Digital Transformation and AI Adoption in Small and Medium-sized Enterprises: Business Model Innovation, Costs and Benefits, and Implementation Barriers

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Abstract

There's a great pressure on SMEs for digital transformation. In this perspective, the integration of AI technology can streamline operations, enhance customer insights, and enable personalized services. In addition, the pandemic created by COVID-19 accelerated the tendency of business sectors to adopt AI. SMEs can gain a competitive advantage by adopting AI in business operations. Despite the opportunities that AI poses, small businesses are slow in the AI adoption process. Therefore, in this situation, it is significant to analyze the challenges concerning resistance to change, limited availability of human resources, etc., of SMEs adopting AI. According to a recent Microsoft Asia AI Adoption report, nearly half of all Asian and small businesses say the significant concerns are about AI-led current issues and concerns. In addition to investing in the company's AI strategy, creating an AI governance framework, and establishing collaboration with the AI partner, it is also important to have sufficient data and quality. SMEs are slow in AI adoption. Despite this, when it comes to the share of SMEs, they are large in numbers. Therefore, it is suggested to create a tailored roadmap for technology adoption with the support of the government. In order for a company to support each other and share infrastructure, it is necessary to have a cooperative ecosystem. However, for SMEs that have a shortage of manpower, it is recommended to set the milestone for the AI journey to achieve a given goal. AI is limited in developing countries like Southeast Asia. Therefore, there are several policies to help tailor companies in terms of lack of financial resources policy or to establish a public-private partnership that openly collaborates and exchanges knowledge and share investment risks. These suggestions are a small step to help SMEs digital transformation successfully. However, overcoming these barriers is essential for business growth and resilience and will allow SMEs to lead innovation in the marketplace.

Keywords: Digital Transformation, Artificial Intelligence, Small & Medium Enterprise, Innovation, Business Models

1. Introduction

Digital transformation affects all businesses, but small and medium-sized enterprises (SMEs) face unique challenges. SMEs that embrace digital transformation strengthen their competitiveness in an increasingly volatile environment. Adopting smart technologies, such as artificial intelligence (AI), is essential for driving digital transformation. Digital transformation requires a change in how an

organization creates and captures value; therefore, organizations need to rethink their business model and consider new and emerging technologies, trends, and disruptive forces.

AI can be observed across a wide array of existing technologies, ranging from cloud computing platforms to advanced big data solutions, and it fundamentally alters the way businesses operate, and how individuals engage and interact with those organizations. The rapid growth of pervasive smart devices, the widespread presence of various social networks, and the extensive monitoring of customer interactions on a massive scale significantly enhance the overall value of business activities that are meticulously constructed from data.

This intelligent integration of AI not only streamlines operational processes but also delivers deeper insights into customer behavior, ultimately leading to more personalized services and improved customer experiences that truly resonate with users. As businesses strategically leverage these groundbreaking advancements in technology, they create innovative and forward-thinking strategies based on the wealth of rich information gathered through these interactions, resulting in more effective engagement with their target audiences.

2. Conceptual Framework

Digital transformation signifies comprehensive repurposing and reimagining of an organization's operations and asset deployment prompted by digital advancements (Lu, Wijayaratna, Huang, & Qiu, 2022). Digital acceleration gained urgency during the COVID-19 pandemic, forcing businesses worldwide to adeptly adopt digital-based solutions to remain competitive. Firms undertaking digital transformation embrace new technologies and tools, evolve digitally-focused modes of operation, and advance their utter product and service offerings. Such transformation remains pivotal to small and medium-sized enterprises (SMEs) because it directly influences their survival and growth.

2.1. Digital Transformation in SMEs

Small and medium-sized enterprises (SMEs) encounter a paradox in digital transformation. They recognize the significance of digital technology, yet their progress remains tumultuous. While many enterprises have initiated or completed their transformation, some still await the first steps or have taken premature actions. Moreover, rapid adjustments are limited. Recent studies indicate a trend toward tailored and diversified digital transformation focusing on non-IT products, user experience, and workplace satisfaction (Lu, Wijayaratna, Huang, & Qiu, 2022). A similar pattern emerges with the introduction of artificial intelligence (AI). Specifically for SMEs, digital transformation and AI adoption coexist as the same process.

Digital transformation fosters innovation in processes, operations, and business models by harnessing existing digital capabilities and learning new ones. Likewise, AI adoption cultivates entrepreneurship that transforms industries and enhances the availability of novel products, services, and operational modes within local and value-added supply chains. Consequently, digital transformation evolves into AI adoption, extending the original twelve capabilities to the new six capabilities unique to AI. For SMEs, AI penetrates an enterprise alongside digital assets, evolving from one capability to acquire additional assets and capabilities. The significance of understanding, defining, and assessing the AI adoption process equates to that of the more commonly recognized digital transformation. (Singh, Khan, Joshi, Katragadda, & Kumar, 2026).

