



Artificial Intelligence Adoption and Impact on SMEs

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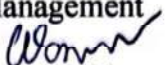
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ABSTRACT

This study investigated the adoption and impact of Artificial Intelligence (AI) on small and medium-sized enterprises (SMEs) by examining how emerging AI technologies transformed the operational landscape of these businesses. SMEs are the backbone of most economies and the integration of AI has the potential to redefine SME strategies across financial, organizational and technological dimensions. Through a documentary research method, this study aimed to provide an in-depth understanding of the enablers, barriers and outcomes that shape AI adoption in SMEs. This study built a conceptual framework that has nine variables organized across three roles. As enablers for adoption, technological readiness, organizational culture and leadership, skilled workforce availability, and data management and quality determined how well-positioned an SME was to adopt AI. As barriers for AI adoption, financial constraints, economic and social resistance, and ethical and privacy concerns limited how far that adoption could go. As outcomes, this study found that SMEs who navigated these enablers and barriers successfully translated that adoption into stronger customer engagement and satisfaction and a more durable competitive advantage, particularly through predictive analytics and personalized service delivery. Overall, this study concluded that AI adoption presents immense potential for SMEs by enabling growth and adaptability and made them more competitive against MNCs. However, achieving successful AI integration requires SMEs to navigate resource constraints, skill gaps and ethical considerations, making strategic planning essential to harnessing AI's benefits and fostering resilience in a competitive digital landscape that will define business survivability going forward.

Keywords: AI adoption, SMEs, technological readiness, organizational culture, competitive advantage

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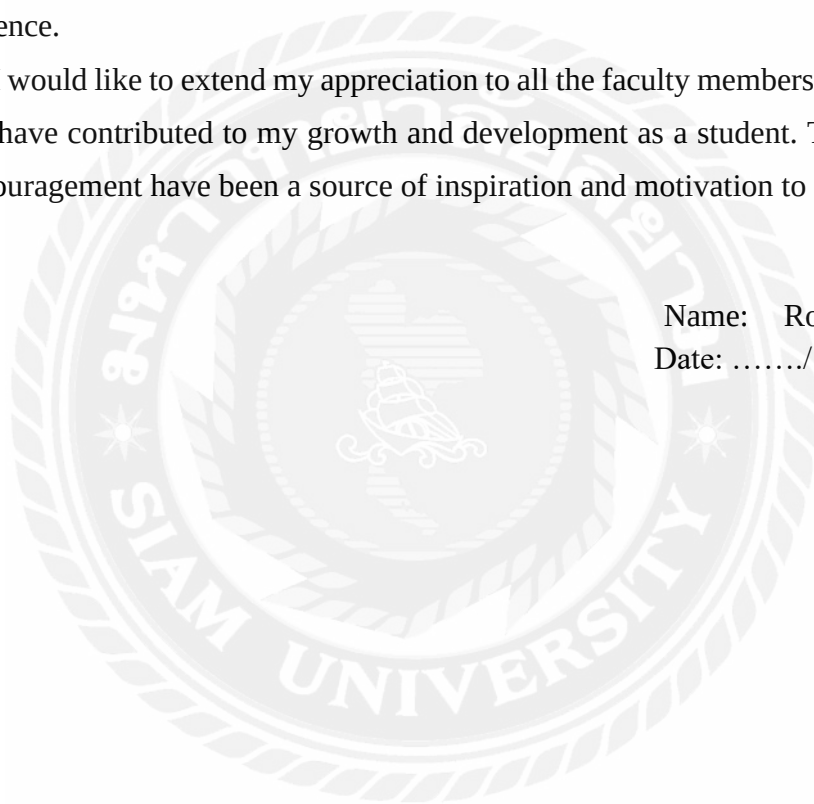
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DECLARATION

I, Roushonul Mahbub, hereby certify that the work embodied in this independent study entitled “Artificial Intelligence Adoption and Impact on SMEs” is the result of original research and has not been submitted for a higher degree to any other university or institution.

(Roushonul Mahbub)



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CHAPTER 1

Introduction

1.1 Research Background

The adoption of Artificial Intelligence (AI) has greatly increased across industries. This adoption transformation the business and added value in productivity, efficiency and has great economic impact. There is an estimate by Chui et al. (2023) that suggest that AI could add between \$2.6 and \$4.4 trillion to the global economy annually. Applications in generative AI is significantly boosting business capabilities in areas such as automation, decision-making and customer engagement. The adoption of AI to small and medium enterprises (SMEs) is very important for their survival in the new digital landscape and this transformation is very impactful not only for SMEs but also consumer and general population. AI is providing tools to SMEs for optimized customer interactions, targeted marketing, data analysis, strategic decision-making helper and many more operations. These tools are allowing them to compete with larger corporations and ensuring their survivability in coming time.

Investment trends further emphasize AI's economic importance as mentioned in Glasner (2024). AI-related startups seeing in U.S. funding doubled in 2023. This growing investor confidence in AI reflects its foundational and far-reaching role in modern business infrastructure by creating both opportunities and challenges. This is also true for as SMEs integrate advanced technologies into their frameworks.

Generative AI tools, like ChatGPT, Alpha Code, Gemini have proven very advantageous for SMEs. This advantage is making AI adoption more accessible, attractive and cost-effective and also proving them an essential have to tools. These models handle vast volumes of data, offering insights that support business strategy, customer service and operational efficiency. AI chatbots have emerged as a cost-effective solution for improving customer engagement and it is especially helpful towards SMEs because its puts ease on SMEs budgetary restriction. These chatbots automate routine interactions and offer 24/7 customer support and engage users with personalized responses based on natural language processing (NLP) and machine learning. For example, sales chatbots smooth the customer experience by providing product recommendations, answering routine questions and assisting with purchases. These tasks reducing the need for human intervention and lowering operational cost. Chatbots also assist SMEs in data gathering. When these data analyzed can reveal trends and customer insights and can further help to create targeted marketing strategies and a more accurate responsive customer experience. Companies who are integrating AI is reporting significant productivity gains and improved customer satisfaction due to the personalization, automation and efficiency AI provides. According to eMarketer (2023), ChatGPT usage in the U.S. is projected to increase from 6.3 million users last year to 61.5 million in 2023, representing an 882% growth.

Cybersecurity is another key aspect of AI adoption for SMEs. Digital transformation increases exposure to cyber threats that can threaten business reputation using misinformation or system degradation using malicious tool. Also the risk of theft of money and information is always ever present when transaction and everyday operation done digitally. AI-based tools provide enhanced threat detection, defense and response capabilities that helps SMEs to secure sensitive data and mitigate cyber risks proactively. Still ethical considerations particularly around privacy and data handling, are paramount as AI systems become integral to operations.

Despite all these benefits challenges for AI adoption remain. Ethical considerations surrounding bias in AI algorithms (Google, apple, amazon as an example) and data privacy concerns associated with training AI models as they use real time user data whose source and agreement with user sometimes no so clear cut and the potential job displacement due to automation require very careful consideration. Additionally, ensuring a skilled workforce capable of developing, deploying and managing AI solutions will be critical for successful adoption. However, SMEs face more challenges in this adoption journey than the enterprises.

As AI adoption expands, it reshapes the SME landscape and this requiring strategic planning to balance benefits and address the associated risks and ethical considerations of AI-powered systems.

1.2 Research Problems

The adoption of Artificial Intelligence (AI) by small and medium enterprises (SMEs) presents a great opportunity for improvement of efficiency, quick digital transformation, greater competitiveness and more personalized customer engagement. Effective marketing strategies from data analysis and strengthening cybersecurity is an added bonus. Yet several persistent challenges hinder its effective implementation. Key areas impacted include customer management, digital transformation, marketing and cybersecurity. Which is also its advantage if it can be handled properly as mentioned earlier.

In the marketing field, AI has established itself as a powerful tool for data-driven decision making, customer segmentation and targeted advertising. These things are crucial for SMEs to build a competitive edge. Because field of SMEs are very competitive. Ahmed (2024) examined the challenges small and medium-sized enterprises (SMEs) face in adopting artificial intelligence (AI) technologies. SMEs get challenge both from similar operation and also from large enterprise. Constraints like limited access to high-quality data and lack of expertise to use AI tools hinder the ability of SMEs to fully exploit AI for marketing purposes.

Mukherjee and Chang (2023) explored the balance between novelty and usefulness in generative AI, drawing inspiration from human creativity. Generative AI is the most sought-after tool to use in SMEs. Gen AI adoption by SMEs faces challenges such as resistance from professionals

concerned about job security and there is concerning issues of model accuracy as GenAI can sometimes "hallucinate" or produce convincing yet incorrect information. Most Notable of the risks include reputational and legal implications as shown in a case where an attorney relied on fabricated case law from a GenAI tool resulting in sanctions. Key GenAI challenges for SMEs include adoption barriers, ethical concerns, accuracy, dependency on third parties, legal risks and financial constraints

Lada et al. (2023) gave importance to leadership as next big challenge for the SMEs. The management or leadership of the SMEs not often fully comprehend the scope of the digital transformation and how to get maximum benefit from it due to the lack of experience on the technological field. Specifically, owners or managers. As SMEs has unique characteristics these challenges keep growing due no fit for all solution is available for SMEs. They would need tailored solution rather than generalized solution and that adds burden to budget and skilled worker pool.

SMEs face cybersecurity challenges which are common when adopting AI and realistically digital transformation happening so widely even if no AI adoption done it is still a big threat as mentioned by Nadella et al. (2024). Limited resources often prevent SMEs from implementing comprehensive AI-driven cybersecurity measures that needed to step up the security and it leaves them more vulnerable to cyber threats like malware, phishing and DDoS attacks. Additionally, even when AI can enhance threat detection and response but the integration of machine learning models (e.g., logistic regression, random forest, gradient boost) may lack the accuracy needed to identify complex threats accurately and reliably. There is always a risk even with added measure. Ethical concerns are also an ongoing issue which includes data privacy and transparency and it further complicate AI adoption in cybersecurity for the SMEs.

Thus, the research problem centered on understanding how SMEs can strategically adopt AI across customer management, digital transformation, cybersecurity and marketing, while overcoming barriers related to financial limitations, resource availability and technical expertise. This study sought to explore frameworks and strategies that address these challenges to enable SMEs to leverage AI effectively for sustained growth and resilience in a competitive digital landscape.

1.3 Research Objectives

- 1.To explore the present state of AI adoption in SMEs, focusing on the specific benefits and challenges these enterprises face in implementing AI-driven tools and technologies.
- 2.To evaluate the impact of AI adoption on core SME outcomes, particularly customer engagement and satisfaction and competitive advantage.

3. To suggest an integrated framework for sustainable AI adoption in SMEs by addressing financial, technical and ethical considerations for long term growth and competitiveness.

1.4 Research Scope

This study aimed to evaluate the adoption and impact of Artificial Intelligence (AI) on SMEs by concentrating on the enablers, barriers and outcomes that shape adoption: technological readiness, organizational culture and leadership, skilled workforce availability, data management and quality, financial constraints, economic and social barriers, ethical and privacy concerns, customer engagement and satisfaction, and competitive advantage. It explored how AI technologies such as generative AI tools and AI-driven data analytics influence SME operations and boost customer engagement and strengthen security measures. Additionally, the study addressed the challenges SMEs face in adopting AI that includes resource limitations, technical constraints and ethical considerations around data privacy and market manipulation by AI creators.

