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AI Adoption in Small and Medium Enterprises: Data Infrastructure, Customer Engagement, and Organizational Capabilities

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Abstract
Artificial intelligence presents opportunities for small and medium-sized enterprises to improve operational processes, sharpen marketing decisions, and enhance customer interactions, yet adoption is uneven due to resource limits, limited technical expertise, and infrastructure gaps. This work synthesizes definitional debates and empirical findings on technological enablers, data practices, applications, and organizational capabilities required for effective adoption in smaller firms. Evidence highlights the need for systematic data architectures, governance, and analytics pipelines as precursors to scalable AI services; staged implementation trajectories often reconfigure platform design and data capture before deploying machine learning and automation. Demonstrated applications include automated customer support and predictive analytics that reduce resolution times, optimize resource allocation, and enable personalized recommendations and continuous service. Organizational antecedents include top management commitment combined with dynamic capabilities for sensing, seizing, and transforming opportunities, plus workforce adaptability supported by targeted reskilling and external technical assistance. Measurement models report reliable constructs for readiness and adaptability, while contextual barriers such as regulatory constraints, investment shortfalls, and consumer data concerns moderate outcomes. Recommendations emphasize aligning AI efforts with strategic goals, investing in data management and people, and leveraging partnerships to convert technological potential into measurable performance improvements.

1. Introduction

Across diverse organizational contexts, artificial intelligence (AI) has been associated with gains in operational efficiency, enhanced decision quality, and improved customer interactions. AI marketing solutions that integrate machine learning, predictive analytics, natural language processing, and automated customer service systems have been used to streamline operations, support decision making, and modernize business-to-consumer communication patterns. In domains such as retail, banking services, and online sales, these technologies have been applied to reduce expenses while enhancing customer service and access to behavioral data, enabling more individualized marketing approaches. Customer-facing applications constitute a central strand of this development. Chatbots, virtual assistants, and call center conversational interfaces provide continuous availability and can deliver personalized support that strengthens customer relationships and satisfaction. E-commerce platforms that employ AI-based recommendation systems generate tailored product suggestions from historical user behavior and stated preferences, contributing to more engaging user experiences. In financial services, AI assists with risk evaluation, fraud detection, and financial consultation, thereby supporting more responsive and data-driven service provision (1). These examples illustrate how AI can embed automation and data analytics into core customer and operational processes. At the same time, research on small and medium-

sized enterprises (SMEs) underscores that AI adoption is uneven and shaped by specific constraints. In several contexts, SMEs lag behind larger organizations in technology uptake and AI integration, largely due to limited resources, insufficient understanding of AI capabilities, and challenges in adapting existing systems. Studies focusing on SME environments identify competitive pressure, top management commitment, employee adaptability, external support, and organizational readiness as key determinants of AI adoption decisions (2,3). Competitive pressure can push firms to incorporate AI into marketing and operational strategies to remain viable in dynamic markets, while top management commitment supports strategic recognition of AI's potential and mobilizes resources for implementation. Employee adaptability and organizational readiness emerge as particularly salient internal conditions. Employee adaptability, understood as the capacity to adjust to new technologies, roles, and processes, is closely linked to the effective utilization of AI tools in everyday work. Organizational readiness, which spans leadership support, culture, infrastructure, and processes, shapes whether AI can be aligned with business strategy, supported by adequate technical and data capabilities, and embedded through appropriate change management. External support, including expertize, technical assistance, customization, training, and ongoing services, can help SMEs overcome capability gaps and leverage AI for improved efficiency, decision making, competitive advantage, and customer service (2). Despite these developments, several research gaps remain. Existing work often aggregates different forms of AI and concentrates on large, resource-rich firms, providing limited insight into how generative and other AI technologies are used by SMEs, especially for sustainability-oriented functions. Evidence indicates that SMEs in technologically constrained environments confront additional barriers related to infrastructure and context-specific limitations, which further complicate AI adoption (4). In some regions, such as Jordan and Sabah, empirical studies report insufficient knowledge about AI's practical influence on small business performance and a lack of detailed understanding of sector-specific adoption drivers (1,2). As a result, the literature on AI and SMEs calls for contextually grounded research designs that can clarify how perceived usefulness, ease of use, organizational conditions, and external support jointly shape AI uptake and its operational consequences for smaller enterprises (1–4).