The Internet, Big Data, and Cloud Computing have reshaped the traditional way of industry, especially for small and medium-sized enterprises (SMEs). The concept of "digital transformation" has

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captured the attention of scholars, practitioners, and policymakers. A growing number of small and medium-sized enterprises (SMEs) are actively embarking on the journey of digital transformation, including the adoption of AI in business operation and management activities. Digital transformation is a concept closely related to "Industry 4.0" and the ongoing changes brought by digital technologies.

2.2. Artificial Intelligence and Its Roles in SME Transformation

Artificial Intelligence (AI) has emerged as an engine of transformation across diverse sectors and has particularly accelerated the digital transition of Small and Medium-sized Enterprises (SMEs) during the COVID-19 pandemic (Lu, Wijayaratna, Huang, & Qiu, 2022). AI integrates cutting-edge technologies such as Machine Learning (ML), Natural Language Processing (NLP), Expert Systems, Image Processing, and many others. Its adoption requires businesses to consider not only technical aspects but also organizational changes related to strategy, processes, structures, and culture. AI offers substantial SMEs transformation opportunities but its implementation is both complex and multidimensional. AI capabilities must be integrated into core business processes, complemented by architecture, data foundation, skills, and resources, before it can support scalable value generation and growth. Before addressing AI-specific issues, SMEs must systematically assess their current digital maturity.

The World Economic Forum recently identified five global megatrends reshaping the operating landscape of SMEs: (1) demographic and social factors, (2) rapid urbanization, (3) artificial intelligence and robotics, (4) climate change and resource scarcity, and (5) digital communication and connectivity. Taking individual opportunities afforded by these megatrends can create incremental value, whereas tackling a combination of them through digital transformation may yield significantly greater competitive advantage. Candidates for AI application within SMEs include marketing, operation, and product opportunities. Marketing tasks around pricing optimization, promotional adjustment, and customer grouping can generate rapid returns to fuel further AI investments. Operational opportunities such as inventory management, delivery scheduling, and demand forecasting facilitate enhanced productivity and trigger follow-on opportunities in other functional areas. Product-related opportunities tend to commandeer larger investments and entail greater risk but can build long-term customer relationships and diversify revenue streams. (Usman, Kess-Momoh, Ibeh, Elufioye, Ilojianya, & Oyeyemi, 2024).

AI adoption hinges on high-quality data—the principal enabler of digital transformation—across the information ecosystem. Stakeholders involved in value co-creation must participate in data sharing and dissemination. Nevertheless, 57% of newly founded industrial enterprises experience data-sharing difficulties. SMEs frequently lack the capability and willingness to engage in data sharing with partners, which represents an additional obstacle to AI uptake. Policy-makers play a crucial role in enhancing the digital ecosystem of small enterprises by creating venues for collaboration, addressing cooperation needs through financing, and promoting high-quality data circulation. (Jussen, Möller, Schweihoff, Gieß, Giussani, & Otto, 2024).

2.3. Business Model Innovation in the Digital Era

In recent years, the concept of business model innovation has gained increasing relevance in academic research and practical management. Along with the emergence of the disruption and innovation paradigm, the study of business models became one of the hottest areas of research in

management science. As a result, the link between business models and business model innovation is majorly growing, especially with the rise of smart business models due to disruptive technologies such as artificial intelligence and ubiquitous computing, the demand for alternative revenue models, and fast changing regulatory environments (E Cuc & Miina, 2018). Business model and business model innovation are even more relevant to SME digital transformation as they not only act as entry points but also manifest managerial focus. Moreover, strong relationship exists between digital transformation and business model innovation. Enhanced appropriability due to digital transformation spurs incumbents to seek the introduction of new business models to capture value from radical innovation (D'Ippolito, Messeni Petruzzelli, & Panniello, 2019).

3. Benefits and Costs of AI Adoption in SMEs

Small and Medium-sized Enterprises (SMEs) have adopted Artificial Intelligence (AI) technologies and Artificial Intelligence of Things (AIoT) to ensure business sustainability and create a competitive edge in the market of micro, small, and medium-sized enterprises for their post-pandemic business activities. SMEs face several challenges regarding the AI transformation process. A review of AI-enabled opportunities and transformation challenges for SMEs highlights the benefits of AI adoption and its implementation hurdles for firms in the post-pandemic digital environment. The article by Lu et al. (2022) offers important insights. (Farmanesh, Solati Dehkordi, Vehbi, & Chavali, 2025).

The adoption of Artificial Intelligence (AI) technologies and Artificial Intelligence of Things (AIoT) by small and medium-sized enterprises (SMEs) to ensure business sustainability and create a competitive advantage in that same market has a considerable impact on their ability to further develop the digital transformation process within the firms targeted towards reinstating the pre-pandemic operations upon emergence from the various lockdown restrictions brought on by the COVID-19 pandemic. SMEs face significant challenges throughout the AI transformation process that impede enterprise expansion through the technology adoption of such advanced technologies; this dilemma has been reviewed in a comprehensive article that discusses the nature of post-pandemic and digital transformation-based AI-enabled opportunities and transformation challenges for SMEs, providing valuable insights on the advantages and barriers of AI adoption for firms in the current transformative digital environment. (Lu, Wijayaratna, Huang, & Qiu, 2022).