Using a documentary research approach, this study inspected existing literature, case studies and industry reports to understand the current scenery of AI adoption in SMEs. The research scope excluded large enterprises to concentrate on the specific needs and constraints of SMEs and aimed to identify frameworks and strategies that SMEs can adopt for viable AI integration. The study's findings are intended to provide insights and practical recommendations for SME leaders to leverage AI technologies effectively while navigating financial, operational and ethical challenges in a competitive digital space.

1.5 Research Significance

This study of "Artificial Intelligence Adoption and Impact on SMEs" is vital for multiple reasons:

1. **Economic Growth and Innovation:** This study reviewed how AI adoption can boost SME productivity, open new business opportunities and increase the competitiveness of SMEs, helping them remain relevant in the years ahead. It also highlighted AI's potential to drive economic growth, job creation and innovation among SMEs.
2. **Addressing SME-Specific Challenges:** AI offers solutions to SMEs' common limitations which are budget, workforce and skilled professionals. At the same time, it can also improve customer service and reduce operational risks. Insights from this research can help SMEs to leverage AI for efficiency and flexibility.
3. **Policy and Ethical Implications:** Understanding AI's impact on SMEs could help policymakers develop supportive frameworks for ethical AI use, data privacy, bias and job displacement. Furthermore, this study identified key skill gaps which will help guide educational programs for a future AI-capable workforce.
4. **Academic Contribution:** This research expands the knowledge base on AI in organizational contexts, specifically SMEs and highlights gaps where further studies can

focus and it will ultimately aid business leaders, policymakers and researchers in navigating AI's role in SME advancement.

In exploring the adoption dynamics and impacts of AI on SMEs, this research provides crucial insights for shaping policies, practices and innovations in a rapidly AI-driven world.

1.6 Research Limitations

1. **Scope of Data:** This study relied on existing literature and case studies which limited its insights to secondary data and it could potentially overlook real-time AI adoption trends and challenges that are unique to individual SMEs.
2. **Over simplification:** SMEs vary significantly by industry, scale and resources which may limit the applicability of findings across diverse SME contexts. Generalizing AI impacts across all SMEs can then lead to oversimplifications.
3. **Rapid Technological Evolution:** AI technologies evolve quickly and insights gained from this research may soon become outdated. Especially as new AI tools and regulatory frameworks arrive.
4. **Ethical and Privacy Considerations:** Addressing AI's ethical implications like data privacy and algorithmic bias is very complex due to different regulations and SME practices. It potentially limits conclusive recommendations on ethical AI adoption.
5. **Resource Constraints:** The National Bureau of Economic Research states that SMEs have varied budgets and technical grounds. So, the suggested AI adoption framework may not fully account for the financial and human resource limitations faced by all SMEs.

CHAPTER 2

Literature Review

2.1 Artificial Intelligence

Recently Artificial Intelligence (AI) has been the new driving force of technology after following decades of technological advancements, quality data gathering tool invention, computing power and much efficient algorithms. Modern AI benefits from developments in complementary fields like robotics, Internet of Things (IoT) and sensors. These developments create more autonomous systems that require minimal human intervention. AI's applications span across businesses and social life. AI is enhancing automation, prediction and processes in areas like natural language processing and image recognition. With far-reaching impacts on industries AI has evolved from early concepts in the mid-20th century. After that speculation like "electronic brain" and "learning machine" help itself establish as a discipline at the 1956 Dartmouth Conference. However highly ambitious and anticipated predictions led to "AI winters" and reduced funding and fading interest over time also slow down the interest. AI research again gained momentum in the 1990s after the new advancement in hardware and algorithm. Though researchers often avoided the term "AI" to avoid negative perceptions. Since then, advancements in subfields like computer vision, speech recognition and robotics have extended AI's capabilities. The OECD in 2018 offered a widely recognized definition by describing AI as machine-based systems that can make predictions or recommendations or decisions based on data. Key components of an AI system include sensors (for data collection), operational logic (processing objectives) and actuators. Together these elements enable AI systems to learn and adapt to their environments and producing outcomes like predictions or automated actions that can influence real or virtual surroundings. (OECD, 2021)

AI promises revolutionary impacts across industries, jobs, economies and daily life yet understanding AI is challenging due to the lack of a unified definition. Scholars differ in their interpretations. While some view AI as artificial life surpassing human intelligence (Russell & Norvig, 2010; Dwivedi et al., 2019), others consider it as any data-processing technology (McCarthy, 2007; Poole & Mackworth, 2010). AI is divided into two main approaches: Artificial General Intelligence (AGI) which is a theoretical self-conscious "mind" which performs specific tasks intelligently (Elements of AI, 2021). Although AI concepts have existed for decades, with milestones like Rosenblatt's (1958) self-learning algorithm and Ivakhnenko and Lapa's (1965) deep learning algorithm, limited data and computational capacity slowed development. Recent technological advancement has made AI's benefits clearer to society and businesses (Elements of AI, 2021). Machine Learning (ML), particularly Deep Learning (DL), has become foundational to modern AI by enabling systems to recognize patterns and make classifications based on data (Dong et al., 2021). Deep Learning processes drive many AI innovations to analyze diverse data with minimal human participation and achieve high accuracy, though the margin of error, while still

present, continues to decrease. Applications of DL range from natural language processing, speech and face recognition to intelligent transportation and autonomous vehicles (Dong et al., 2021; Roa Baez & Igbekele, 2021).

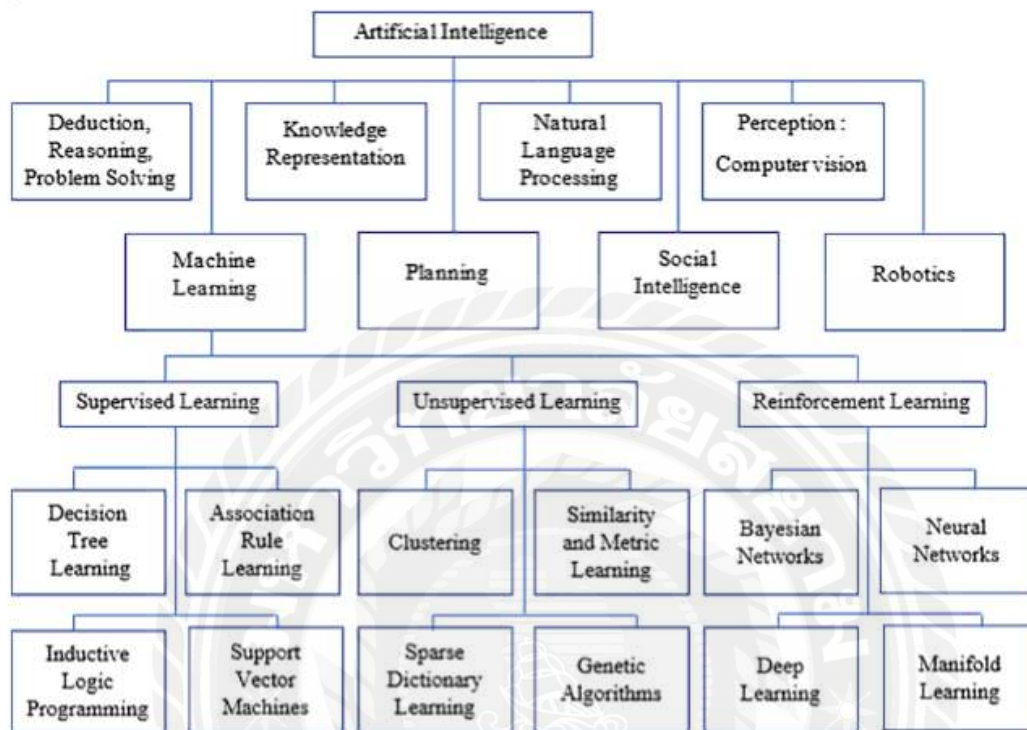


Figure 2.1 - Classification of AI technologies (Image Source: Riahi et al., 2021, p.13)

2.2 Challenges of Adopting AI in SMEs

Adopting Artificial Intelligence (AI) presents numerous challenges for Small and Medium-sized Enterprises (SMEs). Below is an in-depth analysis of these challenges and how SMEs are addressing them:

2.2.1 Lack of Strategy, Leadership Commitment and Organizational Culture

Many SMEs lack a clear AI adoption strategy. This happens quite often due to limited understanding of AI's potential benefits and also field of AI changes very rapidly. This absence of strategic direction can lead to disjointed efforts and missed opportunities. Leadership commitment is very crucial for successful AI integration as it drives resource allocation and organizational focus. Studies indicate that a lack of leadership ownership is a significant barrier to AI adoption in organizations. (Roa Baez & Igbekele, 2021)

To Integrate artificial intelligence (AI) into an organization requires broad and insightful approach that heavily depend on leadership and organizational culture. Leaders play a pivotal role in fostering AI fluency by promoting continuous learning and encourage a mindset open to innovation and cautious enough to give enough scrutiny. Developing a clear AI directive that aligns with the organization's values and ethical standards is an essential requirement. This manifesto should articulate the strategic vision for AI adoption and ensuring that all initiatives are consistent with the company's core principles. Additionally, it is also required to grooming a mindset for the whole organization that embraces change and supports AI integration. This step involves creating an environment where experimentation is encouraged and employees feel encouraged to engage with AI technologies. By focusing on these aspects' organizations can effectively navigate the challenges of AI adoption and leverage its potential to enhance operations and drive innovation. (Bernhardt, 2024)

2.2.2 Shortage of Skilled Talent

The shortage of professionals with AI expertise is a significant hurdle for SMEs. The high demand for skilled worker often leads to competition with larger corporations and this makes it a challenge for SMEs to attract and retain qualified talent. It is quite difficult for SMEs to compete with large corporation in this regard. So it's kind of situation where they have to pick up lower grade talent and that itself impact cost and time in varying degree. (Roa Baez & Igbekele, 2021; Markaki et al., 2023)

This talent gap hinders the development and implementation of AI solutions within smaller enterprises. Studies show that SMEs can solve this talent gap problem by offering training programs that focused improving on AI and digital skills. Furthermore forming partnerships with educational institutions and leveraging government sponsored training programs can enable SMEs to upskill employees without bearing the full cost themselves. This approach not only helps to grow internal expertise but also reduces dependence on external consultants which can be costly for small businesses and sometimes may hinder performance when very rapid response required for crisis. (Roa Baez & Igbekele, 2021; Agrawal et al., 2024)

2.2.3 Data Challenges

For effective AI systems, one of the most important requirements is high-quality and well-structured data. SMEs often struggle with data collection, data management and analysis due to limited resources and expertise. Also lack of quality data is another issue to making the system effective. So, data challenges include data silos, inconsistent data formats and inadequate data governance practices. All of these factors impede AI adoption in SMEs in great length. (Department for Digital, Culture, Media & Sport [DCMS], 2021)

Research suggests that SMEs should focus on building robust data governance frameworks that ensure data consistency and reliability. Implementing centralized data management systems and data cleaning practices can enhance data usability for AI algorithms. Additionally integrating data management with AI projects improves the overall accuracy of AI insights which enables SMEs to make data-driven decisions with confidence. (Ingalagi et al., 2021)

