alignment, experimentation, responsible AI governance, and ecosystem support. The review contributes by positioning AI capability building as a key requirement for sustainable SME competitiveness and industrial transformation.

Keywords: AI capabilities; Manufacturing SMEs; GCC; UAE; Dynamic capabilities; Digital transformation; AI policy

INTRODUCTION

Small and medium-sized enterprises (SMEs) constitute an important foundation of contemporary economies because of their contributions to employment, entrepreneurship, innovation, industrial development and economic diversification. Their strategic importance is particularly pronounced in Gulf Cooperation Council (GCC) countries—Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates (UAE)—where governments are seeking to reduce long-term dependence on hydrocarbons and develop more diversified, technology-intensive and knowledge-based economies. Manufacturing SMEs occupy an especially important position within this transition because they connect entrepreneurship and innovation with industrial production, supply chains, localization and the development of non-oil economic activities. Across the GCC, industrial policy increasingly emphasizes localization, higher-value production, exports and more resilient supply chains.

The strategic role of manufacturing SMEs nevertheless exists alongside substantial competitive pressures. Compared with larger manufacturers, SMEs frequently operate with smaller financial reserves, more restricted access to specialized expertise, less sophisticated technological infrastructure and greater dependence on a relatively small number of managers and employees. They must simultaneously respond to rising operating costs, supply-chain uncertainty, technological change, demanding customers and intensifying domestic and international competition. The source material similarly identifies financial, technological, managerial and human-resource constraints as particularly significant for manufacturing

SMEs and cautions that evidence obtained from large organizations cannot automatically explain how SMEs generate value from emerging technologies.

These pressures make artificial intelligence (AI) increasingly relevant to manufacturing SMEs. AI differs from many conventional information technologies because it can analyse large volumes of structured and unstructured information, identify patterns, generate predictions and continuously modify outputs as additional information becomes available. Such capabilities provide manufacturing firms with opportunities to automate activities, improve forecasting, support quality management, predict equipment problems, optimize inventories and supply chains, strengthen customer intelligence and make more informed decisions. The potential extends beyond production itself to procurement, logistics, marketing, sales, customer relationship management and strategic planning. The economic significance of these possibilities is substantial for GCC economies. The IMF reports that GCC countries have progressed rapidly in AI investment, research and development, infrastructure and talent. AI preparedness in the region exceeds the average for emerging markets, although important gaps remain in areas such as digital innovation and regulation. AI applications could contribute substantially to non-oil economic activity, while manufacturing is among the sectors in which AI can improve productivity. The UAE represents a particularly relevant setting within this regional transformation. SMEs account for more than 94% of companies in the UAE and approximately 60% of non-oil GDP, highlighting their centrality to the country's diversification strategy. A recent study of 81 UAE-based AI and digital SMEs indicates that the country has established a comparatively supportive ecosystem through digital infrastructure, data governance, regulatory development and government support. The attached source similarly positions SMEs as contributors to UAE employment creation, industrial development, entrepreneurship and innovation and connects their development with the country's broader AI and digital-transformation agenda. The UAE's policy orientation is particularly visible through the UAE National Strategy for Artificial Intelligence 2031 and wider digital transformation initiatives. The strategy provides an institutional environment in which businesses are encouraged to adopt and develop AI-enabled activities. The attached literature argues that such initiatives can improve access to technology, infrastructure and knowledge, although organizational outcomes ultimately depend on whether SMEs possess the capabilities necessary to deploy and adapt these resources effectively.

This qualification is important because AI adoption and AI capability are not equivalent. AI adoption describes the acquisition, implementation or use of AI technologies. AI capability instead reflects an organization's ability to mobilize, integrate and reconfigure AI-related technological and organizational resources in response to business and environmental requirements. Technological investment therefore represents only one element of AI-enabled transformation. Firms investing in comparable AI technologies may achieve substantially different outcomes because their abilities to integrate technologies with strategies, processes, people and organizational knowledge differ considerably (Mikalef & Gupta, 2021; Mikalef et al., 2023). This problem is especially significant for manufacturing SMEs. The attached literature indicates that SMEs in the Gulf context encounter shortages of resources and skilled personnel capable of integrating and managing AI solutions, while cultural resistance can constrain organizational change (Al Dhaheri et al., 2024; Shrivastava & Riaz, 2023). More broadly, evidence from manufacturing firms indicates a substantial firm-size divide in AI implementation: smaller enterprises report considerably lower use of AI than large firms and often perceive themselves as too small to justify AI investment.