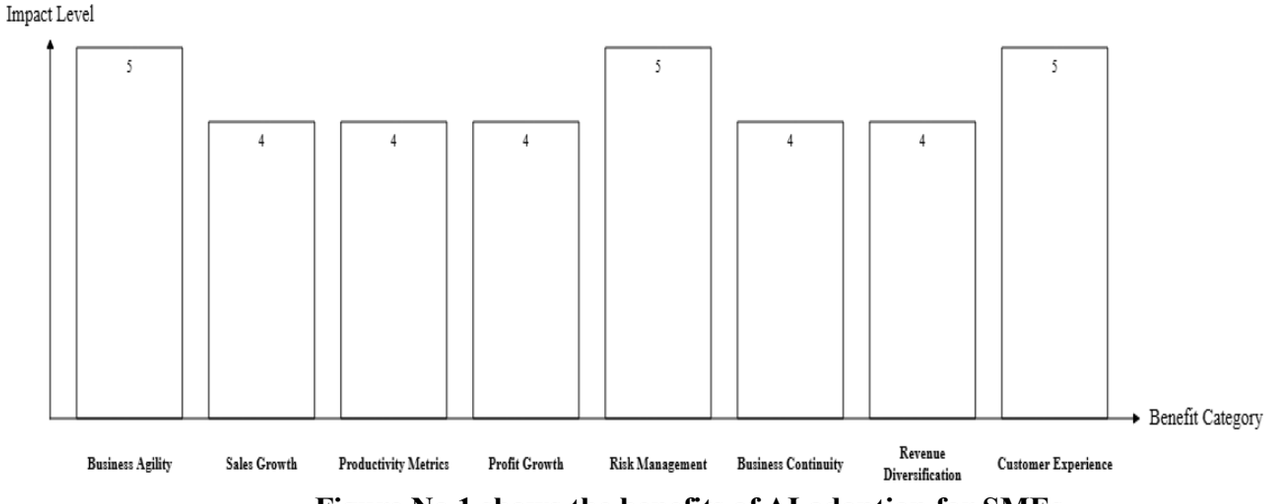

Figure No.1 shows the benefits of AI adoption for SMEs

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The figure demonstrates that: Business Agility, Risk Management, and Customer Experience are perceived as the most influential benefit areas (Impact Level = 5). Other categories such as sales growth, productivity, profit growth, business continuity, and revenue diversification also show strong positive impact (Impact Level = 4). Overall, the figure suggests that AI or digital transformation initiatives generate broad organizational benefits across operational, financial, strategic, and customer-oriented dimensions

Besides business agility and responsiveness to demand shifts, SMEs seek to gain advantage from AI adoption through improvements in performance measures such as sales growth, productivity metrics (in sales per employee, output per hour, etc.) and profit growth, prolonging competitive advantage and justifying the adoption cost. AI adoption is also pursued to structure operational activities based on real-time and predictive insights that help manage risks, eliminate bottlenecks and apply appropriate preventive maintenance, thereby increasing business continuity and supporting compliance. AI has the potential to further diversify revenue streams and income sources to stabilize cash flows, through implementing new distribution channels and improving customer experience as well as through reorganization of pricing. Preventive credit control policies, loan requests, financial reporting and newly required risk analysis are thus enabled to cope with its usage (Lu, Wijayaratna, Huang, & Qiu, 2022).

3.1. Performance Gains and Competitive Advantage

The introduction of AI capabilities brings not only considerable automation but also enhanced analytical capabilities to organizations. The research on large language models demonstrates that systems trained on large datasets can perform tasks similar to earlier AI approaches while requiring much shorter and less organized input instructions, achieving robust results (Lu, Wijayaratna, Huang, & Qiu, 2022). In the past, prior to the availability of data, SMEs were unable to utilize AI. AI-driven business models enable organizations to reduce costs, improve service quality, coordination, productivity, and delivery efficiency.

The advances in AI allow organizations to transition from a product-centric model, which focused on the primary product and its services, to more advanced digital business models capable of delivering higher value. Digital technologies like AI support organizations in creating value from new revenue streams, helping customers achieve desired results. For instance, digital innovation enables suppliers to monitor and analyze the performance of physical equipment installed in customers' premises and to provide enhanced digital customer service, permitting on-site optimization, and improved process productivity. AI automation facilitates the management of large datasets to recommend subsequent actions and to make autonomous decisions. Although SMEs, due to limited resources, find it difficult to develop extensive AI capabilities, organizations can nevertheless still use AI as an important enabler for business model innovation. (Himeur, et al., 2022).