2.2.4 Technological Infrastructure and Resource Constraints

Implementing AI solutions happens in combination of hardware and software. Hardware part need robust technological infrastructure that include advanced hardware, power management for the hardware, advance risk management setup in case of unforeseen disaster and a secondary back up system just to be operational minimally in case of failure of main system. SMEs frequently face financial constraints that limit their ability to invest in necessary infrastructure to achieve this kind of requirement. Which result in reliance on outdated systems that are incompatible with modern AI technologies and cannot possibly fulfill the requirement in case of disaster and risk management. This failure can deeply impact them and even make them out of business due to data loss and an operational inability in times of emergency is always a possibility. (Oldemeyer et al., 2024)

SMEs can adopt cloud-based AI solutions as they provide scalability on need and cost-effectiveness without requiring significant upfront investments. Upgrading IT infrastructure incrementally steps. Such as migrating data storage to cloud platforms and adopting AI-ready software solutions can helps SMEs gradually build a robust tech environment to AI applications. (Agbonyin et al., 2024)

2.2.5 Knowledge and Experience Gaps

Beyond technical skills SMEs often lack organizational knowledge and experience in managing AI projects. It happens in part due to lack of knowledge of leadership and management. This knowledge and experience gap results in failure of understanding AI project lifecycles, integration processes and change management strategies that needed for AI integration. And also, these gaps lead to unrealistic expectations and project failures. (Roa Baez & Igbekele, 2021)

2.2.6 Economic and Social Barriers

Economic constraint is one of the most limiting factors for SMEs. Limited budgets and access to financing hinder SMEs from investing in AI. Social barriers like resistance to change and fear of losing job is growing among employees each day and this also further complicate AI adoption. Addressing these barriers requires comprehensive change in management direction, communication with employees and knowledge share about the benefits of AI. (Schwaeke et al., 2024)

2.2.7 Ethical and Privacy Concerns

AI adoption raises ethical issues related to data privacy, algorithmic bias (cases like google search and amazon suggestion) and transparency. SMEs may lack the resources to implement robust ethical guidelines and compliance measures and that exposes them to legal risks and reputation damage. Establishing clear ethical frameworks is essential to prevent these concerns.

AI systems (algorithms or controller which can be human or another AI) can intentionally or unintentionally maintain existing biases present in their training data which in turn lead to unfair outcomes. For SMEs this may result in biased customer interactions or discriminatory decision-making processes. Implementing robust AI governance frameworks is essential to identify and mitigate such biases and it will also ensure equitable treatment of all stakeholders. (Berlatsky, 2018; BBC News, 2018)

The complexity of AI algorithms can make their decision-making processes obscure. For SMEs this lack of transparency can create issues with customer trust and impede regulatory compliance. Adopting AI governance platforms that promote interpretability of AI action and effect can help SMEs provide clear understandable insights into how AI-driven decisions are made.

AI systems like deep learning models often require to study large amount of data that raises concerns over data privacy of the user as it is still grey line to consider what data is private and what data is not. SMEs need to navigate these concerns carefully to protect sensitive information of the user and comply with regulations. Implementation of AI governance practices that give priority to data privacy and security is very important for maintaining customer trust and to avoid legal, reputational and monetary repercussions.

It is challenging to determine responsibility for AI-driven decisions especially when outcomes are unfavorable and not clear. SMEs need to establish clear accountability structures for their own business safety and ensure their AI applications comply with relevant laws and ethical standards. Developing comprehensive AI governance frameworks can assist SMEs in maintaining accountability and adhering to compliance requirements. (Gartner, n.d.)

2.3 AI Technologies Empowering SMEs

Small and Medium-sized Enterprises (SMEs) are increasingly integrating various types of Artificial Intelligence (AI) into their operations and data analysis to enhance efficiency, decision-making and customer engagement. Key AI applications in SMEs include:

2.3.1 Machine Learning (ML)

Machine Learning (ML) is a subset of Artificial Intelligence (AI) which enables systems to learn from data and improve over time without explicit programming. In the context of Small and Medium-sized Enterprises (SMEs) ML offers very good opportunities to improve operations and decision-making processes. By analyzing large datasets ML algorithms can identify patterns and trends that help to create more effective strategic decisions. SMEs can utilize ML for sales forecasting, customer segmentation and inventory management that leads to optimized resource allocation, increased productivity and efficiency. As an added bonus ML-powered chatbots and recommendation systems can improve customer engagement by providing personalized experiences to customer with more accurate prediction for customer's needs. The growing availability of user-friendly ML tools and platforms makes it more accessible for SMEs to integrate ML into their operations and that increase competitiveness and fostering innovation. (Ism, 2024; ProfileTree, n.d.)

2.3.2 Natural Language Processing (NLP)

Natural Language Processing (NLP) is another branch of artificial intelligence that translate and generate human language. For Small and Medium-sized Enterprises (SMEs) NLP offers practical applications that can improve operational efficiency and customer engagement. One common use is the development of chatbots and virtual assistants which handle customer inquiries and provide support that reduce the workload on human staff and improve response times. Additionally, NLP facilitates sentiment analysis which allows SMEs to monitor customer feedback across social media and other platforms to gauge public opinion and reaction to marketing strategies. By automating routine tasks and providing valuable insights NLP helps SMEs optimize their operations and a better understanding to their customers. (Mudryi, 2023)

2.3.3 Robotic Process Automation (RPA)

Robotic Process Automation (RPA) is the AI process that use software robots or "bots" to automate repetitive standard tasks. It is very useful for SMEs as RPA offers a cost-effective solution for efficient operation and reduced manual workload. By automating processes like data entry, invoice processing and customer onboarding SMEs can achieve significant time savings and much less errors. For example, RPA can handle back-office functions in HR, finance and procurement and that allows employees to focus on another project. Additionally, RPA operates without breaks and that ensures consistent productivity. Implementation of RPA does not need massive changes to the existing IT infrastructure and this makes it easy for the SMEs with limited resources to obtain it. SMEs can leverage RPA to improve productivity, accuracy and can also gain a competitive advantage in their respective markets. (CFB Bots, n.d.)

2.3.4 Predictive Analytics

Predictive analytics uses data analysis, machine learning and statistical models to analyze historical data and forecast future outcomes. For Small and Medium-sized Enterprises (SMEs) implementing predictive analytics can make decision making processes easy and efficient. By analyzing past sales data SMEs can forecast customer demand, optimize inventory levels and reduce holding costs. Additionally predictive analytics enables SMEs to identify potential market trends, allowing for proactive adjustments in marketing strategies and product offerings. In the realm of customer relationship management SMEs can leverage predictive models to assess customer lifetime value and tailor personalized marketing campaigns, thereby improving customer retention rates. Despite the clear advantages many SMEs face challenges in adopting predictive analytics due to limited resources and technical expertise. However, the increasing availability of user-friendly analytics tools and platforms are making it more accessible for SMEs to harness the power of predictive analytics. Predictive analytics helps to improve competitiveness and growth for SMEs. (SME Scale, 2024)

2.3.5 Computer Vision

Computer Vision (CV) is a branch of artificial intelligence that enables machines to interpret and process visual information from the world by mimicking human vision. For Small and Medium-sized Enterprises (SMEs) integrating CV technologies can lead to significant operational enhancements. In manufacturing SMEs utilize CV for quality control by automating the inspection process to detect defects and ensure product consistency and reduced manual labor and minimize errors. Retail SMEs employ CV for inventory management by using image recognition to monitor stock levels and track product placement which optimizes supply chain efficiency. Additionally, CV-powered security systems enhance surveillance capabilities, providing real-time monitoring and threat detection. Despite the clear advantages SMEs often face challenges in adopting CV due to resource constraints and the need for specialized expertise. However, the increasing availability of affordable CV solutions and user-friendly platforms is making it easier for SMEs to implement these technologies which leads to improved productivity and competitiveness. (Novatix, 2023)

2.4 Conclusion

The adoption of Artificial Intelligence (AI) in SMEs marks as a revolutionary shift for operational efficiency, customer engagement and innovative capabilities. AI technologies such as Machine Learning (ML), Natural Language Processing (NLP), Robotic Process Automation (RPA), Predictive Analytics and Computer Vision provide SMEs with tools to improve its operation, make data-driven decisions and gain a competitive edge in their industries. However, the journey toward full AI integration presents unique challenges for SMEs. From technological and financial

constraints to organizational and ethical barriers. To maximize the benefits of AI SMEs should prioritize the following:

- **Data Strategy:** Develop a data strategy to ensure data quality, accessibility and security.
- **Skill Development:** Invest in training and development to build a skilled workforce capable of using AI technologies.
- **Ethical AI:** Follow the ethical principles to mitigate biases and ensure transparency in AI systems.
- **Collaboration and Partnerships:** Collaborate with AI experts, technology providers and other SMEs to share knowledge and resources.
- **Start Small and Scale:** Begin with small-scale AI projects to gain experience and build confidence.



CHAPTER 3

Research Methodology

3.1 Research Design

This study focused on studying the relationship between AI adoption, challenges and its impact on SMEs. A comprehensive documentary research method was employed with the objective to ensure the understanding of this study. This research method involved an in-depth examination of existing documents including academic articles, industry reports, government policies, news articles and case studies. By researching these sources, the study aimed to:

1. **Determine key factors for AI adoption:** Identifying factors like technological readiness, financial constraints, ethical issues and organizational culture that are making impact on SMEs adoption of AI.
2. **Identify the specific applications of AI in SMEs:** Not all AI is used in SMEs or for other business operation. This study identified the AI technologies specifically used by SMEs in areas like customer service, marketing, operations and finance.
3. **Evaluate the impact of AI on SME performance:** This research also examined if use of AI had any significant impact on performance indicators such as revenue, productivity and customer satisfaction.
4. **Challenges and opportunities:** This study explored the challenges faced by SMEs in AI adoption. Data quality, skill gaps and ethical concerns are some of the major challenges on technological level. There are also economic challenges of AI adoption. Besides challenge this study also determined opportunities. SMEs can leverage AI to gain a competitive advantage to ensure survival on very rapidly changing technological and economic landscape and this study identified those opportunities.
5. **Examine government policies and initiatives:** SMEs need government help to find their footings with AI. So, this study also examined the government policies and initiatives that are aimed at promoting and actively helping AI adoption among SMEs and try to find out results.

3.2 Sources of Data

The secondary sources used in this study fell into several categories. Sources were selected for their relevance to AI adoption in SMEs and for recency, with priority given to material published within the 2020–2024 period.

Peer-reviewed research publications were drawn from journals including World Journal of Advanced Research and Reviews; International Journal of Computer Engineering & Technology; Australian Journal of Business Science Design & Literature; Industrial Marketing Management;

Journal of Strategy and Management; Communications of the ACM; Computer Science Review; International Journal of Information Management; Journal of Open Innovation: Technology, Market, and Complexity; Migration Letters; California Management Review; Management Review Quarterly; Business Horizons; Journal of Small Business Management; conference proceedings including IOP Conference Series: Materials Science and Engineering; Proceedings of the IEEE International Conference on Information, Intelligence, Systems & Applications (IISA); and foundational academic texts and a graduate thesis, namely Artificial Intelligence: Foundations of Computational Agents (Cambridge University Press); Artificial Intelligence: A Modern Approach (Prentice Hall); Challenges of AI Adoption in SMEs (Master's thesis, KTH Royal Institute of Technology, DiVA portal).