The challenge is therefore not merely whether manufacturing SMEs are willing to adopt AI but whether they can establish the organizational conditions through which AI generates sustained business value. Mikalef et al. (2023) provide a particularly useful framework by conceptualizing organizational AI capability through AI infrastructure capability, AI business-spanning capability and proactive AI stance. The source material adopts these same three dimensions. AI infrastructure capability encompasses data architecture, computing resources, connectivity, security and access to AI applications; AI business-spanning capability captures the alignment of AI initiatives with business strategies and functions; and proactive AI stance represents experimentation, organizational learning and continuous improvement. This capability perspective corresponds closely with Dynamic Capabilities Theory (DCT). DCT argues that competitive advantage in changing environments depends not merely on possessing resources but on firms' abilities to sense

opportunities and threats, seize opportunities through resource mobilization and transform organizational resources and processes (Teece, Pisano & Shuen, 1997; Teece, 2007). The attached literature explicitly applies this reasoning to manufacturing SMEs, suggesting that AI capability provides a stronger explanation of value creation than technology possession alone.

Despite increasing research on AI, three gaps justify further synthesis. First, much of the literature remains oriented toward AI adoption, readiness and implementation, rather than capability development and value realization. Second, research concerning AI capabilities has often examined large organizations or contexts that differ substantially from resource-constrained manufacturing SMEs. Third, GCC-specific evidence remains fragmented despite the region's substantial investment in AI infrastructure and national strategies. Recent UAE research continues to describe SME AI adoption in emerging economies as insufficiently explored.

Accordingly, this review examines how manufacturing SMEs in GCC countries, with particular attention to the UAE, can develop AI capabilities capable of transforming AI investments into organizational value. Specifically, the paper aims to: (1) synthesize existing research concerning AI and manufacturing SMEs; (2) examine opportunities associated with AI infrastructure capability, AI business-spanning capability and proactive AI stance; (3) identify technological, financial, human, organizational and ethical challenges restricting capability development; and (4) formulate a future research and policy agenda for strengthening AI capabilities among GCC manufacturing SMEs.

REVIEW METHODOLOGY

This study adopts a structured narrative literature review to synthesize research on AI capability development among manufacturing SMEs, with particular attention to the GCC and UAE contexts. The review focused on literature addressing artificial intelligence, AI capabilities, digital transformation, manufacturing SMEs, dynamic capabilities, and AI governance. Relevant peer-reviewed studies were identified through major academic databases such as Scopus and Web of Science, supplemented by targeted searches of Google Scholar and authoritative institutional reports where GCC-specific evidence was required. Search terms included combinations of “artificial intelligence,” “AI capability,” “manufacturing SMEs,” “digital transformation,” “dynamic capabilities,” “GCC,” “UAE,” and “responsible AI.”

Studies were prioritized when they addressed organizational AI capabilities, manufacturing or SME contexts, AI-enabled operational transformation, or institutional conditions relevant to GCC economies. Particular emphasis was placed on recent literature, while seminal studies were retained where necessary to establish the theoretical foundations of Dynamic Capabilities Theory and AI capability. Studies focusing exclusively on technical algorithm development without organizational or managerial implications were excluded. Because empirical research specifically examining AI capabilities in GCC manufacturing SMEs remains limited, evidence from broader manufacturing, SME, B2B, and digital-transformation research was incorporated where conceptually relevant. The selected literature was subsequently synthesized around the three dimensions of AI infrastructure capability, AI business-spanning capability, and proactive AI stance, together with the cross-cutting issues of organizational constraints, responsible AI governance, and GCC institutional context.