2. Foundations of Artificial Intelligence in Small Business Contexts

2.1 Definition and Scope of AI

Definitions of artificial intelligence vary across fields, yet several sources converge on key elements that clarify its scope for organizational applications. One account describes AI as a field of computer science dedicated to creating intelligent machines capable of performing tasks that typically require human intelligence, emphasizing abilities such as data analysis, learning from experience, decision making, and problem solving through algorithms, machine learning techniques, and large datasets (2). A complementary definition characterizes AI as the study of algorithms that enable machines to reason and carry out cognitive functions including problem solving, object and word recognition, and decision making (3). Taken together, these descriptions frame AI as a collective term for applications that reproduce or augment human cognitive functions in computational systems (2,3). Historical contextualization further refines this scope. The phrase "Artificial Intelligence" was coined by John McCarthy

in 1956 at the Dartmouth Conference, which is widely regarded as the starting point of AI research. Substantial progress in AI techniques did not emerge until the 1970s, in part because early efforts were constrained by limited data availability and immature computing technologies. Subsequent developments associated with Industry 4.0 and the proliferation of data generating devices accelerated AI by supplying large volumes of data and the networking infrastructure required for large scale data sharing, enabling more advanced applications across domains (3). Current descriptions emphasize the breadth of AI's application areas. AI systems encompass subfields such as natural language processing, computer vision, robotics, expert systems, and neural networks, and are applied in healthcare, finance, transportation, gaming, small and medium sized enterprises, and marketing strategy (2). Everyday manifestations include chatbot interactions, web searches, and voice assistants, alongside deployment in education, industry, and health services. Despite this diversity, research still reports the absence of a universally accepted single definition of AI, reinforcing the value of treating AI as an umbrella term for a wide range of algorithmic approaches. Within small business and SME contexts, AI is often conceptualized through its functional roles and the specific tools it activates. One synthesis highlights AI powered tools that automate routine activities such as data entry, scheduling, and basic customer service inquiries, as well as algorithms that analyze customer data to personalize marketing campaigns, product recommendations, and chatbot interactions (3). Another review characterizes AI in SMEs as a general purpose technology that can streamline internal processes, support strategic and operational decision making, and enhance productivity across marketing, sales, and performance management. These accounts position AI not as a single technology but as a configurable ensemble of analytic and automation capabilities that organizations can embed into diverse business processes (2,3). Public understanding and acceptance form part of AI's practical scope. Analyses of media coverage show that AI is increasingly visible in public discourse, with both optimistic narratives and concerns about issues such as job displacement, ethics, and safety risks. Negative news is reported to exert a stronger influence on perceptions, which can generate resistance to AI powered products and services and potentially affect organizational attempts to derive competitive advantage from AI deployments (3). In parallel, domain specific studies in regions such as Jordan and Sabah describe AI in terms of concrete applications including digital marketing, personalization, predictive analytics, and decision support for SMEs, while also noting gaps in understanding of AI capabilities among managers and resource constraints that limit effective adoption (1,2). Through these combined perspectives, AI in small business environments can be delineated as a multifaceted technological domain spanning algorithmic intelligence, data driven analytics, and automated interaction systems that are shaped by both technical possibilities and contextual adoption conditions (1–3).

2.2 Relevance of AI to SMEs

Across small and medium sized enterprises, AI is positioned as a strategic tool for enhancing decision processes, marketing effectiveness, and overall business performance. Studies on SMEs in diverse contexts report that AI supported applications can streamline operations, improve strategic decisions, and optimize performance, but they also underline that realizing these benefits requires deliberate