Institutional and policy-level data were sourced from OECD (Organisation for Economic Co-operation and Development); GOV.UK (Department for Digital, Culture, Media & Sport). Industry and consulting perspectives were drawn from reports published by McKinsey & Company; Goldman Sachs; PwC; Gartner, while current developments were tracked through news and trade coverage from BBC News; NBC News; New York Post; Crunchbase News.

Additional web-based materials, including company blogs, platform reports, and online industry resources, were drawn from eMarketer; Semrush; Chatbase; Intelliarts; Novatix; ProfileTree; SME Scale; Talent Development Leader; CFB Bots; Elements of AI (University of Helsinki & MinnaLearn).

3.3 Research Process

This study focused on the pivotal role of AI in coming days in SMEs. So, a critical analysis related to opportunities and challenges is always a focus for this research. It began with an introduction that described AI's ever-growing role in business and economy. From there this study defined the primary problem around AI adoption in SMEs focusing on challenges in technology, financial limitations, resource availability and ethical issues. The study then established specific objectives to guide the research, such as understanding the impact of AI on SME productivity, customer management, digital transformation, cybersecurity and marketing.

After that, the study conducted an in-depth literature review on AI technologies, mechanism, AI tools and their applications relevant to SMEs by examining recent academic articles, industry reports and web-based sources. The literature review also covered challenges and solutions for AI integration, including data strategy, talent acquisition, ethical concerns and emerging AI-driven solutions (e.g., machine learning, NLP, predictive analytics). A documentary research approach was followed to assess existing information sources related to AI adoption. The study then identified critical factors for AI adoption within SMEs and explored both opportunities and barriers. The next step of the research was document selection: scholarly journals, industry reports, case studies and government publications that provide insights into AI's impact and adoption

frameworks. Sources fell into two main categories: web-based articles (e.g., McKinsey reports, eMarketer insights) and scholarly research publications (e.g., OECD reports, studies on AI in SMEs). The researcher aimed to ensure a comprehensive collection of qualitative data that reflects the global and industry-specific insights on AI adoption by SMEs that are recent and relevant.

The third step was to create a framework that presented this study's research theme. This framework presented the essence of this research, which is the impact of AI in SMEs operation and the problem they face and what could be the possible solution.

The final step was content analysis to assess recurring themes in barriers like cost constraints, skills shortage and data management. The analysis then revealed key findings on how AI adoption affected SME performance metrics such as revenue, productivity and customer satisfaction. This step also aimed to provide practical recommendations for SMEs to leverage AI effectively while managing costs, data privacy and skill requirements. This research also aimed to provide insights into policies and support systems (such as government initiatives) that can further assist SMEs in overcoming barriers to AI adoption.

3.4 Analysis Framework and Conceptual Framework

The analysis framework on AI's impact on SMEs was built mainly on nine variables and three roles. The three roles are enabler, barrier and lastly outcome.

The variables in this conceptual framework include the following:

Enablers:

- **Technological Readiness:** Represents the infrastructure and compatibility required for AI adoption.
- **Organizational Culture and Leadership:** Emphasizes the importance of leadership commitment and support for AI integration.
- **Skilled Workforce Availability:** Highlights the access to talent and training needed to operate AI effectively.
- **Data Management and Quality:** Focuses on the quality, governance, and consistency of data, which is foundational for effective AI implementation.

Barriers:

- **Financial Constraints:** Includes budget limitations and limited funding for new AI technologies.
- **Economic and Social Barriers:** Accounts for employee resistance and job security concerns, which may impede adoption.

- **Ethical and Privacy Concerns:** Focuses on compliance with data privacy regulations and the risks of algorithmic bias.

Outcomes:

- **Customer Engagement and Satisfaction:** Examines how AI can improve customer service and personalization, leading to increased satisfaction.
- **Competitive Advantage:** Describes how AI can help SMEs differentiate themselves in the market, leveraging tools like predictive analytics and NLP for better positioning.

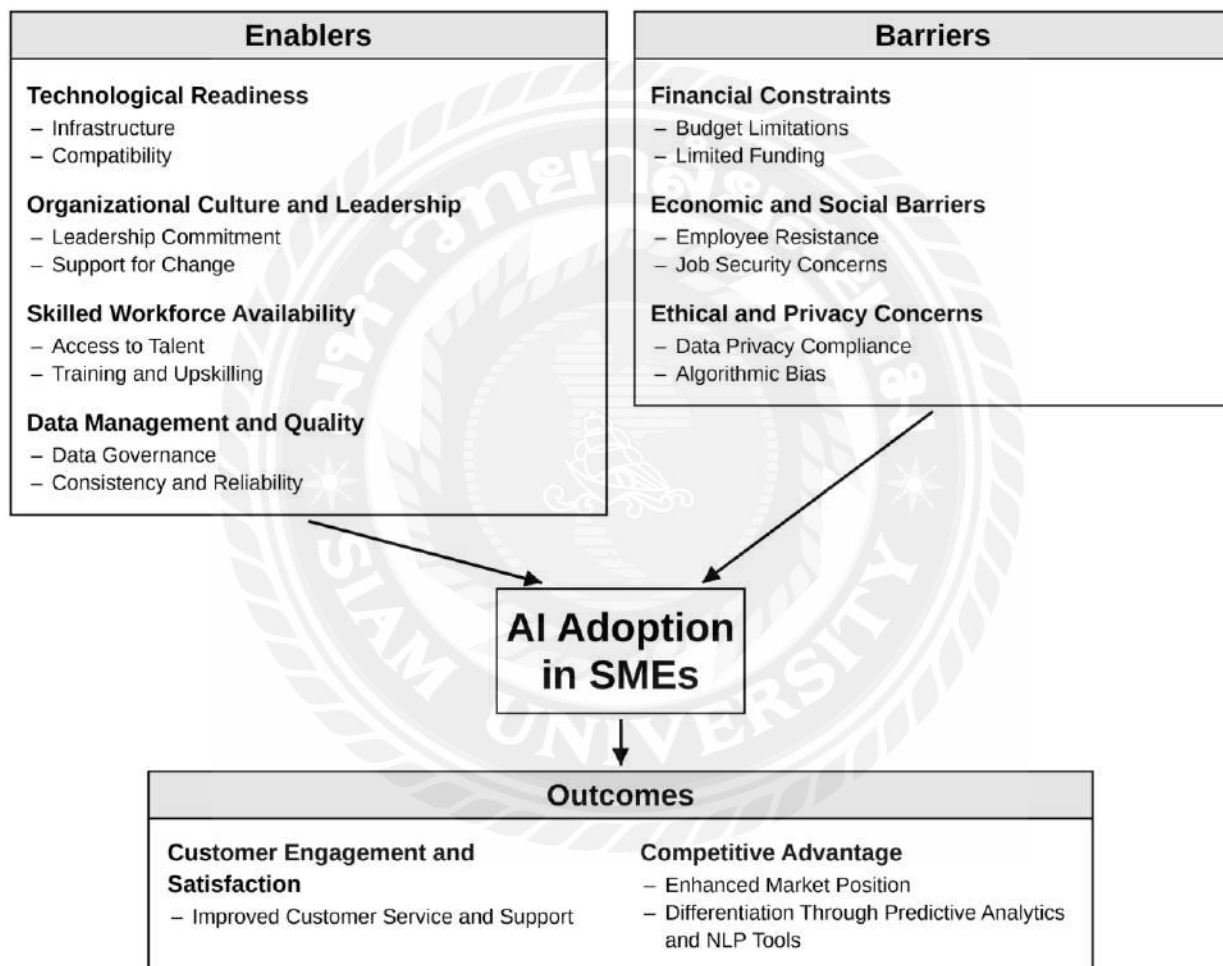


Figure 3.1 Conceptual Framework of AI Adoption in SMEs

Variable	Description	Source
Technological Readiness	1.Infrastructure Requirements for AI Deployment. 2.Compatibility with Current Technology.	Chatterjee et al., 2022; Denning & Lewis, 2020; OECD, 2021; Oldemeyer et al., 2024
Organizational Culture and Leadership	1.Leadership Commitment to AI Adoption. 2. Support for AI-Driven Change within the Company.	Lada et al., 2023; OECD, 2021; Roa Baez & Igbekele, 2021
Skilled Workforce Availability	1.Access to Talent. 2.Training and Upskilling.	Peretz-Andersson et al., 2024
Data Management and Quality	1.Data Governance. 2.Consistency and Reliability.	OECD, 2021; Peretz-Andersson et al., 2024; Rajaram & Tinguely, 2024; Roa Baez & Igbekele, 2021
Financial Constraints	1.Budget Allocation for AI Integration. 2. Access to Financial Resources for AI Investment.	OECD, 2021; Peretz-Andersson et al., 2024
Economic and Social Barriers	1.Employee Resistance 2.Job Security Concerns	Baabdullah et al., 2021; Mendoza Arce et al., 2024; OECD, 2021; Peretz-Andersson et al., 2024; Rajaram & Tinguely, 2024; Roa Baez & Igbekele, 2021
Ethical and Privacy Concerns	1.Data Privacy Compliance 2.Algorithmic Bias	Baabdullah et al., 2021; BBC News, 2018; Berlatsky, 2018; OECD, 2021; Rajaram & Tinguely, 2024
Customer Engagement and Satisfaction	1.Customer Service Improvement via AI 2.Personalization and Responsive Interactions.	Baabdullah et al., 2021; eMarketer, 2023; Mendoza Arce et al., 2024; OECD, 2021; Rajaram & Tinguely, 2024
Competitive Advantage	1.Market Positioning through AI Capabilities 2.Differentiation through Predictive Analytics	Adesina et al., 2024; Agbonyin et al., 2024; Mendoza Arce et al., 2024; OECD, 2021; Peretz-Andersson et al., 2024; Rajaram & Tinguely, 2024

Table 3.1 Analysis Framework

CHAPTER 4

Findings

4.1 Technological Readiness

Artificial intelligence is no longer a futuristic concept; it is a major catalyst transforming business practices and decision-making across industries. For SMEs, the promise of AI lies in its potential to streamline operations, enhance productivity and foster innovation. Yet the path to successful AI adoption is fraught with challenges, including change management, integrating new technologies with legacy systems, and overcoming resource constraints (Schwaeke et al., 2024).

AI adoption presents a significant opportunity for SMEs in terms of business growth, operational efficiency and effective decision-making. However, for SMEs to leverage AI successfully, they must first overcome a series of infrastructure and compatibility challenges. This section examines the technological infrastructure and system compatibility that SMEs require in order to integrate AI solutions effectively (Oldemeyer et al., 2024; Ahmed, 2024).

4.1.1 Infrastructure Requirements for AI Deployment

A strong digital infrastructure is a fundamental precondition for AI adoption, since it determines an SME's ability to process large datasets, implement machine learning models and integrate AI into existing business workflows. One of the primary requirements for AI readiness is a modernized IT infrastructure that includes high-speed internet, cloud computing capabilities and advanced computing hardware. Many SMEs operate outdated IT infrastructure that was not designed to handle the high computational demands of AI applications, which makes upgrading to high-performance computing, cloud services and AI-compatible software essential for seamless AI integration (Schwaeke et al., 2024).