3.2. Operational Efficiency and Cost Structures

The digital transformation of small and medium-sized enterprises is designed not just for mere survival in the competitive market but also to enable these businesses to realize and attain a broader spectrum of advantages and opportunities. Traditional concerns related to business operations often act as significant barriers to successful transformation, making it crucial to address these issues head-on. The integration of digital transformation with big data technology is fundamental in facilitating

intelligent and effective management practices. This transformation empowers management to attain a much higher level of cost efficiency and effectiveness while simultaneously redefining and enhancing capital management strategies. By embracing this fusion, small and medium-sized enterprises can navigate challenges more adeptly and capitalize on new avenues for growth and innovation. (Krishnan, 2024).

3.3. Revenue Diversification and Customer Experience

AI adoption enables revenue diversification via the development of new business models and improved customer experience through better service standards and personalized solutions (Lu, Wijayaratna, Huang, & Qiu, 2022).

By adopting AI models similar/relevant to competitors, firms can create platforms that provide comprehensive services and become dedicated partners, offering tailored solutions in real time while generating substantial additional revenue. AI facilitates the implementation of customer relationship management and sales-management systems, financial-analysis systems, and recommendation engines. Specific customer and supplier information is crucial for marketing activities that collect, analyze, and utilize customer feedback and suggest appropriate products to interested customers via emails. The use of AI makes it possible to build a solid information base on core customers, enabling better marketing of packaged/after-sale services and enhancing value-added services. (Ugbaja, Nwabekee, Owobu, & Abieba, 2024).

3.4. Investment Requirements and Financial Implications

Digital technologies play a crucial role in assisting both creative and strategic work across various industries. However, high financial barriers can significantly impede small and medium-sized enterprises (SMEs) from opting for advanced artificial intelligence technologies like machine learning and natural language processing. Presently, investees who are supported by partner firms, affiliates, and private enterprises are regarded as the preferred choice in navigating this complex landscape. The emergence of AI-enabled intelligent devices, sophisticated sensor networks, and advanced robotics has the potential to spark a new wave of industrial innovation that can transform how businesses operate. Additionally, the establishment of complementary digital technologies, such as cloud computing and the roll-out of 5G networks, is set to enhance AI creativity and functionality in these new industrial scenarios, fostering unprecedented growth and opportunities for innovation. (Iyelolu, Agu, Idemudia, & Ijomah, 2024).

4. Implementation Barriers and Enablers

According to Lu et al. (2022), the implementation of Artificial Intelligence (AI) in small and medium-sized enterprises (SMEs) can be influenced by several factors. The barriers and enablers recognised in the literature include:

Organizational and cultural barriers: Organizational and cultural aspects, such as resistance to change, difficulty identifying adoption paths, lack of internal champions, poor strategic alignment, and lack of trust in new technologies, can affect AI implementation decisions.

Resource and capability constraints: Most studies identified insufficient financial resources and a shortage of adequate talent and skills as major adoption barriers. A lack of focus on AI, inadequate technologies, insufficient cooperation with external organizations, and immature technology solutions were cited as additional obstacles.

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Data, privacy, and security considerations: Data quality, accessibility, privacy, and security significantly impact AI adoption across various industries. SMEs with higher confidence in data quality, easy data integration, and data-sharing technologies are more likely to adopt.

Technology selection, integration, and scalability: Several industries encountered difficulties selecting and integrating an appropriate technology or platform, together with obtaining requisite data and capabilities. Emerging AI technologies and fast-evolving technologies make appropriate technology selection challenging. companies need to ensure that the solutions they choose can grow with their business.

External and regulatory influences: External factors, such as government or regulatory influence, dominant customers in the supply chain, free tools, and evolving technologies, play a positive role in AI adoption. However, regulations on data sharing, usage, and privacy can constrain implementation decisions, especially in sensitive sectors, especially in sensitive sectors (Lu, Wijayaratna, Huang, & Qiu, 2022).

4.1. Organizational and Cultural Barriers

Digital transformation in SMEs comprises using digital technologies to create value-added products and processes and improve decision-making and customer service. Despite its advantages, internal and external organisational and cultural barriers can obstruct adopting such initiatives (Lokuge & Duan, 2023). Finding a fit-for-purpose blend of tools and capabilities, whether in-house or with an AI partner, is essential. Integration with existing workflows and identifying where AI adds value are crucial steps, as is establishing human–AI collaboration. Building an open organisational culture and trust in AI enhances learning and maximises its potential. Success hinges on clear vision and commitment throughout the organisation and on identifying relevant uses that deliver business value, address key processes, and have sufficient data (Terho, 2018).

The understanding that human and social factors are fundamental to developing AI applications has spread from large companies to the wider SME ecosystem. Even in highly competitive sectors like retail and finance, many SMEs anticipate that customer-facing AI will be less important than back-office, supply-side applications. The ability to gather high-quality, high-frequency data is crucial. Given the ad hoc nature of many small companies, long-term planning is unlikely to be rewarded.

4.2. Resource and Capability Constraints

Despite the acknowledged potential of AI in enhancing small and medium-sized enterprises (SMEs), many remain at the pre-adoption stage. Most SMEs fail to successfully integrate AI due to a lack of organisational readiness in terms of human, financial, and material resources. Knowledge and professional skills regarding AI are usually limited, especially among leadership and employees, which constitutes the primary challenge. (Olukoya, Alumona, & Okoro, 2025).