planning, investment, and expertize for successful integration with existing systems (2,3). Within this framing, AI is treated as a powerful enabler of growth, innovation, and competitiveness in digital markets, particularly when organizations can match technological solutions to clearly identified business needs and ensure accurate, unbiased data for model training (3). Marketing and customer related functions constitute a central area of relevance. By using machine learning and data analytics, SME marketers can derive detailed insights into customer behavior and preferences and employ these insights to design more personalized, effective, and efficient campaigns. Such applications span personalized recommendations, targeted communication, and improved segmentation, and they are regarded as important for decision making regardless of SME size, sector, or product and service portfolio (2). In consumer facing industries in Jordan, AI marketing solutions integrate machine learning, predictive analytics, natural language processing, and automated customer service systems to streamline operations and provide access to rich behavioral data, which firms can use to develop individualized marketing approaches and updated business to consumer communication patterns. Customer engagement and service delivery form another major domain in which AI is operationally salient for SMEs. AI powered chatbots, virtual assistants, and call center conversational interfaces offer continuous availability and can strengthen customer relationships by enabling more responsive and personalized support. In Jordanian retail, banking, and online sales, these tools contribute to enhanced customer experiences while simultaneously simplifying work processes and reducing expenses. Financial sector examples show that AI applications support risk evaluation, fraud detection, and financial consultation, indicating how data driven systems can extend SME capabilities in domains that traditionally required substantial human expertize (1). Beyond front end interactions, AI contributes to operational efficiency and internal value creation. Empirical syntheses on AI and SMEs describe AI as enabling automation, predictive analytics, and data driven decision making that can improve productivity and reduce manual labor in a range of business functions. Automation can reduce errors and simplify administrative processes, while predictive systems help firms forecast demand, monitor environments, and adjust strategies under conditions of technological turbulence and market volatility. These capabilities are particularly salient where SMEs face competitive pressure and must do more with fewer resources to remain viable, as AI supported tools can help them adapt business models, monitor regulatory compliance, and expand into wider markets via digital channels such as e commerce and online marketplaces (3). At the same time, research focused on specific SME ecosystems reveals that AI's relevance is conditioned by context specific constraints. In Sabah, Malaysia, local SMEs significantly lag in AI adoption due to a lack of fundamental understanding of AI capabilities and inadequate resources for adaptation and integration, despite their recognized importance for the regional economy (2). Similar gaps are documented for Jordan, where there is insufficient empirical evidence on AI's practical influence on business performance, customer attitudes, and engagement tactics, and firms often lack awareness that user perceptions and trust in AI services directly affect adoption rates and outcomes (1). These findings underline that AI's potential to enhance operations, customer experience, and competitiveness in SMEs is substantial but not automatic, depending critically on organizational readiness,

external support, and local infrastructural and knowledge conditions (1–3).

3. Technological Enablers for AI Adoption in SMEs

3.1. Infrastructure and Tools

Empirical work on AI in consumer industries and SME contexts foregrounds data infrastructure as a central enabler of advanced applications. In the case of the PrestaShop platform, a dedicated Data Strategy Team was created in 2021 specifically to build systematic data collection capabilities, complemented by external ecosystem intelligence tools that enrich merchant and partner profiles. This restructuring included platform level changes to support data capture and analytics, positioning the organization for later AI integration. A subsequent phase, explicitly labeled as data readiness for AI integration, involved configuring the platform for large scale data collection and analysis, followed by pilot AI services and internal capacity development. These steps underline that robust data architectures and analytics pipelines are treated as prerequisites for AI deployment rather than incidental by products of digitalization. In PrestaShop's ongoing AI enabled transition, capabilities and infrastructure remain under development, indicating that the underlying tooling and data systems must evolve alongside business model transformation. Operational tools built on this infrastructure support concrete performance gains. At PrestaShop, machine learning has been integrated into the customer support system, contributing to a measurable reduction in average ticket resolution time and an increase in automated content delivery tailored to user history and behavior. Customer care managers describe these changes as generating rapid improvements through dynamic content provision and AI generated resources in a learning academy, reflecting how AI tools are embedded into support workflows. Data driven dashboards, such as those implemented with Looker, enable strategic reallocation of resources and identification of profitable merchant clusters, illustrating how analytics interfaces become part of the operational toolset for decision makers. Over time, these tools have supported a broader shift from reactive to proactive business development, including the design of new revenue generating services informed by ecosystem level data analysis (5). Survey based research in Jordanian consumer industries provides complementary evidence on how specific AI functionalities depend on adequate technological and data infrastructures. Measurement models include items capturing the capacity of firms to use AI to predict behavior, offer relevant solutions, and personalize customer experiences, while simultaneously acknowledging capital, cost, and knowledge constraints in personalization and the early stage of AI use in local e commerce. Additional indicators frame operational efficiency around AI enabled error minimization, process simplification, cost and delivery time reduction, and sectoral patterns such as slow AI adoption in finance due to regulatory concerns and investment needs. These constructs implicitly assume the presence of data networks and secure infrastructures, as other items in the same model highlight data security issues as major constraints and stress the importance of quality data networks for maximizing AI benefits (1). Together, these findings connect AI applications, operational efficiency, consumer engagement, and business performance to the availability of reliable technical infrastructures and data management capabilities. Within SME focused adoption models, organizational readiness and external support function as infrastructural enablers at the