Computing power and cloud integration are another major technological consideration. AI applications involving deep learning and real-time analysis require significant computational resources, and many SMEs cannot afford high-end hardware such as graphical processing units or other AI-specific processors. Cloud-based AI services from providers such as Amazon, Google and Microsoft offer a cost-effective alternative, allowing SMEs to access AI functionality on demand, reduce upfront investment costs and scale with greater flexibility. Edge computing is also becoming an essential tool for SMEs that need to process AI-driven insights closer to the data source, particularly in industries that require real-time analytics (Oldemeyer et al., 2024).

AI is transforming SME operations by improving process automation, decision-making and overall efficiency. However, AI implementation also introduces considerable cybersecurity risks that SMEs need to address to ensure a safe and lasting deployment. SMEs often lack the extensive

cybersecurity infrastructure found in large enterprises, which leaves them particularly vulnerable to data breaches, AI-driven fraud and attacks on machine learning models. Building a secure and scalable infrastructure is therefore an essential task for SMEs seeking to leverage AI effectively while mitigating cyber risk. Research applying machine learning models directly to SME cybersecurity incidents supports this concern, while also showing that predictive tools such as random forest and gradient boosting classifiers can meaningfully improve an SME's ability to detect and categorize emerging threats (Nadella et al., 2024).

Data infrastructure plays an equally critical role in AI implementation, since AI models depend on large volumes of structured and unstructured data for training, operation and optimization. Most SMEs, however, have data collection mechanisms that fall short of the required standard or volume, which limits AI accuracy and performance. To overcome this, SMEs need to invest in cloud-based data management, real-time data processing and secure storage. Cloud services such as Amazon Web Services, Google Cloud AI and Microsoft Azure AI provide scalable solutions that let SMEs leverage AI without having to invest heavily in on-site infrastructure.

Secure data infrastructure is another critical necessity for AI deployment in SMEs. Because AI models rely on significant volumes of data, how that data is stored, processed and protected has a direct bearing on an SME's ability to function safely. Due to limited awareness and, in some cases, a shortage of resources, many SMEs operate without proper protection policies or the technology needed to enforce them, exposing them to cyber threats such as data breaches, hacking and ransomware attacks (OECD, 2021). To address these risks, SMEs need encrypted data storage to keep business and customer data secure, and AI-driven systems should embed multi-factor authentication and role-based access control to limit unauthorized access. End-to-end encrypted data transmission further strengthens protection against cyber-attacks, and remains one of the risk factors SME leaders consistently underestimate when evaluating AI investments (Ahmed, 2024).

Secure storage, however, is only part of the picture: AI models must also be robust against adversarial attacks. Introducing corrupted data into an AI model can result in incorrect AI-driven decisions, a phenomenon known as data poisoning, which poses a serious threat to SMEs relying on AI-based solutions for fraud detection, credit scoring or automated decision-making. By implementing AI model auditing techniques, SMEs can proactively check algorithms for inconsistencies and weaknesses that could otherwise be exploited. Implementing explainable AI (XAI) can further improve transparency, giving organizations the ability to recognize and remediate model biases or errors before they compound into security threats (Nadella et al., 2024).

Infrastructure planning for SMEs must also account for AI scalability and a long-term cybersecurity strategy. AI adoption is not a one-time investment like purchasing a piece of equipment or software; it is a continuous process that calls for regular updates, risk assessments and security improvements. SMEs should invest in modular AI architectures that let them add new security capabilities as the business scales — for example, starting with small-scale applications

such as chatbots, automated fraud detection or cybersecurity analytics, and expanding gradually while maintaining security best practice. A robust data infrastructure, selective adoption of common APIs, and compliance with cybersecurity standards are all important to making AI work for SMEs. By investing in cloud computing, scalable AI solutions, workforce training and sound financial planning, SMEs that take a strategic approach to these hurdles will be well placed for future innovation and sustainable growth in the digital age.

4.1.2 Compatibility with Current Technology

Beyond infrastructure, SMEs must also ensure that their existing business systems and software are compatible with the AI solutions they want to adopt. Integrating AI with legacy systems is one of the most challenging tasks in this respect: many SMEs still rely on legacy Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems that were never designed to accommodate AI-based automation, and most of the time these systems cannot integrate AI-powered analytics or predictive modeling directly. AI-based solutions can instead be layered onto new infrastructure that sits alongside existing ERP and CRM software, maintaining a working connection between both systems (Oldemeyer et al., 2024). Interestingly, not all empirical evidence agrees on how much this factor matters in practice: in a cross-sectional study of Indian SMEs, Jadhav (2021) found that compatibility did not show a statistically significant correlation with AI adoption decisions, suggesting its influence may vary by context and by how directly a firm's existing systems are exposed to AI integration.

AI literacy and workforce readiness represent another significant compatibility roadblock. While large corporations have entire teams dedicated to researching and developing AI technologies, most SMEs lack staff with the technical background to deploy and oversee AI-powered systems. This shortage of AI-skilled personnel makes it harder for SMEs to understand the insights AI generates or to resolve issues when they arise. A hybrid approach that combines outsourced AI development with in-house employee training and external AI consultancy services offers SMEs a more balanced route to adoption (Oldemeyer et al., 2024; Schwaeye et al., 2024).

Compatibility, however, cannot be measured by technical infrastructure alone; it must also account for business processes and workforce adaptability. As employees begin working with AI-based decision-making tools, predictive analytics and automation systems, they need to expand their existing skill sets to keep pace. Industry evidence suggests that the organizations with the strongest cultures of innovation also tend to show the highest rates of AI adoption, since the acceptance and use of AI systems within an organization depends heavily on employees' perceived ease of use and perceived usefulness of the system (Chatterjee et al., 2022; Schwaeye et al., 2024).

External factors also shape AI adaptability within SMEs, including industry regulations, compatibility with existing industry standards, and partnerships with technology providers. Because many SMEs depend on third-party AI vendors, aligning external AI solutions with

internal business workflows becomes essential to achieving operational efficiency and minimizing disruption. Cloud-based AI solutions, for instance, offer greater flexibility and scalability, allowing SMEs to adopt AI technologies without extensive changes to their on-premise systems (Denning & Lewis, 2020; Saleem et al., 2024).

Taken together, these findings suggest that a major step toward successful AI adoption in SMEs is ensuring compatibility between new technology, the existing IT landscape, business needs and workforce skills. By investing in flexible IT structures, training employees and aligning AI efforts with business processes, organizations can secure lasting returns from AI deployment. Addressing compatibility issues early in the implementation process plays an essential role in strengthening SMEs' competitiveness and operational efficiency.

4.2 Organizational Culture and Leadership

While technological readiness is a necessary condition for AI adoption, organizational culture and leadership commitment are equally important enablers. Leadership is critical to ensuring that employees feel empowered by AI-driven change, that they are upskilling for AI integration, and that AI-related strategies stay aligned with business goals. AI adoption in SMEs is positively shaped by executive involvement and organizational preparedness, which in turn relates directly to allocated funding, employee adaptability and digitalization across the organization (Lada et al., 2023). AI adoption represents a paradigm shift for organizations, bringing rapid changes to existing workflows, decision-making processes and organizational structures, and change management is therefore a key part of a successful AI rollout. In Roa Baez and Igbekele's (2021) interview study of the Swedish AI ecosystem, the head of AI at one large firm summarised this balance by observing that AI is "10% about algorithms, 20% about technology" and around 70% about change management and people (p. 21). This captures a central theme running through the literature: AI adoption is not simply a technology challenge but a challenge of culture, structure and psychology. This finding echoes a broader pattern identified across the wider literature on SME AI adoption, where organizational culture, communication and adaptable leadership consistently emerge as a distinct enabling cluster alongside technological and environmental factors (Schwaeke et al., 2024).

4.2.1 Leadership Commitment to AI Adoption

Resistance to change and the need for strategic communication are critical hurdles that must be overcome before wider AI adoption can be achieved. Responsibility for this rests with leadership and management, who must address not just individual use cases but whole-of-organization programs and strategic alignment. Organizations need visionaries and advocates who understand AI's purpose, potential benefits and fit with the organization, not merely an awareness of the technology. The interviewees in Roa Baez and Igbekele's (2021) study stressed that organizations

led by individuals with a clear vision were better able to navigate the complexities of AI adoption, and that leaders who stayed engaged with the change process — along with the teams they led — made transitions smoother (Roa Baez & Igbekele, 2021).

At the leadership level, commitment to AI adoption plays an imperative role in its success. Leadership is a key driver of any AI project because it shapes the culture for digital transformation, determines investment in AI as an implementation strategy, and ensures that employees adapt to a phased AI change process. Top management commitment is a significant determinant of AI adoption, since it directly influences strategic decision-making, financial investment and overall organizational readiness (Lada et al., 2023). This aligns with correlational evidence from Indian SMEs, where management support was one of the strongest and most consistent predictors of AI adoption decisions (Jadhav, 2021).

Without committed managers, smaller enterprises struggle to resolve the practical problems that arise during AI implementation. SME owners already face limited capital, a shallow talent pool, fragmented technological infrastructure and a lack of in-house computing expertise, all of which make large-scale AI implementation difficult. When leadership views AI as a strategic investment rather than simply an optional tool, SMEs are more likely to succeed. Research shows that organizations whose leadership actively supports AI initiatives adopt AI at higher rates, because such leaders manage change effectively, listen to employee concerns and foster an environment in which AI solutions are seen as valuable business assets (Lada et al., 2023; Badghish & Soomro, 2024).

One of the most persistent barriers to AI adoption is that leaders are often hesitant to invest in AI technologies because of the perceived risk of a high and uncertain return on investment. Most SMEs operate on limited budgets, which makes AI investment feel costly and uncertain. On the other hand, evidence indicates that leaders who invest early in AI infrastructure, workforce training and strategic realignment are often rewarded with long-term gains, including greater operational efficiency, more data-driven decision making and an enhanced customer experience (OECD, 2021). A digital-first outlook allows SME leaders to narrow the technological gap and keep their organizations competitive in an increasingly AI-driven business environment.

Organizational readiness for AI integration is another critical factor tied to leadership commitment. Research indicates that an SME's readiness to adopt AI is closely linked to its leadership's willingness to pursue digital transformation (Lada et al., 2023). This entails ensuring that employees are equipped with the necessary AI skills, that business processes align with AI functionality, and that the infrastructure needed to support relevant applications is in place. AI adoption initiatives struggle without strong leadership commitment, as employees may disengage out of fear of being displaced, overworked or underprepared. Leaders should therefore proactively communicate the value of AI, invest in reskilling employees, and cultivate a work culture that encourages experimentation and innovation (Ahmed, 2024).

Beyond internal organizational factors, leadership also plays an important role in addressing external challenges related to AI adoption, such as regulatory compliance, cybersecurity risk and partnerships with technology providers. AI-driven businesses are required to adhere to existing global data privacy laws, ethical AI guidelines and relevant industry standards in order to use AI responsibly. SME leaders need to take a proactive stance on regulatory compliance by embedding ethical AI and cybersecurity principles into their AI strategy (OECD, 2021). Partnerships with AI vendors, research organizations and government initiatives can also give SMEs access to expertise, funding and best practices that help them scale AI use while minimizing risk.

Leadership commitment is, in short, the golden thread running through successful AI adoption in SMEs. Leaders who champion AI, invest wisely, prepare their workforce and navigate regulatory hurdles put their organizations on a path toward sustainable, AI-led growth. AI adoption is not simply a technology upgrade; it is a shift in mindset across teams that is possible only with the right leadership, a culture of digital innovation, and an AI vision that is tightly linked to business needs.