Related Literature: Manufacturing SMEs and AI Capabilities

Manufacturing SMEs in the GCC Context

The GCC provides a distinctive context for studying SME digitalization because economic diversification, industrial development and technological transformation are being pursued simultaneously. GCC governments have embedded digital transformation within national development strategies, although their specific programs and stages of implementation differ. Saudi Arabia, the UAE, Qatar, Bahrain, Kuwait and Oman have all introduced national initiatives supporting digital transformation and advanced technology. Manufacturing assumes particular significance because diversification requires productive capabilities

beyond hydrocarbons. Manufacturing SMEs can contribute through local production, supplier development, innovation, employment and participation in global value chains. Nevertheless, the digital capabilities of firms remain uneven. The IMF identifies dependence on imported technologies and services, insufficient domestic digital production, and continued needs for R&D and innovation financing among the regional challenges. The UAE illustrates both the opportunities and tensions inherent in this transition. On the one hand, its infrastructure, regulatory initiatives and AI ecosystem provide favorable conditions. On the other, SME-level capability remains heterogeneous. The attached research similarly stresses that manufacturing SMEs operate with more constrained technological, financial and human resources than large organizations. Consequently, a distinction must be drawn between a country's national AI readiness and an individual SME's organizational AI capability. Advanced national infrastructure does not guarantee that individual manufacturers possess appropriate data architectures, technical skills, strategic alignment or experimentation routines.

The GCC should nevertheless not be treated as a homogeneous AI and manufacturing environment. Although Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the UAE share broad objectives concerning economic diversification and digital transformation, they differ in industrial scale, manufacturing structure, digital infrastructure, SME ecosystems, workforce composition, regulatory development, and the maturity of national AI initiatives. The UAE and Saudi Arabia have placed particularly strong emphasis on AI-enabled economic and industrial transformation, supported by substantial digital infrastructure and national investment, whereas other GCC states pursue digitalization within different industrial structures, resource bases, and institutional priorities. These differences may affect SMEs' access to AI expertise, financing, data infrastructure, technology providers, industrial customers, and government support. Consequently, evidence derived from UAE manufacturing SMEs should not automatically be generalized to all GCC member states. The GCC is more appropriately understood as a group of related but institutionally heterogeneous national contexts in which AI capability-development pathways may differ. Comparative research is therefore required to determine how country-level institutional conditions shape firm-level AI capability.

From AI Adoption to AI Capability

Early organizational AI research frequently approached the phenomenon as an adoption question: What encourages firms to adopt AI? What prevents adoption? Are employees willing to use it? More recent research increasingly recognizes that adoption represents the beginning rather than the completion of AI-enabled transformation. This distinction is strongly reflected in the attached literature. AI adoption concerns implementation and use, whereas AI capability concerns the organizational ability to integrate, mobilize and reconfigure AI resources. Mikalef and Gupta (2021) similarly conceptualize AI capability as an organizational capability generated through complementary technological, human and organizational resources. For manufacturing SMEs, the distinction is consequential. An SME may purchase an AI-enabled production, forecasting or CRM application but remain unable to generate significant value because data are fragmented, employees lack appropriate expertise, managers do not understand how the system supports business objectives or the organization lacks routines for improving the application. Dynamic Capabilities Theory provides an appropriate theoretical explanation. Manufacturing environments are subject to changes in technology, demand, supply chains and customer requirements. AI capability therefore becomes valuable when it helps firms sense changes, seize opportunities and transform existing processes.

AI Infrastructure Capability

AI infrastructure capability represents the technological foundation necessary to deploy and utilize AI. The source material identifies data management architecture, network and cloud services, computing resources, AI facilities, security infrastructure and AI applications as core elements.

In manufacturing SMEs, these resources support applications such as predictive maintenance, production planning, quality analytics, inventory optimization, forecasting and customer intelligence. Recent IMF analysis identifies predictive maintenance, supply-chain and inventory optimization, automation, energy optimization and waste reduction among potential manufacturing applications of AI in the UAE.