organizational level. Organizational readiness is defined to encompass leadership, employees, culture, infrastructure, and processes that together determine whether a firm can effectively adopt and leverage AI technologies. High readiness ensures alignment with business strategy, robust data management, and suitable technical infrastructure, all of which support improved efficiency and decision making. External support packages expertize, technical assistance, customization, data management, training, and continuous services into a complementary resource base that allows SMEs to access and operate AI tools they could not build alone. These forms of support compensate for internal resource and capability gaps, enabling SMEs to develop the infrastructural conditions required for AI adoption and to convert abstract technological potential into operational tools that enhance performance (2).

3.2. Data Management

Data practices underpin many of the AI functionalities documented in SME and platform contexts, linking data collection, storage, and analysis directly to operational and customer facing outcomes. At PrestaShop, the creation of a Data Strategy Team and subsequent restructuring of the platform explicitly targeted systematic data capture and analytics, which later supported AI based automation in ecosystem monitoring and decision making. Machine learning integration in the customer support system relied on historical user data to reduce average ticket resolution time and deliver content dynamically based on user profiles and behavior. These same data resources fed Looker dashboards that allowed managers to identify profitable merchant clusters and reallocate resources strategically, illustrating how curated datasets become central to AI enabled decision support and market segmentation (5). Measurement models in Jordanian consumer industries operationalize data related constructs that implicitly assume robust data management capabilities. Items describing AI applications emphasize enhanced and personalized customer experiences, prediction of consumer behavior, and the provision of relevant solutions, all of which depend on access to reliable behavioral data. Constructs for business performance refer to AI tools that build customer profiles, personalize experiences, and improve efficiency, again presupposing systematic data collection and processing. Additional indicators highlight that Jordanian organizations use AI to analyze customer data for market insights and to monitor buying behaviors and supply chains, while simultaneously underscoring that data security issues are a major constraint and that quality data networks are essential for realizing AI benefits. These scales position data security and network quality as integral components of the broader data management environment required for AI driven personalization, operational efficiency, and performance improvements (1). Organizational level enablers of AI adoption in SMEs incorporate data management within wider readiness constructs. In Sabah, organizational readiness is defined through leadership, employees, culture, infrastructure, and processes, a configuration that includes the technical and procedural arrangements needed to manage data effectively. High levels of readiness are described as ensuring alignment between AI technologies and business strategy and as providing the necessary technical infrastructure for data handling. External support captures complementary resources such as data management expertize, technical assistance, and training, which help SMEs that lack internal capacity to

build and operate appropriate data systems. Construct validity assessments for these factors report high average variance extracted and composite reliability for organizational readiness and AI adoption measures, suggesting that data related capabilities are statistically coherent elements of the readiness construct (2). Open source platform research offers a detailed view of how governance and architecture shape data management for AI. For PrestaShop, decentralised user controlled infrastructures initially limited data access, compelling a redesign of business model architecture to enable data collection and harmonisation before AI could be scaled. Studies on this case describe a staged trajectory in which data readiness for AI integration involved restructuring the platform for analytics, followed by a phase where AI acted as a trigger for ecosystem mapping, market segmentation, and merchant expert matchmaking. Subsequent phases treated AI as a driver and enabler, with data informed market intelligence guiding strategic focus on particular merchant segments and supporting development of new offerings such as subscription based enterprise distributions. Across these stages, data architecture, governance mechanisms, and tools like CloudSync and analytics specialists are identified as essential for transforming fragmented, decentralised data into a managed resource base that supports AI enabled personalisation, targeting, and scalable value creation (3,5).