4.2.2 Support for AI-Driven Change within the Company

Transparent and precise communication is essential to addressing employee fears and skepticism. Leaders must openly discuss the implications of AI adoption, including its impact on roles and workflows. By involving employees in decision-making and clearly explaining the value AI brings, organizations can build trust and reduce resistance. Framing AI as a technology that assists employees rather than replaces them is central to this, and it mirrors findings elsewhere in the literature, where open, ongoing communication with employees is identified as a distinct pillar of the organizational culture needed for successful AI adoption (Schwaeke et al., 2024).

One strategy that emerged as successful in Roa Baez and Igbekele's (2021) interviews was creating "AI ambassadors" — employees who advocate for AI initiatives within the organization. These ambassadors act as a bridge between leadership and the broader team, promoting AI adoption and providing peer-to-peer support during the transition. SMEs, with their smaller and more agile teams, are particularly well placed to benefit from internal champions of this kind (Roa Baez & Igbekele, 2021).

AI adoption often involves uncertainty, which becomes especially visible during the training and deployment of AI models. A culture that supports experimentation and treats failure as part of the learning process is therefore crucial. Adopting a "fail fast" philosophy, in which unsuccessful experiments are treated as learning opportunities rather than failures, can encourage innovation and sustain momentum.

Resistance often stems from a lack of understanding, knowledge and confidence in using AI technologies. Providing employees with training and proper guidance to understand AI and its

applications is therefore a vital step in the adoption process. Upskilling initiatives not only close knowledge gaps but also empower employees to engage with AI systems, strengthening their sense of job security and their contribution to the organization's goals (Iyelolu et al., 2024).

The size of an organization also influences the complexity of its communication strategies. In larger organizations, managing change means navigating multiple layers of hierarchy and diverse teams, whereas smaller organizations typically have shorter communication channels that let leaders engage directly with employees and address concerns. Consistent with this, SMEs reported fewer challenges related to resistance compared with larger companies (Roa Baez & Igbekele, 2021).

4.3 Skilled Workforce Availability

Access to a skilled workforce is an absolute requirement for successfully adopting and implementing AI in SMEs. The ability to attract, develop and retain skilled professionals directly affects an organization's ability to integrate AI into existing processes and carry out digital transformation, and the combination of a skilled workforce and AI undeniably shapes an SME's capacity for innovation, product development and competitive positioning. This section examines the challenges and strategies of talent acquisition in SMEs, focusing on the shortage of senior talent, the reliance on junior talent, and the importance of cross-functional expertise (Peretz-Andersson et al., 2024; Ingalagi et al., 2021).

4.3.1 Access to Talent

The AI sector is growing rapidly, which in turn is driving high demand for talent. SMEs, however, face stiff competition from large enterprises with far greater resources for hiring skilled workers, and they often cannot match the salaries and benefits that larger corporations offer, which makes hiring experienced AI professionals a significant challenge. Even when SMEs do manage to recruit senior talent, retaining them is another major difficulty: senior professionals are often drawn away by better offers or more prestigious roles, and SMEs struggle to provide the long-term career growth opportunities needed to retain them in a competitive job market. This shortage of senior AI talent hampers SMEs' strategic goals — without experienced professionals to guide the process, AI projects can face delays and fail to achieve optimal results, since senior talent is crucial for project management, algorithm development and integrating AI into business processes. In a study of SMEs in the manufacturing sector, several firms reported stalled AI initiatives due to a lack of senior AI experts. As one manager explained, "The absence of senior expertise has left us dependent on external consultants, which increases costs and reduces our in-house capacity to manage AI systems" (Peretz-Andersson et al., 2024). This talent shortage is not unique to any one context: a systematic review of the wider SME literature likewise identifies a persistent lack of in-

house AI specialists as one of the most frequently cited resource constraints on adoption (Schwaeke et al., 2024).

4.3.2 Training and Upskilling

Given their financial constraints, SMEs frequently rely on junior professionals to fill the talent gap. Junior hires, including recent graduates and early-career professionals, offer a cost-effective alternative to senior hires, and although they may lack experience, junior talent can be trained to meet the specific needs of the organization (Iyelolu et al., 2024).

SMEs frequently collaborate with academic institutions to identify and recruit talent. Internship programs and sponsored research projects give students the opportunity to work on real-world problems while giving SMEs access to a pipeline of potential hires. Several Swedish SMEs, for example, have done this successfully through master's thesis projects in which students work with the firm on applying AI to manufacturing. SMEs are also upskilling their junior employees directly, through programs designed to train them in essential AI skills such as data analysis, machine learning and cloud-based AI tools — an approach that helps bridge skill gaps while increasing employee loyalty and reducing turnover (Ingalagi et al., 2021).

Investing in junior talent allows SMEs to plant the seeds of a sustainable AI workforce: building a pool of AI specialists internally can yield a pipeline of experts who develop alongside the organization over time, consistent with the wider goal of strengthening organizational readiness for AI. Implementing AI also requires technology integration across multiple business functions, so diverse, cross-functional teams spanning IT, marketing and operations are critical to ensuring that AI implementation stays aligned with organizational goals. These teams support a more holistic approach to problem solving and ease the adoption of AI. Because SMEs commonly have departmental silos that hamper communication and cooperation, cross-functional teams can help by fostering information sharing and joint decision-making. Manufacturing SMEs in Sweden, for instance, reported that establishing cross-departmental AI task forces helped them tackle process inefficiencies and improve customer demand forecasting. Regular workshops and team meetings further familiarize employees with the range of AI opportunities available across industries and help align technical capabilities with business objectives.

AI projects also benefit from individuals with hybrid expertise — professionals who combine technical knowledge with domain-specific skills. An AI specialist with experience in supply chain management, for example, can optimize logistics more effectively than a purely technical expert, which is why SMEs increasingly seek employees who can bridge technical and functional areas. Talent acquisition remains a major challenge for SMEs adopting AI: the shortage of senior talent, the reliance on junior talent, and the need for cross-functional expertise together shape the landscape of workforce development in this sector. These challenges can be addressed through

targeted recruitment, partnerships with academic institutions and cross-departmental collaboration, allowing SMEs to build a sustainable talent pipeline that strengthens both the effectiveness of AI adoption and their long-term competitiveness (Peretz-Andersson et al., 2024; Schwaeke et al., 2024).

4.4 Financial Constraints

While AI has the potential to transform a business, its adoption among SMEs is still at an early stage. SMEs, compared with large corporations, generally operate with smaller budgets and a limited ability to raise external finance, which makes it difficult to acquire the infrastructure, personnel and other resources a successful AI introduction requires. The OECD (2021) identified high initial costs, uncertainty about future returns and underdeveloped funding ecosystems as significant barriers to AI uptake among smaller firms, compounded by limited public awareness, fragmented policy support and a mismatch between the financing available and SMEs' specific needs. Understanding and addressing these financial barriers is essential if SMEs are to participate fully in, and benefit from, AI-driven digital transformation (OECD, 2021; Comunale & Manera, 2024).

4.4.1 Budget Allocation for AI Integration

For SMEs, particularly in the manufacturing sector, adopting AI is a promising but resource-intensive undertaking. One of the most pressing problems identified in the literature is that SMEs are rarely able to set aside dedicated internal budgets for AI integration: with profit margins far thinner than those of larger businesses, SMEs have little room to commit new funding to ventures of this kind. SMEs consequently find it hard to embrace technologies such as AI (Oldemeyer et al., 2024). As Peretz-Andersson et al. (2024) noted, AI integration requires not only strategic vision but also substantial capital investment in computing infrastructure, data platforms and qualified personnel, and these internal budgetary limitations often force SMEs to choose between continuity of operations and investment in innovation. Their empirical evidence from Sweden's manufacturing SMEs illustrates where this conflict lies: AI implementation is frequently blocked by the high cost of acquiring AI-enabling infrastructure such as smart sensors, cloud services and AI-compatible machinery. Firms such as Alpha and Beta, for example, invested substantial sums in smart sensors and computing capacity but were still hit hard by the further capital investment that updated systems and facilities required. Mapping an enterprise's hardware and software capabilities to identify where this investment should go itself demands considerable time and financial planning (Peretz-Andersson et al., 2024). This financial pressure is a recurring theme across the broader SME literature, where limited funds are consistently identified as one of the most significant barriers to AI adoption, regardless of geography or sector (Schwaeke et al., 2024).

The budgeting challenge is not limited to technology purchases. Developing internal capacity — whether by hiring data scientists or training existing staff in AI skills — imposes further financial burdens. Peretz-Andersson et al. (2024) described how the SMEs in their case study tried to build internal resources by bringing in outside talent and launching their own training programs, but these efforts depended heavily on access to funds, which was often limited. As one production development manager in the study put it, success in AI projects depends on both willing people and ready systems, and both are closely tied to how much budget is available for system upgrades and human resource development. Participating SMEs also reported that financial investment is needed continuously, not only at the outset of AI adoption but throughout the process of sustaining and scaling AI operations — implementing standardized cloud systems such as Microsoft Azure, or integrating ERP with AI tools, both require ongoing budget allocation. Many SMEs turned to partnerships with outside AI consultants to compensate for limited in-house capacity; while useful for closing knowledge and implementation gaps, these partnerships can become costly without a long-term investment strategy of the company's own (Peretz-Andersson et al., 2024).

A further complication in AI budgeting is the intangible nature of the expected return on investment. Unlike tangible assets, AI systems rarely offer instant or easily quantifiable financial returns, which makes decision-makers reluctant to commit funding. As a result, investment in AI is often deliberately kept small or piecemeal, which limits the overall results that corporate AI initiatives can achieve. Without a clear, well-funded roadmap, SMEs struggle to progress from pilot projects to full-scale AI integration (Peretz-Andersson et al., 2024).

How quickly and how deeply SMEs adopt AI therefore depends in large part on their access to internal budgets. As Peretz-Andersson et al. (2024) indicated, SMEs are generally keen to integrate AI but face several major financial barriers in doing so. What SMEs need is a dual approach that combines external support systems with internal financial strategies aimed at making digital transformation a genuine pillar of business growth.

4.4.2 Access to Financial Resources for AI Investment

If SMEs are to adopt AI at scale, having the financial means to do so is essential. AI holds the promise of radical change in automation, predictive analytics and optimization across business functions, but SMEs continually run into structural barriers when trying to secure the funding these initiatives require (OECD, 2021). While large corporations typically have multiple options for raising capital, including their own R&D budgets, SMEs tend to operate within narrow financial margins and depend on external finance that may either be unavailable or offered on terms unsuited to forward-thinking, innovation-led projects such as AI adoption (OECD, 2021; Comunale & Manera, 2024).

The OECD (2021) highlighted this financing gap directly: traditional financial institutions, including commercial banks, remain reluctant to extend credit to SMEs for AI projects, citing high upfront costs, uncertain returns and the intangible nature of AI assets. Access to finance usually requires a track record of success and a degree of collateral that new or early-stage SMEs — particularly those outside technology-intensive sectors — often cannot provide (OECD, 2021). Because the value and outcomes of AI solutions are difficult to quantify, and no internationally agreed financial indicators for AI return on investment yet exist, financial institutions tend to perceive AI lending as riskier, which further discourages institutional investment. Fintech solutions such as AI-powered credit scoring and alternative sources of finance offer a promising way forward, but despite their potential, such approaches remain the exception rather than the rule within SME financing (OECD, 2021).