Infrastructure, however, cannot be equated with capability. Data must be sufficiently accurate, integrated and accessible. Systems must communicate with one another, and firms need adequate cybersecurity and governance. For smaller manufacturers operating with legacy machinery or fragmented systems, integration may be more difficult than purchasing an individual AI application.

AI Business-Spanning Capability

AI business-spanning capability represents the organizational ability to align AI investments with strategic priorities and integrate AI planning across managerial and functional activities. It includes understanding the business value of AI, integrating AI planning with strategic planning, ensuring managerial understanding of investments and maintaining flexible planning processes. This capability is particularly important for SMEs because scarce resources increase the cost of poorly targeted investment. Managers need to distinguish between AI applications that are technologically impressive and applications that address strategically meaningful production, supply-chain or customer problems. Business-spanning capability also addresses functional fragmentation. Data generated in production can potentially inform quality, procurement, sales and customer management, but such value emerges only when insights cross organizational boundaries. Mikalef et al. (2023) consequently position strategic alignment as central to transforming AI resources into organizational value.

Proactive AI Stance

The third dimension, proactive AI stance, captures organizational experimentation, learning, exploration and continuous improvement. The attached source describes it through experimentation with new AI tools, employee exploration, continuous improvement and awareness of emerging innovations. A proactive stance is particularly important because AI technologies change rapidly. SMEs cannot regard AI implementation as a one-off investment. They need mechanisms for experimenting with applications, evaluating results, learning from implementation and modifying processes. This dimension closely resembles the transforming component of dynamic capabilities. It enables organizations to renew how resources are deployed rather than remaining locked into existing technologies and routines.

FINDINGS AND DISCUSSION

The literature suggests that AI capability development among GCC manufacturing SMEs involves a tension between significant economic opportunity and persistent capability constraints. The GCC has relatively strong national AI infrastructure and ambitious government strategies, but organizational readiness remains uneven. Indeed, regional evidence identifies organization and talent, data and technology, adoption and scaling, and strategy as major challenges to building AI capability.

Table 1. AI Capabilities, Opportunities and Challenges for Manufacturing SMEs

Capability	Principal opportunities	Major SME challenges	Key literature
AI infrastructure capability	Automation; predictive maintenance; forecasting; quality improvement; data-driven decisions; supply-chain optimization	Investment costs; fragmented data; legacy systems; cybersecurity; integration difficulties	Mikalef et al. (2023); Mikalef & Gupta (2021); Peretz-Andersson et al. (2024)
AI business-spanning capability	Strategic AI investment; cross-functional integration; improved decisions; alignment with production and customer requirements	Managerial AI knowledge; strategic misalignment; functional silos; unclear ROI	Mikalef et al. (2023); Abou-Foul et al. (2023)
Proactive AI	Experimentation; organizational	Risk aversion; resource	Mikalef et al. (2023);

stance	learning; innovation; agility; continuous AI improvement	scarcity; resistance to change; skills limitations	Sjödin et al. (2023); Shrivastava & Riaz (2023)
Responsible AI governance	Trust; legitimacy; responsible innovation; safer data use	Privacy; bias; transparency; accountability; regulatory uncertainty	Mikalef et al. (2022); Hermann (2022); Behera & Bala (2023)

Opportunity 1: Productivity and Operational Intelligence

One of the clearest opportunities concerns operational productivity. AI can automate repetitive tasks while enabling manufacturers to analyse production information more rapidly. Predictive maintenance can reduce unplanned equipment downtime, while predictive analytics can improve demand and production forecasting. Inventory optimization can reduce excess stock and shortages, and AI-supported quality analytics can identify patterns associated with defects. For SMEs, these opportunities have strategic importance because resource productivity is often more important than resource abundance. SMEs cannot necessarily compete with large manufacturers by possessing more equipment, employees or capital; they can potentially compete by utilizing existing resources more intelligently. However, productivity gains require more than algorithms. Appropriate data must exist, systems need integration, employees need skills to interpret outputs, and managers must redesign decisions around AI-generated information. The attached evidence reinforces this point by showing that AI resources become meaningful when technological resources are complemented by strategic alignment and experimentation.