4. AI Applications for Small Business Solutions

4.1. Operational Efficiency

Operational outcomes linked to AI applications are described in terms of automation, error reduction, and process streamlining, particularly in consumer industries that resemble many small business environments. AI technologies are reported to perform automated processes within technical and administrative domains, enhancing business processes and reducing human errors. Organizations using AI have documented improvements in inventory management, fraud identification, marketing process automation, and risk evaluation. AI driven analytics are described as operating on real time processing of large data volumes, which supports faster and more precise business decisions and contributes to productivity gains in manufacturing and service functions. In administrative departments, AI assists in reducing mistakes and simplifying operations, which can raise manufacturing productivity and decrease implementation time and cost for services. Empirical models that measure operational efficiency in Jordanian consumer industries further specify how AI functions are associated with efficiency indicators. One construct defines operational efficiency through items such as AI minimizing errors and simplifying processes in administrative work, enhancing production, and improving efficiency by reducing costs and delivery times. Additional items reference global financial sector experiences, where AI contributes to efficient loan processing and fraud detection, while noting that adoption in Jordan's finance sector remains slow because of regulatory concerns and investment requirements. These measurement items collectively embed AI supported error reduction, cost savings, and time compression within a broader efficiency framework that links automation and analytics to improved operational performance. Global assessments of AI's efficiency effects extend beyond single sectors. Drawing on resource based view arguments, one account reports that about 30% of AI based efficiency improvements are reflected directly in improved business results, connecting process optimization to

financial performance outcomes. Operational efficiency is framed as producing high quality outputs at lower production costs relative to competitors, with AI enabled automation, refined resource distribution, and coordinated partnerships contributing to process improvement. Infrastructure upgrades that remove bottlenecks and other inefficient behaviors are highlighted as complementary interventions that, together with AI, streamline operations. Within this perspective, process improvement, automatization of services, and optimized resource allocation are treated as central mechanisms through which AI supported efficiency underpins marketplace performance and sustainability goals. Findings from Jordanian consumer industries also reveal contextual constraints that shape whether such efficiency gains materialize locally. Regulatory barriers and limited technical infrastructure are identified as obstacles for firms seeking to translate globally observed efficiency benefits into domestic results. Operational efficiency did not exhibit a direct, statistically strong influence on business performance in one structural model, despite being conceptually important for organizational success. This pattern is interpreted as implying that efficiency improvements alone may be insufficient without additional strategies related to consumer trust and engagement. Nonetheless, companies that deploy AI systems to make predictions about markets, prices, and supply chains are described as experiencing increased operational efficiency and more informed decision making, suggesting that predictive analytics can still yield meaningful process gains even in constrained environments. Overall, research on Jordanian and international settings situates AI enabled operational efficiency at the intersection of automation, predictive analytics, infrastructural conditions, and complementary customer focused strategies (1).

4.2.Customer Engagement

AI driven customer interfaces such as chatbots, virtual assistants, and call center conversational systems are positioned as central mechanisms for strengthening ongoing relationships between firms and consumers. These tools provide continuous, 24 / 7 availability, deliver personalized responses, and support rapid resolution of inquiries, which together cultivate higher levels of satisfaction and a more robust relational base. In consumer industries worldwide, such applications enable real time interaction and tailored experiences that shape service quality perceptions and deepen engagement. However, empirical work focused on Jordan reports that current implementations in local firms and banks do not yet reach international standards of consumer engagement, pointing to a gap between technological possibilities and realized practice in this context. Measurement constructs for customer engagement in Jordanian consumer industries operationalize these ideas in more detail. Items in the structural model capture beliefs that AI strengthens customer relations through chatbots, virtual assistants, and call center interfaces, that AI chatbots provide 24 / 7 support and improve customer service, and that such tools are increasingly adopted by Jordanian banks and firms. At the same time, other items acknowledge that chatbot adoption lags behind global benchmarks and is slowed by regulatory and investment challenges. This configuration of indicators reflects both the perceived engagement benefits of AI mediated interaction and the structural frictions that temper diffusion and limit the intensity of customer engagement gains at present. Conceptual sections in the same study frame customer engagement as a key