Neural network techniques can analyze large volumes of alternative data, including transaction histories as well as social media activity, which can help banks refine credit scoring for small loans and reduce lending errors (OECD, 2021). While this technology carries the potential to lower default rates and lending costs, it has so far found only limited application, and mainly within more advanced digital economies (OECD, 2021). Compounding this, the absence of a dedicated legal entity for AI-related activities and weak data communication capabilities act as further obstacles to successful AI adoption. Together, these factors point to a need for additional investment in digital infrastructure — cloud computing, IoT devices and high-speed connectivity — on top of SMEs' existing expenses (OECD, 2021), which is one reason many enterprises can launch small AI pilots but struggle to scale them further because of financial constraints (OECD, 2021).

Public policy can help bridge this financing gap. The OECD (2021) recommended building a stronger evidence base on AI return on investment to guide both SME managers and financial institutions, and encourages policymakers to develop specialized financing instruments for SMEs, including government-backed innovation grants, subsidies for AI adoption and concessional financing models. Centralized knowledge-sharing platforms, such as the OECD.AI Policy Observatory, can also help showcase leading practices, improve financial literacy and build investor confidence in AI investment. This is consistent with empirical findings that government support is one of the significant factors shaping AI adoption outcomes for SMEs (Badghish & Soomro, 2024).

Even where public funding or policy support exists, however, SMEs are often held back by limited awareness, complex application processes and insufficient internal capacity to apply for this kind of support. A further challenge stems from a lack of alignment between national policies and local support systems, which can leave funding options for SMEs fragmented and inconsistently accessible (OECD, 2021).

While technological improvements and policy initiatives can help address some of these constraints, a more holistic, SME-centered approach is still needed — one that expands access to

alternative finance, aligns public support instruments with the economic and investment realities SMEs face, and equips SMEs with both the financial and informational tools they need to engage in AI transformation confidently and sustainably.

4.5 Economic and Social Barriers

AI holds immense potential for SMEs, capable of improving productivity, efficiency and innovation. Yet alongside this potential, SMEs face their own particular economic and social barriers to adoption. From an economic perspective, they frequently struggle with limited financial resources, restricted access to diverse talent, and the cost of building and maintaining AI infrastructure (OECD, 2021; Peretz-Andersson et al., 2024). Socially, the challenges are just as significant, with employee resistance and fears around job security acting as major barriers. Organizational inertia and slow technological uptake can often be traced to limited digital literacy, fear of job displacement, and skepticism about AI's role in decision-making (Roa Baez & Igbekele, 2021; Rajaram & Tinguely, 2024). This interplay of economic and social factors underscores the importance of supporting SMEs through human-centered initiatives, not purely technological ones, if the challenges surrounding AI implementation are to be resolved and SMEs are to be more fully integrated into the AI ecosystem.

4.5.1 Employee Resistance

Employee resistance is one of the major social barriers to AI adoption in SMEs. Integrating AI technologies often brings substantial change to work processes, skill sets and roles, which creates uncertainty and fear among employees (Roa Baez & Igbekele, 2021). This resistance often stems from limited understanding of, or experience with, AI systems, particularly in SMEs where digital literacy is unevenly distributed across the workforce. The OECD (2021) highlighted that employees' attitudes and awareness — the human factor — are a key determinant of successful AI adoption: when workers remain passively engaged with digital transformation, their disengagement or reluctance can impede the transition (Iyelolu et al., 2024).

Peretz-Andersson et al. (2024) similarly emphasized that AI adoption in SMEs is as much a people challenge as a technological one. Their research suggests that manufacturing SMEs need to invest in earning employee trust in AI systems through ongoing communication, training and inclusive project planning. When employees are not shown how AI will affect their roles, they may come to believe they will become irrelevant or lose control over their work, which can lead to passive or even active resistance to change. This is particularly problematic in SMEs, where individual employees often carry multiple responsibilities, making their buy-in essential to operational continuity.

SMEs also tend to have informal or immature change management mechanisms, since structured models are often lacking and employee concerns go unaddressed. Rajaram and Tinguely (2024) explained that with generative AI technologies capable of performing complex cognitive tasks — such as content creation or customer interaction — employees may come to see the technology not merely as a tool but as a direct competitor. If not handled carefully, this perception can erode morale and productivity. Because SMEs generally lack dedicated HR or change management expertise to address these psychological and organizational issues, this gap can stall or delay AI rollout (Schwaeke et al., 2024).

4.5.2 Job Security Concerns

A second issue closely tied to employee resistance is concern over job security. As AI takes on increasingly complex cognitive and creative tasks, workers in SMEs have reason to fear more than the automation of routine jobs alone (OECD, 2021). These fears are not unfounded: evidence shows that AI applications can already displace human roles in areas such as customer service, data entry and marketing decision-making (Mendoza Arce et al., 2024). This creates a paradox for SMEs — AI promises increased efficiency and reduced labor costs, yet its implementation can simultaneously undermine employee trust and generate resistance rooted in perceived threats to employment.

The psychological effects of job insecurity may be especially pronounced in SMEs, where job roles tend to be less standardized and more interwoven than in larger organizations. Unlike larger firms, which can more easily implement institutionalized reskilling plans and internal job postings, SMEs often lack the flexibility to reassign displaced workers into new roles (Baabdullah et al., 2021). This raises the stakes for workers, who may feel reluctance or fear when the time comes to adopt or support AI systems. According to Roa Baez and Igbekele (2021), these feelings are compounded by a lack of transparency around AI decision-making, which reinforces employees' sense that they are losing agency in the workplace.

Generative AI's growing ability to perform complex tasks once considered secure — writing, design and strategic planning among them — has heightened fears of obsolescence even among knowledge workers. Rajaram and Tinguely (2024) argued that SMEs need to mitigate these concerns by framing AI as a supplement rather than a substitute for human work. This requires effective communication plans and concrete assurances on job security, backed by investment in reskilling and upskilling programs. However, such programs demand financial and organizational capacity that many SMEs simply do not have, which makes building employee trust in AI more difficult still.

In sum, economic and social barriers such as employee resistance and fear of job loss remain major obstacles to AI adoption in SMEs, closely bound up with organizational culture, leadership approach and workforce readiness. Addressing them requires SMEs to invest in both their technology stack and a people strategy that accounts for the human, emotional and psychological dimensions of the transition to AI.

4.6 Ethical and Privacy Concerns

Alongside AI's potential to revolutionize efficiency, decision-making and customer engagement come important ethical and privacy challenges that SMEs are often ill-prepared to address. Unlike large corporations with dedicated legal and technical teams, SMEs typically lack the resources and expertise to safeguard ethical AI adoption, particularly when it comes to complying with data privacy laws and managing algorithmic bias. One of the biggest challenges for SMEs — especially where personal and sensitive operational data has effectively become a commodity in the age of AI — is ensuring their AI systems keep pace with continuously evolving data protection requirements (OECD, 2021). Because they often rely on opaque, pre-trained AI models, SMEs are also vulnerable to inadvertent bias that can lead to discriminatory practices or flawed business decisions (Baabdullah et al., 2021), a risk further heightened by their dependence on third-party vendors and cloud-based services, where control over data and algorithmic processes can become limited. As Rajaram and Tinguely (2024) observed, the rise of generative AI adds a further layer of complexity, underscoring the need for greater transparency and ethical oversight of AI-generated content. Attending to ethics and privacy is therefore not a box-ticking exercise but a necessary condition for sustainable AI adoption among SMEs, a point echoed by broader reviews of AI regulation, which find that ethics and data protection remain among the areas academic research and policy actions least agree on how to handle (Comunale & Manera, 2024).

4.6.1 Data Privacy Compliance

SMEs must grapple with the ethical implications of incorporating AI into their operations, particularly around data privacy compliance. Because AI systems, especially machine-learning-based ones, typically process large volumes of data that often include sensitive information about customers or employees, SMEs come under pressure to comply with data protection regulations such as the General Data Protection Regulation (GDPR) in Europe or equivalent frameworks elsewhere (OECD, 2021). Most SMEs, however, do not have legal counsel or compliance teams to ensure that personal data is governed properly. The OECD (2021, 2022) pointed to a further risk: many SMEs do not fully understand how their data is collected, stored and processed by AI systems, particularly when that processing is handled by third-party platforms or cloud-based Software-as-a-Service (SaaS) providers (Comunale & Manera, 2024).

This problem intensifies when SMEs delegate AI capabilities to external vendors through Machine-Learning-as-a-Service (MLaaS) arrangements. While these services often come with

built-in security features, they also raise concerns about data ownership, data portability and vendor lock-in (OECD, 2021). Because SMEs may lack complete control, or even visibility, over the datasets used to train their AI models, they face a heightened risk of unintentionally violating privacy regulations, and limited resources mean they are less likely to conduct rigorous audits of their vendors' data management practices. Data privacy compliance is therefore a multifaceted issue that extends well beyond technical implementation, requiring legal literacy and active governance that many SMEs currently lack (Roa Baez & Igbekele, 2021).

4.6.2 Algorithmic Bias

Algorithmic bias is another significant ethical risk SMEs face in adopting AI. It occurs when AI outputs are systematically skewed against certain groups, distorting the business decisions built on them. For SMEs, which often lack the capacity to collect and process large volumes of data themselves, unrepresentative or poor-quality training data is a common cause of bias (OECD, 2021). Because SMEs typically rely on pre-trained models or third-party tools, they can unknowingly inherit the biases embedded in those systems, and they rarely have the technical expertise needed to audit or interpret the underlying decision logic (Ahmed, 2024).

One of the most widely publicized examples of algorithmic bias involved facial recognition systems that performed markedly worse on people with darker skin tones (BBC, 2018). These errors stemmed from underrepresentation in training datasets, which caused the systems to generalize poorly across demographic groups — a clear illustration of how a mathematically sound algorithm can still produce biased outcomes when trained on biased data, with consequences that can extend to human rights, customer trust and legal compliance.

In a similar vein, a report by NBC News (Berlatsky, 2018) described how Google's search algorithms have perpetuated existing social biases, since search results are shaped by patterns of past user behavior and website rankings that can mirror broader social inequities. This undermines the assumption that AI systems are neutral or objective: rather, they tend to echo and amplify the values embedded in their data and programming. For SMEs using AI-based platforms for marketing, hiring or customer profiling, such biases can lead to exclusionary practices, diminished customer satisfaction and reputational damage, sometimes without the business even being aware of it.

The consequences of algorithmic bias can be damaging to both business integrity and consumer trust, whether through biased hiring algorithms that lead to discriminatory recruitment practices or biased recommendation systems that exclude entire customer segments. Baabdullah et al. (2021) noted that businesses deploying AI for business-to-business (B2B) customer interactions often lack the infrastructure to track or respond to such unintended consequences, which can expose them to reputational or legal risk. Compounding this, AI systems that self-correct based on

sequential data can perpetuate and amplify discrimination if feedback loops and human oversight are not built into the system (OECD, 2021).

Ethical issues are further magnified in generative AI systems capable of producing content independently. Rajaram and Tinguely (2024) argued that generative AI can pose a threat to employee identity and consumer trust, given how opaque the content-generation process often is. This challenge is especially relevant for SMEs using generative AI for marketing or customer service, since they rarely have the capacity to verify that generated outputs are authentic and fair. Without clear guidance or built-in auditing capabilities, SMEs run the risk of deploying systems that breach ethical guidelines or amplify bias.