The manufacturing context also creates operational challenges that distinguish AI capability development from AI adoption in service-oriented SMEs. Many smaller manufacturers operate mixed production environments in which newer digitally connected equipment coexists with legacy machinery that was not designed to generate or exchange real-time data. Consequently, smart-factory integration may require retrofitting existing machinery with sensors, edge devices, connectivity interfaces, or intermediate data-acquisition systems rather than replacing entire production lines. The relevant capability is therefore not simply the ability to purchase AI applications, but the ability to connect shop-floor data with production planning, quality management, maintenance, inventory, and managerial decision systems. For resource-constrained SMEs, phased retrofitting may provide a more feasible pathway than complete smart-factory transformation, beginning with high-value use cases such as predictive maintenance, automated quality inspection, energy monitoring, and production scheduling.

Opportunity 2: Strategic Agility

AI can improve the speed at which SMEs recognize changes in customers, production conditions, suppliers and markets. This corresponds directly with the sensing dimension of Dynamic Capabilities Theory. Business-spanning capability is critical here. AI-generated information needs to influence actual organizational decisions rather than remain within technical systems. When managers integrate AI insights with production, procurement, marketing and sales decisions, the firm can respond more rapidly to emerging changes. This is especially relevant in GCC manufacturing, where firms are exposed to international supply chains, imported technologies, changing localization requirements and ambitious national industrial policies.

A further manufacturing-specific consideration concerns B2B supply-chain linkages. Manufacturing SMEs frequently operate as suppliers, subcontractors, distributors, or specialized producers within supply networks led by larger firms. Their AI capability is therefore partly dependent on their ability to exchange reliable information with customers, suppliers, logistics providers, and technology partners. AI-supported demand forecasting, inventory optimization, procurement planning, traceability, and quality assurance become substantially more valuable when internal production data can relate to external supply-chain information. Conversely, incompatible systems, weak data standards, limited supplier digitalization, or restrictions on sharing commercially sensitive data may constrain these benefits. AI business-spanning capability should

therefore extend beyond internal functional integration to include the SME's capacity to participate effectively in digitally connected B2B manufacturing ecosystems.

Opportunity 3: Innovation and Experimentation

AI provides manufacturing SMEs with opportunities to experiment with new products, services, business processes and customer solutions. A proactive AI stance allows firms to identify new applications without requiring immediate large-scale deployment. This is important because SME resource limitations can make large technological projects risky. Incremental experimentation provides an alternative path. SMEs can begin with narrowly defined applications, evaluate outcomes, learn from failures and scale successful solutions. Sjödin et al. (2023) connect AI with dynamic capabilities and business-model innovation, while the source material specifically associates proactive AI capability with experimentation, learning and continuous reconfiguration.

Challenge 1: Financial and Scale Constraints

The first significant constraint is resource availability. AI investment involves more than software acquisition. Firms may require cloud services, sensors, data infrastructure, integration, cybersecurity, employee training and external expertise. SMEs therefore face a scale disadvantage. Recent manufacturing evidence finds substantially lower AI implementation among SMEs than larger enterprises. This challenge suggests that policy programs should avoid assuming that all SMEs can follow the same capability-development trajectory as large manufacturers.

Challenge 2: Data and Infrastructure

AI depends on data. Manufacturing SMEs may possess considerable operational information, but that information may exist in spreadsheets, separate databases, older machinery or incompatible systems. The problem is therefore not simply data availability but data usability. AI infrastructure policy should consequently emphasize interoperability, data quality, cloud access and cybersecurity rather than focusing solely on purchasing technology.

Challenge 3: Skills and Managerial Capability

The shortage of specialized personnel represents another important constraint. The attached literature explicitly identifies limited access to skilled personnel capable of integrating and managing AI systems.

Technical skills alone are insufficient. Managers also require AI literacy: the ability to understand where AI can generate value, evaluate investments, recognize limitations and connect technological possibilities with organizational priorities. This corresponds with GCC evidence identifying organization and talent as the largest challenge to developing AI capability.