Successful AI transformation requires top management support to navigate the complexities of deployment and to set realistic expectations regarding its capabilities. Unfortunately, many SMEs exhibit minimal awareness of, or maintain unrealistic outlooks toward, AI's true potential. Talent shortages and skill gaps—many practitioners are unclear about the capabilities and procedures required—hinder adoption even among the most prepared. Financial constraints pose another significant obstacle. The high costs and uncertain returns associated with AI projects sometimes lead to the so-called "digital paradox": firms delay implementation despite positive indicators. Advanced

solutions typically entail substantial investment, yet the cash flow of many SMEs remains limited. In the absence of clearly articulated value props, SMEs risk financial strain while seeking to comply with emerging digitalisation strategies. Finally, material resources—especially infrastructure and data—are critical. Many SMEs lack the requisite infrastructure and face difficulties acquiring enough, or sufficiently high-quality, data for successful AI deployment. (Schönberger, 2023)

4.3. Data, Privacy, and Security Considerations

Digital transformation encompasses digital technologies, such as automation, artificial intelligence, and augmented reality, that help to enhance company processes and create new, often digital, service offerings. Effective implementation is, however, challenging; organizations wishing to implement digital technologies are grappling with issues of data security, privacy, and ethics, as well as with a lack of clear strategic roadmaps (Quach, Thaichon, D. Martin, Weaven, & W. Palmatier, 2022).

4.4. Technology Selection, Integration, and Scalability

Aiming for a high level of automation constitutes a common aspiration among small and medium-sized enterprises (SMEs) when embracing artificial intelligence (AI). SMEs typically possess smaller data volumes than large enterprises and seek to concentrate their limited data resources on selected high-value business processes.

Due to their relatively smaller organization size, SMEs also favour the construction of easily integrated AI or digital solutions and require additional external indicators (e.g., protocols, APIs, or services) to identify suitable integration opportunities. Deploying an ad-hoc service or integration model through intermediate platforms becomes feasible by establishing a relatively independent AI business model or digital service first, followed by further integration with other service points. Incrementally enhancing the accessibility of service integration further increases the customer base, explaining the emphasis on upgraded integration services. Expanding basic AI or digital services promotes systematic engagement with service providers and suppliers, easing the acquisition of complementary or industry-specific equipment and resources. (Arroyabe, Arranz, De Arroyabe, & de Arroyabe, 2024).

4.5. External and Regulatory Influences

Many factors outside the company, both on economic and technological matters, influence AI adoption (Lu, Wijayaratna, Huang, & Qiu, 2022). Regulatory frameworks for data privacy, transportation, cyber security, intellectual property protection, taxation, administration burdens and many other fields strongly affect companies' operations. Nevertheless, governmental policy in terms of support, incentives for innovation and technology investments will help eliminate certain barriers for SMEs.

A supportive legal and regulatory framework, both formally and informally operated, is required before AI deployment in SMEs. The selection of technology and partner relationships in AI also depend on the economic and industrial policy of the governmental.

5. Roadmaps and Strategic Pathways for SMEs

A successful AI-enabled transformation depends on the initial assessment of readiness to digitally acquire advanced technologies, prioritizing use cases, and understanding potential return on investment.

Once the enterprise selects a use case, either a radical or a more incremental approach can be taken. The first option suits less mature organizations where everyday operations are still paper-based;

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this strategy develops the use case from scratch, fostering an innovational mindset that builds digital workplace, infrastructure, competence, and culture capabilities. Incremental transformation for a more digitally mature organization focuses on refining existing activities, gradually improving the selected use case with gains from scaled-up outputs reinvested into AI development. Promoting AI adoption requires fostering collaboration between firms and academia, and between companies within a specific supply chain, sharing experimental results and skilling up the entire supplier ecosystem. (Esangbedo, Zhang, Esangbedo, Kone, & Xu, 2024).

5.1. Assessing Readiness and Prioritizing Use Cases

Firms typically initiate their transformation processes by evaluating their current levels of digitalization and establishing a baseline for ADPM. Determining a firm's readiness and suitability for the various types of AI use cases helps prioritize and visualize ADPM opportunities and, more importantly, anticipate potential obstacles. The discrepancies between anticipated benefits relative to costs versus actual outcomes remain significant, magnifying the need for prudent selection and implementing the most opportune, impactful, and simple use cases. Each AI use case is rated according to a standardized quantifying methodology that accounts for consideration dimensions, economic factors, competitor practices, customer preferences, symbiosis with other transformations, and process methodologies. Supportive artificial intelligence applications act as enablers across a broad range of contexts, assisting early-stage firms in identifying valuable opportunities and prospective asymmetric advantages, particularly in high-potential markets. (Drydakis, 2022).