determinant of business performance. Engaged customers are more likely to repurchase, remain loyal to a brand, and disseminate positive word of mouth, thereby providing behavioral information that helps firms optimize marketing strategies and increase satisfaction. Within a resource-based view perspective, such engagement is characterized as an intangible strategic asset that can sustain high levels of performance results, while technology acceptance arguments imply that consumers will use engagement tools when they perceive them as useful and easy to use. Findings also caution that negative experiences with AI personalization, particularly when recommendations are perceived as inappropriate or overly invasive, can produce adverse engagement outcomes, underscoring the need to balance personalization intensity with ethical and contextual sensitivity. Research on AI marketing in Jordan broadens this picture by situating customer engagement within a wider digital communication environment. AI marketing solutions integrating machine learning, predictive analytics, natural language processing, and automated customer service systems are described as streamlining operations and reshaping business to consumer communication patterns. These systems enable access to behavioral data that supports individualized marketing approaches, while recommendation engines in e commerce contexts generate personalized suggestions from historical behavior and stated preferences. Continuous chatbot availability combined with customer service functions is associated with improved satisfaction and contributes to enhanced loyalty and communication quality, although overall empirical coverage of engagement tactics in Jordan remains limited and context specific constraints such as data privacy concerns and cultural sensitivity issues are identified as barriers to broader acceptance. Within this evidence base, customer engagement appears as a multi dimensional construct shaped by interaction frequency, perceived service quality, personalization experiences, and underlying trust in AI applications. AI powered interfaces can provide meaningful relational benefits when they deliver convenient, responsive, and culturally appropriate services, yet their impact depends on local regulatory environments, investment capacities, and consumer attitudes toward data security and automation. Consequently, firms in contexts such as Jordan face the dual task of deploying AI tools that technically enable rich engagement while simultaneously addressing the attitudinal and institutional factors that condition whether consumers will embrace these modes of interaction (1).

5. Organizational Capabilities for AI Integration

5.1. Leadership and Vision

Strategic support from owners and top managers plays a decisive role in whether AI initiatives are legitimized, resourced, and sustained in smaller organizations. In SME contexts, top management commitment is defined as the degree of support and dedication that senior decision makers provide to initiatives such as AI adoption, shaping long term direction, market choices, and technology investments. Empirical work associates this commitment with recognition of AI's potential, overcoming resistance to change, and ensuring that AI is leveraged as a strategic tool to enhance decision making, competitiveness, and overall performance. Without explicit endorsement and resource allocation from senior leaders, AI initiatives are unlikely to progress beyond exploratory stages or to be integrated into core business processes (2,3). Leadership support has been examined in more depth

in family business settings, where governance structures and socioemotional priorities intensify its importance for AI driven innovation. In these firms, leaders often occupy dual roles as family members and business professionals, and their stance toward AI is central to reconciling technological change with family values and long term goals. Leadership support legitimizes AI projects, aligns them with concerns about control and legacy, and guides decisions about investing in technological infrastructure and human capital. Conceptual analyses identify leadership support as one of five critical antecedents of AI adoption in family businesses, alongside technological readiness, cultural openness, organizational agility, and knowledge management, all of which form the premises for innovation when combined with appropriate capabilities. Dynamic Capabilities Theory offers a structured lens to explain how leadership and vision translate into innovation outcomes in such contexts. Dynamic capabilities are conceptualized as higher order processes of sensing, seizing, and transforming that allow firms to integrate, build, and reconfigure internal and external competencies under environmental uncertainty. For family firms pursuing AI initiatives, dynamic capabilities mediate the connection between leadership support and innovation capabilities, ensuring that strategic intent is operationalized through resource reallocation, experimentation, and continuous adjustment. A specific proposition advances that dynamic capabilities make leadership support actionable, linking leaders' vision, strategic decisions, and resource commitments to concrete innovation capabilities rather than static technology acquisition. This capability perspective implies that vision alone is insufficient. Leaders need to foster sensing activities that monitor technological trends and customer needs, seizing behaviors that mobilize resources into pilot AI projects, and transforming actions that reconfigure routines and roles to embed AI in everyday operations. Conceptual frameworks developed for family firms argue that, in the absence of these dynamic processes, AI is likely to be implemented in a generic manner that fails to unlock its full potential, resulting in underutilized technologies and limited innovation outcomes. Conversely, when leadership vision is combined with systematic efforts to cultivate dynamic capabilities, AI related antecedents such as technological infrastructure, cultural openness, and knowledge management can be converted into sustained innovation capabilities over time (6). Parallel work on SMEs more broadly reinforces the centrality of leadership vision by framing digital leadership as an internal antecedent of AI adoption and business model adaptation. Digital leaders with a strong belief in technology's potential and a clear vision for its role in strategy are described as enabling SMEs to adjust their business models, coordinate resources, and engage with complementary technologies such as big data analytics, particularly under conditions of technological turbulence and post crisis adjustment. In this stream, leadership oriented toward digital transformation is linked to the ability to detect and seize AI related opportunities, rearrange capabilities via digital platforms, and orchestrate gradual but continuous changes in business models that sustain competitiveness in an AI influenced environment (3). Across these strands, research shows that effective leadership and a forward looking vision function as integrating mechanisms that connect AI adoption decisions with organizational capabilities and long term competitive positioning. Leaders who articulate clear AI related goals, align them with broader strategic and socioemotional objectives, and invest in the development of