Challenge 4: Resistance to Change

Manufacturing SMEs frequently rely on established routines developed over many years. AI may challenge these routines by changing how decisions are made, how employees work and how information flows through the organization. Shrivastava and Riaz (2023) identify cultural resistance as a barrier within UAE SMEs. This means proactive AI stance is partly a behavioral and cultural capability. Employees need opportunities to experiment, managers must tolerate controlled failure, and learning must be integrated into implementation.

Challenge 5: Responsible AI and Governance

As AI becomes more deeply embedded in organizational decisions, ethical governance becomes increasingly important. The attached literature identifies privacy, fairness, transparency, accountability, explainability and algorithmic bias as major concerns. For manufacturing SMEs operating in B2B

environments, these concerns extend beyond compliance. Firms exchange commercially sensitive information with customers, suppliers and partners. Poor data governance or opaque AI decisions can damage trust. Accordingly, responsible AI should be treated as a cross-cutting condition of capability development, rather than simply an additional technology feature.

Future Research and Policy Agenda

The review indicates that the next phase of research should move beyond explaining whether SMEs adopt AI toward explaining how AI capability develops and under what conditions it creates sustainable value.

Table 2. Future Research and Policy Agenda for GCC Manufacturing SMEs

Area	Research gap	Future research question	Policy direction
Infrastructure	Limited SME-specific capability thresholds	What constitutes minimum viable AI infrastructure for manufacturing SMEs?	Shared cloud/data infrastructure and SME technology support
Data	Data ownership often emphasized more than usability	How do data quality and interoperability affect AI value?	Data-readiness grants and standards
Business spanning	Limited understanding of AI-business alignment	How does managerial AI literacy influence AI performance?	Executive AI training
Human capability	Persistent AI skills shortages	Which skills configurations are most important for SMEs?	SME-focused AI workforce programs
Experimentation	Cross-sectional evidence dominates	How do AI capabilities evolve through experimentation?	Regulatory sandboxes, innovation labs and pilot funding
Ecosystems	SMEs cannot internalize all AI resources	How do universities, vendors and large firms complement SME capabilities?	AI manufacturing hubs and partnership schemes
Ethics	Responsible AI often separated from capability research	How does responsible AI governance influence SME AI value?	Practical SME AI governance frameworks
GCC context	Country-specific evidence remains fragmented	How do AI capability pathways differ across GCC states?	GCC benchmarking and data sharing
Manufacturing	Much AI research remains service-oriented	Which manufacturing processes generate the greatest SME AI returns?	Sector-specific demonstrators
Outcomes	Adoption frequently used as final outcome	When does AI capability translate into productivity and competitiveness?	Outcome-based AI support programs

Policy: Move from Adoption Subsidies to Capability Development

A central policy implication is that governments should avoid measuring AI transformation simply through numbers of firms adopting AI. An SME subscribing to an AI service is not necessarily AI capable. Policy should instead support the development of infrastructure, strategic integration, employee capabilities and organizational learning. The source material already identifies financial incentives, digital infrastructure, workforce upskilling and AI awareness as relevant policy interventions.

Establish Manufacturing AI Capability Hubs

GCC governments could develop sector-specific AI capability hubs through collaboration among universities, technology providers, industrial associations and manufacturing SMEs. Such hubs could provide shared technical expertise, demonstration facilities, data-management guidance and pilot projects. This model reduces the need for each SME to internalize expensive specialist resources.

Develop AI Skills at Two Levels

Training should distinguish between technical AI capability and managerial AI capability. Technical training should address data engineering, analytics, AI integration and cybersecurity. Managerial training should develop AI literacy, investment evaluation, strategic alignment, responsible governance and change management. This distinction is particularly important because recent UAE evidence indicates that top-management support and employee capability are both significant to SME AI adoption.

Encourage Experimentation Rather Than Large-Scale Initial Investment

SMEs should be encouraged to undertake smaller AI experiments linked to clearly defined manufacturing problems. Government programs could fund pilots in predictive maintenance, quality control, energy efficiency, supply-chain forecasting or customer analytics. Such an approach directly strengthens proactive AI stance by creating opportunities for learning before scaling.