5.2. Incremental versus Radical Transformation

Digitally transformed organizations can emerge from radical, revolutionary change or from evolution and continuous improvements. Four models exist: radical transformation, process-oriented transformation, functionality-oriented transformation, and incremental transformation (Zhang, et al., 2024). Radical transformation radically alters the whole organization by shifting its business model or by majorly revising the organization's strategic objectives and corresponding value proposition. Integrated and seamless end-to-end solutions, comprehensive manufacturing service networks, and global system-integrated supply chains may require such radical changes (Von Leipzig, et al., 2017).

The process-oriented model extends the digital transformation paradigm to processes constituting the entire organization. Multi-Material-Processing and series-production make such an enterprise a benchmark. The functionality-oriented model applies the transformation to all functionalities such as R&D, manufacturing, marketing, and multi-channel selling jointly in pursuit of both digitalization and digitization. Incremental transformation affects a limited scope, either focusing on specific functions along the whole value chain or on individual intercrossed processes or activities.

5.3. Ecosystem Engagement and Partnerships

Most digital transformation initiatives seize the momentum of an ongoing trend. The 2020 pandemic only accelerated existing incentives for organisational and operational change. UK SMEs had already advanced their digital capabilities from 43 percent engagement in late 2018 to 52 percent at the start of 2020. By mid-2021, this level had risen to 63 percent. After the outbreak, 88 percent of UK firms planned one of several forms of digital investment. More than one-third of SMEs scheduled physical-to-digital transformation (statutory and management reporting) and physical-to-digital migration of customer-facing interfaces. The flicker of opportunity in uncertain environments further

encourages creative destruction—using advanced technology to replace long-standing business models (Lu, Wijayaratna, Huang, & Qiu, 2022).

5.4. Governance, Metrics, and Change Management

Management and implementation of transformation processes involve more than just determining the destination; they also encompass identifying the best path towards it, as well as controlling the journey as it takes place. Within SMEs, these topics assume a further level of complexity due to the limitations of resources. The quest for the right governance structure often leads companies to consider the use of external partners, which can be both an enabler and a barrier. Open innovation initiatives may facilitate robust development in use case definition, yet, in practice, there are as many cases of co-development that face barriers as there are of successful ones. (Le, Kunasekaran, & Rasoolimanesh, 2022).

SMEs may also welcome the opportunity to share costs or engage in projects that provide knowledge and skills in an affordable manner; however, clear agreement on the scope of contributions needed, who is to provide them, and how products generated through the initiative can be shared tends to remain a significant hurdle, leading SMEs to prefer to work alone even when an opportunity to collaborate is available. Internally, indicators remain a challenge. The desire to remain focused on value addition, and not solidly on technology advancement, tends to favour the use of high-level metrics alongside the exploration of additional use cases but, consistently pinpointing progress on those strategic indicators proves elusive (Lokuge & Duan, 2023).

6. Case Insights and Empirical Evidence

As we find in Fig. No2, Small and medium-sized enterprises (SMEs) represent 99.9% of the businesses in the European Union. SMEs in the industry and trade sectors of the EU adopted artificial intelligence (AI) tools at a rate of 42% and 37%, respectively. Only 7% of SMEs in Europe adopted AI based on findings from the European Commission small business act survey.

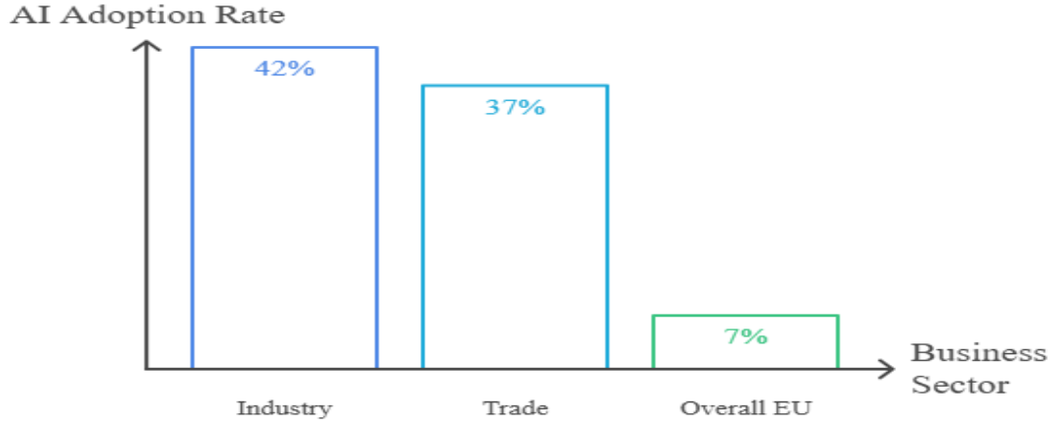

Figure No.2 Shows AI Adoption Rates Among EU SMEs

AI adoption rate among SMEs in Finland is lower than the European average, and entrepreneurship in Finland has been in steady decline since 2020. The adoption of AI and other digital technologies can address the declining entrepreneurship and competitiveness. Understanding companies that have successfully and unsuccessfully adopted AI can provide insight into barriers, capabilities, and environmental aspects of AI implementation within SMEs. (Keränen, 2025).