dynamic capabilities create conditions under which AI can move from isolated tools to drivers of innovation and performance in small and family owned enterprises (2,3,6).

5.2. Workforce Skills

Developing appropriate workforce capabilities is repeatedly identified as a decisive condition for effective AI adoption in small and medium sized enterprises. Employee adaptability is defined as an individual's ability to adjust and thrive in changing work environments, encompassing flexibility, open mindedness, and a willingness to learn new technologies, processes, and roles. In SME settings, such adaptability is considered crucial because these firms often operate in dynamic and competitive markets that demand continuous adjustment. AI technologies in areas such as automation, machine learning, and data analytics can streamline processes, improve productivity, and enhance decision making, but their benefits depend on employees being able to integrate these tools into their work. Staff who possess strong adaptability skills can quickly learn how to use AI tools, reconfigure their job roles to collaborate with AI systems, and acquire new skills as needed. They are described as embracing the changes and opportunities introduced by AI and contributing directly to the successful implementation and utilization of AI technologies within their organizations. This focus on adaptability is formalized in SME adoption models that articulate a specific hypothesis: employee adaptability significantly influences the adoption of AI technologies. Within these models, the relationship between adaptability and AI integration is treated as mutually dependent, with adaptable staff facilitating implementation and AI driven changes in turn requiring further adaptation. Empirical constructs for employee adaptability are operationalized through reflective measurement models that capture dimensions such as flexibility and readiness to learn. Reported factor loadings for adaptability items range from 0.696 to 0.872, with an average variance extracted of 0.641 and composite reliability of 0.877, indicating that the underlying construct is reliably measured and conceptually coherent in the context of AI adoption. Discriminant validity assessments using the Heterotrait Monotrait ratio of correlations show that adaptability is distinct from, yet related to, other antecedents such as competitive pressure, external support, organizational readiness, and top management commitment. These psychometric results substantiate the argument that adaptability represents a specific workforce capability that meaningfully shapes AI uptake in SMEs (2). Alongside adaptability, broader workforce skills in technological and managerial domains emerge as central levers for AI integration. Analyses of organizational readiness for AI stress that changes in work processes, roles, and responsibilities accompany adoption, requiring clear communication, training, and support so that employees understand benefits and feel prepared to adjust to new ways of working. Practical guidance includes evaluating existing skill gaps and investing in training initiatives that enhance proficiencies in programming, machine learning, and data analysis. These recommendations position technical skills as part of a wider readiness package that also involves cultivating a culture of continuous improvement and collaboration. Research on top management commitment complements this view by arguing that senior leaders should prioritize the development and training of employees in relevant technological and managerial competencies to ensure the workforce can effectively utilize AI technologies. Upskilling and reskilling opportunities are framed as

necessary conditions for realizing AI's potential, with workforce capabilities explicitly linked to improved decision making, efficiency, and performance outcomes. In this perspective, organizational readiness, leadership commitment, and employee skills are intertwined: readiness initiatives must include structured capacity building, and leadership support is critical for allocating resources to systematic workforce development that aligns with AI related strategic objectives (2,3).