Develop SME-Specific Responsible AI Guidance

Ethical frameworks developed for large corporations may be difficult for SMEs to operationalize. GCC policymakers should therefore provide simplified governance templates covering data privacy, algorithmic fairness, human oversight, accountability and vendor assessment. The attached source explicitly recommends policies and regulatory frameworks that protect stakeholders and increase trust in AI-enabled business systems.

Ethical frameworks developed for large corporations may be too complex and resource-intensive for manufacturing SMEs to operationalize. Rather than requiring elaborate AI governance structures, resource-constrained SMEs need a minimum viable governance approach that embeds essential safeguards within existing managerial and operational responsibilities. A practical SME-oriented governance template could therefore consist of five components:

(1) AI use-case registration, documenting the purpose, data inputs, expected benefits, risks, and responsible owner for each AI application; **(2) data governance checks**, confirming the legitimacy, quality, security, confidentiality, and permitted use of production, employee, customer, and supplier data; **(3) human oversight**, identifying decisions that require managerial or technical review rather than relying exclusively on automated recommendations; **(4) vendor and model assessment**, requiring SMEs to evaluate external AI providers in relation to data access, cybersecurity, transparency, reliability, contractual responsibility, and system support; and **(5) periodic monitoring**, using a short checklist to record model errors, unexpected outputs, operational incidents, user concerns, and corrective actions.

For manufacturing SMEs, this governance process should be proportional to operational risk. An AI application used for general sales forecasting, for example, may require lighter controls than an AI system

influencing product quality, predictive maintenance, worker safety, supplier evaluation, or production decisions. Responsibility can initially be assigned to an existing manager or cross-functional team rather than requiring a dedicated AI governance department. GCC policymakers, industry associations, and manufacturing capability hubs could support this approach by providing standardized one-page AI risk registers, vendor-assessment checklists, data-governance templates, human-oversight protocols, and incident-reporting forms. Such simplified tools would enable SMEs to operationalize responsible AI while recognizing their limited financial, technical, and human resources.

Strengthen GCC-Level Coordination

Finally, a regional perspective is needed. Although GCC countries pursue different national strategies, they share challenges relating to skills, technological dependence, data availability and industrial diversification. The IMF similarly recommends education and training, greater data availability and regulatory frameworks that mitigate AI risks without unnecessarily discouraging innovation. Regional benchmarking could allow policymakers to compare manufacturing SME AI readiness, infrastructure capability, workforce skills and AI outcomes. Shared standards and cross-border knowledge networks could also help SMEs access markets and technological expertise beyond their domestic economies.

Contributions and Conclusion

This review contributes to the literature in four principal ways. First, it shifts the discussion of AI in manufacturing SMEs from technology adoption toward organizational capability development. This distinction is theoretically significant because possessing AI technologies does not ensure that firms can create value from them. The review therefore responds to the limitations of adoption-oriented studies by emphasizing the resources, competencies and routines required to mobilize AI effectively.

Second, the paper develops a multidimensional interpretation of AI capability based on AI infrastructure capability, AI business-spanning capability and proactive AI stance (Mikalef et al., 2023). These dimensions provide a structured explanation of AI-enabled value creation: infrastructure establishes the technological foundation; business-spanning capability connects AI with strategic and functional priorities; and proactive AI stance supports experimentation, learning and continuous adaptation. This conceptualization is consistent with the attached literature's treatment of AI capability.

Third, the review contextualizes AI capability within GCC manufacturing SMEs, with particular attention to the UAE. This contextualization matters because national AI readiness should not be equated with firm-level capability. The UAE provides advanced infrastructure, an increasingly mature AI ecosystem and substantial policy support, yet SMEs continue to face resource, skills and organizational constraints. The UAE case therefore demonstrates an important distinction between an AI-enabling national ecosystem and AI-capable individual firms.