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6.1. Sectoral Variations in AI Adoption

The findings of a recent survey indicate that the adoption of AI technologies varies across different industries. AI usage in China is relatively high in sectors such as information technology, transportation, instructive industries, resource-sharing industries, automobile manufacturing and retail, medical care, and food manufacturing. In contrast, AI is less prevalent in sectors like banking, public services, and social organizations. These patterns reveal that interest in new technologies may initially arise in emerging areas that emphasize improved production and process efficiency before gradually penetrating traditional industries. Within the population of small and medium-sized enterprises (SMEs), satisfaction with AI adoption is similarly uneven across sectors. For example, SMEs in the health and automobile industries express greater satisfaction with their AI initiatives than their counterparts in the finance, retail, and food sectors. (Khan, Jabeen, Mehmood, Soomro, & Bresciani, 2023).

6.2. Small versus Medium Enterprise Dynamics

Small enterprises tend to move at a faster pace in AI adoption than medium enterprises, especially in retail. Small enterprises are much more likely than medium enterprises to integrate AI into customer interfaces and to deploy AI for enhancing customer experience . Although more benefits from AI applications have been identified for medium enterprises than for small enterprises, small enterprises are more willing to implement AI technologies. Such an inclination is attributed to small enterprises obtaining a holistic view of problems and opportunities when identifying the potential of AI. (Schönberger, 2023)

Adapting to the new normal after a disruption such as the COVID-19 pandemic requires an urgently established presence in an evolving and complex digital ecosystem. Small enterprises are more likely to engage in digital activities to explore the opportunities provided by AI than medium enterprises, thereby potentially leading to higher AI adoption rates. Small enterprises also find it easier than medium enterprises to integrate newly acquired technologies with existing resources. Being large provides medium enterprises with better access to funding for investment, after which several resources can be leveraged across departments to continuously improve digital assets. Medium enterprises favour initiatives that cover a wider scope across the operation pipeline, whereas small enterprises tend to focus on limited and demarcated areas, either in front-end or back-end interactions. (Roman & Rusu, 2022).

6.3. Lessons from Successful and Failed Initiatives

Across countries, sectors, and enterprise sizes, the Covid-19 crisis has prompted many organizations to accelerate the uptake of digital technologies. Digital transformation is the innovative adoption of multiple advanced digital technologies and their systematic application to fundamentally alter an organization’s operations, governance, culture, and business models, among other dimensions. Various studies underscore the important role of digital transformation in creating new business opportunities to recover from the crisis and even thrive under the ensuing economic uncertainty. Small and medium-sized enterprises (SMEs) form the backbone of many economies and are the worst affected by the pandemic on account of their inherent characteristics. Therefore, it is vital to examine their state of digital transformation.

A recent global survey reveals that, compared with large enterprises, SMEs have lower rates of digital transformation across various types of advanced digital technologies. These include Internet of

Things (IoT), big data analytics, artificial intelligence (AI), cloud computing, robots, and cyber security. In parallel, the degree of corporate digital transformation correlates positively with their performance improvement during the pandemic. The AI adoption rate for SMEs is particularly low. In the first half of 2021, only 16 percent of SMEs claimed to have adopted any form of AI, compared with 32 percent of large enterprises. After taking into account multiple influencing factors, small enterprises are found to apply more advanced technologies than medium-sized enterprises. Moreover, the extent of their digital transformation was greater than average in the manufacturing and financial services sectors but lower in resources extraction and retailing (Lokuge & Duan, 2023).

While SMEs' levels of digital transformation and technology adoption are below those of large firms, the pandemic has intensified their need to seek more digital opportunities. A longitudinal case study examined twelve digital transformation initiatives, both successful and unsuccessful, in a small-sized local public transport company from 2010 to 2021. The results indicate that for many medium-sized SMEs a major transformation is within the reach of basic digital opportunities offered by basic technologies and existing business models accepted by customers that are adjacent to an organisation's current domain.

7. Policy and Supportive Ecosystem Implications

Transformation to the digital economy creates new concepts of enterprises, business models, products and services. The global COVID-19 crisis in 2019 catalysed the transformation by accelerating new ways of working, such as activity and location; scaling up more sustainable business models; enhancing labour productivity; intensifying digitalisation; pushing Artificial Intelligence (AI) forward; and growing concern on cybercrimes accordingly (Lu, Wijayaratna, Huang, & Qiu, 2022). Seeking better digital solutions becomes the first priority of enterprises especially for Small and Medium Enterprises (SMEs) to stay competitive and survive. Digital transformation enables SMEs to open up new business channels such as ecommerce, omni-channel sales data, payment transactions, and working from home, all of which help the SMEs continue operation during the crisis. Three typical areas of digital solutions are identified for organisations to build up as follows: digital operations, digital products and services, and digital supply chain.