6. Conclusion

The synthesis highlights a consistent pattern: artificial intelligence can enhance small and medium sized enterprises by improving operational processes, enriching customer interactions, and supporting more data driven decision making, but realizing these benefits depends on a combination of technical, organizational, and institutional conditions.

On the technical side, systematic data collection, harmonized architectures, and analytics pipelines are prerequisites for advanced AI functions. Platform level actions such as creating a dedicated data strategy team, redesigning decentralized data governance, and implementing analytics tools enable progressive stages of adoption , from data readiness and pilot services to scaled AI offerings and market intelligence. Practical examples show that machine learning embedded in customer support and dashboarding tools can shorten ticket resolution times and reveal profitable merchant segments when underlying data flows are mature and coherent.

Data management practices are central. Curated historical data, secure networks, and governance mechanisms permit personalization, prediction, and automation. Where data architectures remain fragmented, firms face barriers to model training, monitoring, and scaling. External assistance that supplies data engineering expertise, cloud syncing tools, and analytics specialists can bridge capacity gaps for smaller firms that lack inhouse resources.

Operational impacts arise through automation, error reduction, and predictive analytics. Use cases include inventory optimization, fraud detection, and streamlined administrative workflows. Yet process improvements do not automatically translate into superior business outcomes without complementary strategies that address consumer trust and engagement. Evidence shows that predictive systems can raise efficiency and informed decision making, but contextual constraints such as regulation and infrastructural limits can mute direct performance gains.

Customer engagement benefits from AI mediated interfaces like chatbots and virtual assistants, which provide round the clock response and personalized interactions that can boost satisfaction and loyalty. Adoption levels and service quality vary by setting; in some markets implementations lag behind international standards due to investment, regulatory, and cultural factors. Careful balancing of personalization intensity with privacy sensitivity and ethical design remains necessary to avoid adverse reactions to intrusive or inappropriate recommendations.

Organizational capabilities determine whether technology delivers value. Leadership commitment and a clear strategic vision are necessary to legitimize AI initiatives, allocate resources, and guide integration into business models. In family owned and small firms, leaders must combine strategic intent with dynamic capabilities that sense opportunities, mobilize resources into pilots, and transform routines and roles so AI is embedded rather than isolated. Workforce skills complement leadership: employee adaptability, continuous training, and

targeted upskilling in data and analytics correlate with higher adoption. Measurement evidence indicates that adaptability is a reliable construct within adoption models (item loadings in the 0.696–0.872 range, average variance extracted around 0.641, and composite reliability near 0.877), and it is distinct from other antecedents such as competitive pressure and external support.

External support emerges repeatedly as a compensatory mechanism for resource constrained SMEs. Consulting services, technical assistance, customization, and ongoing training enable firms to access capabilities they cannot build alone and to progress through staged adoption trajectories. Policy and ecosystem actors can amplify these effects by improving digital infrastructure, clarifying regulatory expectations, and subsidizing capacity building where appropriate.

Regional evidence underscores heterogeneity in adoption. Some settings exhibit proactive platform led transformations that reconfigure data architectures and produce measurable operational improvements, while others exhibit slow uptake caused by low awareness, limited resources, and regulatory caution. Research gaps remain, particularly regarding the role of generative AI and sustainability oriented applications in smaller firms, and more context sensitive empirical work is required to map sectoral differences and long term performance impacts.

Practical implications follow from these findings: prioritize data readiness before large scale AI investments; sequence adoption through pilot projects tied to measurable outcomes; align senior leadership, workforce development, and IT governance; and leverage external partners to compensate for capability shortfalls. Attention to privacy, ethical design, and culturally appropriate engagement practices will support customer acceptance and long-term value realization.

Future investigations should emphasize longitudinal case studies, comparative analysis across sectors and regions, and evaluation of newer AI modalities in small firm settings. By combining technological investments with organizational development and supportive external ecosystems, small and medium sized enterprises can move from isolated experiments to sustained, measurable improvements in efficiency, customer relations, and strategic agility.

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