Fourth, the paper contributes to policy by arguing for a transition from AI adoption policy to AI capability policy. Financial incentives for technology acquisition remain useful, but sustainable transformation additionally requires data readiness, managerial AI literacy, employee skills, experimentation mechanisms, responsible governance and ecosystem collaboration. For manufacturing SMEs, the central strategic question is therefore changing. It is no longer simply "Should we adopt AI?" The more consequential question is "What technological, strategic and adaptive capabilities must we develop to generate sustained value from AI?"

For GCC policymakers, a parallel shift is required. Success should not be assessed solely by AI investments, infrastructure or adoption rates. The more meaningful outcome is whether manufacturing SMEs develop the capabilities to integrate AI into productive activities, continuously improve its application, manage its risks responsibly and ultimately strengthen productivity, innovation and international competitiveness.

REFERENCES

1. Abou-Foul, M., Ruiz-Alba, J. L., & López-Tenorio, P. J. (2023). The impact of artificial intelligence capabilities on servitization: The moderating role of absorptive capacity—A dynamic capabilities perspective. *Journal of Business Research*, 157, 113609.
2. Al Dhaheri, M. H., Ahmad, S. Z., & Papastathopoulos, A. (2024). Do environmental turbulence, dynamic capabilities, and artificial intelligence force SMEs to be innovative? *Journal of Innovation & Knowledge*, 9(3), 100528.
3. Alkhoudi, S., Shaer, S., & Salem, F. (2025). The Artificial Intelligence SMEs Ecosystem in the UAE: Overcoming Challenges, Expanding Horizons. Mohammed Bin Rashid School of Government. This recent UAE report is based on 81 UAE AI/digital SMEs and is especially useful for strengthening the UAE contextual section.
4. Behera, R. K., & Bala, P. K. (2023). Unethical use of information access and analytics in B2B service organisations: The dark side of behavioural loyalty. *Industrial Marketing Management*.
5. Chatterjee, S., Chaudhuri, R., & Vrontis, D. (2022). AI and digitalization in relationship management: Impact of adopting AI-embedded CRM system. *Journal of Business Research*, 150, 437–450.
6. Hermann, E. (2022). Leveraging artificial intelligence in marketing for social good—An ethical perspective. *Journal of Business Ethics*, 179, 43–61.
7. Mikalef, P., & Gupta, M. (2021). Artificial intelligence capability: Conceptualization, measurement calibration, and empirical study on its impact on organizational creativity and firm performance. *Information & Management*, 58(3), 103434.
8. Mikalef, P., Islam, N., Parida, V., Singh, H., & Altwaijry, N. (2023). Artificial intelligence (AI) competencies for organizational performance: A B2B marketing capabilities perspective. *Journal of Business Research*, 164, 113998.
9. Mikalef, P., Lemmer, K., Schaefer, C., Ylinen, M., Fjörtøft, S. O., Torvatn, H. Y., Gupta, M., & Niehaves, B. (2022). Enabling AI capabilities in government agencies: A study of determinants for European municipalities. *Government Information Quarterly*, 39(4), 101596.
10. Peretz-Andersson, E., Tabares, S., Mikalef, P., & Parida, V. (2024). Artificial intelligence implementation in manufacturing SMEs: A resource orchestration approach. *International Journal of Information Management*, 77, 102781.
11. Saeedikiya, M., Salunke, S., & Kowalkiewicz, M. (2024). Toward a dynamic capability perspective of digital transformation in SMEs: A study of the mobility sector. *Journal of Cleaner Production*, 439, 140718.
12. Shrivastava, V. K., & Riaz, S. (2023). Adoption of Big Data and AI in UAE SMEs in unpredictable environment. 9th International Conference on Control, Decision and Information Technologies (CoDIT 2023), 816–821.
13. Sjödin, D., Parida, V., & Kohtamäki, M. (2023). Artificial intelligence enabling circular business model innovation in digital servitization: Conceptualizing dynamic capabilities, AI capacities, business models and effects. *Technological Forecasting and Social Change*, 197, 122903.
14. Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), 1319–1350.
15. Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533.