The digitalisation endeavour of SMEs manifests in improved operational excellence, new business models, enhanced customer experience, and data-driven decision management. A proper move to Digital 3.0 stage is much desired for SMEs to benefit. Artificial Intelligence (AI), a game-changing technology bundle expected to release massive potential, offers a vast frontier of benefits that can elevate enterprises' performance capability to address new challenges appropriately over short timescales. AI is expected to enhance customer engagement, employee productivity, accelerate time to market and develop next-generation business models. A complementary relationship exists between AI and digital transformation to drive significant organisational change. The expansion of digitalisation coverage serves as the foundation to unlock the potential of AI. Digital transformation is essential for an enterprise to secure the first-mover position to explore a brand-new frontier and avoid from embracing disruptive change.

7.1. Policy Interventions to Lower Adoption Barriers

The 2019 Digital Economy and Society Index (DESI) positioned the European Union among the most advanced digital economies. While strengthening its overall position, the latest report highlighted weaknesses in data and artificial intelligence. The 2021 Updated Digital Decade Report stressed the

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necessity of investing in digitalisation for the recovery of the EU economy following the COVID-19 pandemic. Data – the new currency of the digital economy – emerges as a primary driver of the digitalisation of firms, services, and business models, presenting challenges for many micro, small and medium-sized enterprises (SMEs) already affected by economic constraints and increasing energy costs. Measures to boost the availability and sharing of datasets and to address issues around data ownership, quality, security, and interoperability are crucial for the data economy (Lu, Wijayaratna, Huang, & Qiu, 2022).

7.2. Financial Instruments and Risk Mitigation

Many governments recognize that lack of finance is a major obstacle to AI adoption by SMEs entering the digital transformation. Financial assistance can come in many forms, such as grants, investment credits and tax incentives. Various instruments for financial transaction in the EU, such as soft loans, equity financing, guarantees and venture capital, have been successful for practical projects all over Europe as they widen the range of investment possibilities for many projects. Public-private partnerships or multi-level government partnerships can support financial solutions financing financial assistance in a timely manner. (Boonmee, Mangkalakeeree, & Jeong, 2025).

To align with private investment schemes and to facilitate various sectoral SME priority projects such as energy sustainability, the promotion of the digitalisation and decarbonisation investment schemes can be used as an umbrella framework. Government offers substantial project finance, business angel matching-fund setup and private equity funds, all of which enhance the visibility of a project as SMEs entering digitalisation. Supportive public schemes can grant subsidies, technical and training support on project identification and proposal preparation, regulations on procurement and competition. (Lu, Wijayaratna, Huang, & Qiu, 2022).

7.3. Skill Development and Workforce Transition

Digital transformation through the adoption of Artificial Intelligence (AI) constitutes a huge opportunity for Small and Medium-sized Enterprises (SMEs).

AI adoption requires a digital service-oriented business model supported by a high-quality data ecosystem, which is still problematic for SMEs. The gap in AI capabilities and underlying business models conducted by SMEs, requires the collaboration of relevant suppliers as well as governmental and organizational support to the individual enterprises and suppliers which, among others, should include the updating of the legal and regulatory framework. (Schleth, Breu, Kanbach, & Kraus, 2026).

8. Conclusion

Digital transformation has emerged as an essential priority for small- and medium-sized enterprises (SMEs), especially in the wake of the COVID-19 pandemic and the subsequent economic challenges it has created. The importance of adapting to new technologies has never been more apparent, as businesses strive to navigate a rapidly changing landscape. Among these technological advancements, data-driven breakthroughs, particularly in the realm of artificial intelligence (AI), have taken the forefront as top priorities for numerous SMEs. The successful adoption of AI is instrumental in facilitating service-oriented and data-driven transformations, which ultimately helps in generating new forms of economic and social value that can benefit both the enterprises themselves and the communities they serve. However, the journey toward embracing these innovations is not without its challenges. Many SMEs face significant organizational and operational barriers that can impede their

ability to effectively implement AI solutions. Overcoming these hurdles is crucial, as it will not only enhance the resilience and competitiveness of these enterprises but also play a vital role in driving the digital and green transition that is necessary for sustainable growth in the post-pandemic era. By addressing and dismantling these challenges, SMEs can position themselves to thrive amid the ongoing changes in the business environment and contribute to a more sustainable future.

This paper thoroughly investigates the intricate phenomenon through a comprehensive conceptual framework that encompasses three foundational and deeply interconnected constructs—digital transformation, artificial intelligence (AI), and business model innovation. It meticulously examines the associated costs and benefits that come with these elements, identifies several barriers to adoption that organizations might face, and ultimately proposes a variety of pathways and implementation strategies for successfully navigating this complex landscape. While larger and more resourceful firms are under immense pressure to engage in transformation and employ AI technologies to remain competitive, smaller firms continue to regard such significant change as optional, provided they can maintain their existing business model without disruption. Additionally, it is essential to recognize that legislation and regulatory frameworks can play a crucial role in promoting transformation by implementing more focused and supportive policies. Such policies are designed to lessen the burden on small and micro enterprises, thereby fostering an environment conducive to both growth and innovation.

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