4.7 Data Management and Quality

AI is widely recognized as a major contributor to improved innovation, operational efficiency and competitive advantage among SMEs. Yet the success of AI adoption hinges on the quality of the underlying data and how well it is managed, which remains a struggle for many SMEs. While large companies generally have well-established digital systems, such as customer data platforms, to manage their information, SMEs are more likely to rely on fragmented systems, inconsistent data practices and limited governance protocols (OECD, 2021). Data governance, consistency and reliability are key to ensuring that AI systems operate safely and ethically: poor input data quality can cause algorithmic failures, and the absence of formalized data governance exposes SMEs to compliance and privacy risks (Peretz-Andersson et al., 2024). Inconsistent data across different functions further limits SMEs' ability to scale AI initiatives and draw useful insights from them (Roa Baez & Igbekele, 2021). As the economy becomes increasingly AI-driven, SMEs must focus their digital transformation plans on these foundational aspects of data in order to build trust, transparency and sustainable business models that keep pace with new technologies and preserve their market position.

4.7.1 Data Governance

Effective data governance is a crucial foundation for AI adoption, particularly for SMEs, which often lack even basic digital infrastructure. Data governance encompasses the policies and procedures that ensure data remains accurate, secure, accessible and ethically handled throughout its lifecycle, and AI systems need well-governed, structured data ecosystems to perform optimally. Many SMEs, however, still lack formal guidelines and dedicated staff to manage data governance effectively (OECD, 2021), and their data is often siloed across departments or stored in unstructured formats such as spreadsheets and local databases, which makes it difficult to extract, standardize or convert into AI training inputs (Peretz-Andersson et al., 2024; Schwaeye et al., 2024).

The OECD (2021) identified the absence of a “data culture” as a major obstacle to wider AI adoption among SMEs. Without a sound governance foundation, a company tends to run AI in isolated pockets rather than as a broad-based, data-driven initiative, and the absence of governance mechanisms puts data privacy and regulatory compliance at greater risk. Because many AI solutions rely on customers’ or employees’ personal information, SMEs are under growing pressure to comply with the GDPR and similar regulations, even when they have few resources to keep pace with new legislation (Rajaram & Tinguely, 2024). Without governance, data misuse or mislabeling can lead to biased AI outputs or legal penalties, undermining the very benefits AI is meant to deliver.

SMEs’ growing dependence on third-party platforms such as Software-as-a-Service (SaaS) and Machine-Learning-as-a-Service (MLaaS) adds a further layer of data governance challenges, including concerns over data ownership, portability and long-term control, since vendors may impose restrictions that limit an SME’s ability to extract or reuse its own data (OECD, 2021). To capture the maximum long-term benefit from AI, SMEs need to invest not only in AI capabilities but also in data stewardship practices that ensure data is used ethically and strategically.

4.7.2 Consistency and Reliability

Data quality and reliability remain paramount to making AI work for SMEs. AI models depend on clean, complete and consistent datasets for pattern recognition and prediction, and inconsistencies — missing values, duplicate entries or outdated information — can lower model accuracy and generate unreliable insights, which is particularly damaging in customer-facing or operational systems (Baabdullah et al., 2021). Insufficient documentation, distributed IT systems and manual data entry procedures leave many SMEs struggling with persistent data quality issues (Roa Baez & Igbekele, 2021).

Inconsistent data is a particularly critical concern, since it not only degrades algorithm performance but also erodes user trust in AI. When employees repeatedly encounter false-alarm outcomes, they begin to question the accuracy of AI recommendations, and this loss of trust slows adoption and encourages human overrides that cancel out the efficiency gains AI is meant to deliver. As Peretz-Andersson et al. (2024) noted, implementing technology in SMEs is knowledge-intensive not only in terms of orchestrating technical resources but also in building the internal capability to continuously check and validate the data feeding into AI systems.

SMEs also face additional reliability challenges because of their limited capacity for real-time data processing and systems integration. Many AI tools depend on up-to-date information to deliver real-time predictive analytics or automated decisions, yet SMEs often still run legacy systems without automated data pipelines, resulting in data delays and discrepancies. As the OECD (2021) noted, firms in less digitally advanced economies tend to show lower adoption of even basic data

analytics and consequently lag further behind in AI, weighed down by compromised data reliability.

The solution lies in building internal capacity for data cleansing, normalization and validation, alongside efforts to standardize datasets — for example, by creating common formats and metadata tags. At the same time, industry and government stakeholders need to support SMEs with toolkits, training and incentives that encourage high-quality data practices, since even the best AI tools cannot deliver meaningful value without trustworthy data.

4.8 Customer Engagement and Satisfaction

The rapid development of AI technology has permanently changed how businesses interact and communicate with their customers, offering considerable potential for SMEs looking to improve customer service and satisfaction. SMEs, which have traditionally been constrained by their size, budget and technical capacity, are increasingly using AI to deliver enterprise-class customer experiences through automation and personalization, providing more real-time responses to customers (Baabdullah et al., 2021; OECD, 2021). Chatbots and AI-based recommendation engines are making customer service more seamless for SMEs across multiple touchpoints through predictive analytics, and the rise of generative AI platforms such as ChatGPT — whose usage grew by roughly 900% in 2023 (eMarketer, 2023) — reflects a broader shift among SMEs toward using AI to replicate human-like conversation, streamline customer interactions and provide immediate, reliable support. As Mendoza Arce et al. (2024) and Rajaram and Tinguely (2024) both noted, these technologies allow SMEs to build highly personalized and engaging experiences at scale, strengthening customer loyalty and differentiating them from competitors. Even so, realizing these benefits requires SMEs to implement AI diligently, with careful attention to data privacy, ethical use and long-term customer trust.

4.8.1 Customer Service Improvement via AI

AI has played a pivotal role in improving customer service for SMEs while lowering its cost. AI-driven solutions such as chatbots, automated response systems and intelligent virtual assistants give SMEs round-the-clock availability and faster resolution of common queries. Mendoza Arce et al. (2024) noted that AI integration allows SMEs to automate routine service processes, reduce human error and deliver a more consistent customer experience across digital channels, resulting in quicker response times and higher customer satisfaction (Mendoza Arce et al., 2024; Aljarboa, 2024).

The emergence of generative AI tools such as ChatGPT has further changed how businesses interact with customers: usage grew by roughly 900% in 2023 (eMarketer, 2023), reflecting a significant shift toward generative AI for customer engagement. SMEs use these tools to replicate human conversation, interpret natural language input, and generate relevant responses in customer

service scenarios. With minimal configuration, generative AI lets SMEs handle high volumes of inquiries, route complex cases to human agents, and maintain a professional communication style even without a large support team — helping level the playing field between SMEs and larger firms in customer support.

Baabdullah et al. (2021) noted that AI also enables SMEs to practice more proactive service management. Predictive analytics allows businesses to anticipate customer needs, resolve issues before they arise, and follow up after purchase to improve satisfaction and retention — helping SMEs move away from purely reactive service models toward anticipatory strategies that create a more seamless customer experience.

4.8.2 Personalization and Responsive Interactions

Beyond improving operational efficiency, one of AI's greatest advantages for SMEs is the ability to personalize customer interactions at scale — tailoring messages, content, offers, product suggestions, tone and timing to individual activity, preferences or purchase history. The arrival of generative AI tools and large language models such as ChatGPT has made it possible for SMEs without dedicated data science teams to generate personalized customer journeys (Rajaram & Tinguely, n.d.), dynamically adjusting the options presented to visitors in real time and fostering deeper engagement and stronger brand loyalty (Aljarboa, 2024).

Mendoza Arce et al. (2024) support this view, noting that AI allows SMEs to track and analyze customer data in order to anticipate behavior and adjust marketing accordingly. This responsiveness not only increases customer satisfaction but also drives higher conversion rates, as offerings become more closely tailored to individual needs. AI further allows SMEs to adjust messaging tone, frequency and distribution channel for each audience segment, extending a level of personalization once available only to larger corporations.

AI-based personalization also supports post-sale management, allowing SMEs to deliver customized follow-up messages, exclusive offers or feedback requests that build long-term customer loyalty — a capability that is especially valuable in B2B and service-oriented SMEs, where relational capital carries significant weight (OECD, 2021). These benefits, however, come with real challenges around the ethical use of customer data and transparency in AI-driven decisions. SMEs need to design personalization strategies that comply with privacy regulations and build trust through transparency about how customer data is used (Rajaram & Tinguely, 2024).

4.9 Competitive Advantage

AI offers SMEs a genuine path to sustainable competitive advantage in today's digital landscape. Unlike traditional tools that provide only limited insight, AI allows SMEs to increase operational efficiency, make more data-driven decisions and engage customers with greater accuracy,

positioning them as viable competitors to larger enterprises (OECD, 2021). The emergence of advanced AI tools — particularly generative AI and predictive analytics — has democratized capabilities once reserved for large technology firms, making them accessible to SMEs as well (Rajaram & Tinguely, 2024). Incorporating AI into core functions such as marketing, product development and customer service equips SMEs with the speed, personalization and innovation needed to redefine their market positioning and stand apart from competitors (Peretz-Andersson et al., 2024). AI-powered predictive insights further support proactive decision-making, helping SMEs anticipate trends, reduce risk and respond quickly to shifting market demand (Agbonyin et al., 2024). Beyond improving efficiency, AI is increasingly becoming a competitive necessity for SMEs navigating digital transformation in highly competitive markets. This pattern is consistent with firm-level evidence that AI integration is associated with measurable productivity gains, particularly among smaller firms operating at the technological frontier (Kopka & Fornahl, 2024).

4.9.1 Market Positioning through AI Capabilities

Amid growing global competition and digital disruption, SMEs are looking for ways to strengthen their market position, and AI is one of the clearest enablers available to them. With AI, an SME can compete not only on price or scale but also on innovation, customer responsiveness and operational excellence (Mendoza Arce et al., 2024). AI-powered systems help SMEs build more targeted marketing campaigns, optimize customer interactions and turn data into actionable insight, which can improve the customer experience, raise conversion rates and strengthen brand recognition. AI also allows SMEs to automate rule-based marketing processes and reach narrow, audience-specific segments that would be difficult to access through traditional means (Mendoza Arce et al., 2024; Nafizah et al., 2024).

Generative AI, in particular, gives SMEs access to tools that are both creative and scalable — capabilities that were previously the preserve of large corporations (Rajaram & Tinguely, 2024). Through tools such as ChatGPT and other large language models, SMEs can produce market-ready output, including dynamic web content, promotional materials and client proposals, at minimal cost. This democratization of digital capability lets even smaller firms present themselves as technologically capable, progressive brands. AI's speed and flexibility not only improve SMEs' operational agility but are also helping redefine their position within competitive landscapes: rather than lagging behind, SMEs equipped with AI are increasingly positioned as innovators in their own right.

Resource orchestration theory further supports the argument that SMEs build competitive advantage by skillfully governing and deploying AI capabilities alongside human capital and existing systems (Peretz-Andersson et al., 2024). This allows firms to reallocate internal resources in response to market demand, making them more responsive to external pressures while maintaining a differentiated strategic position.

4.9.2 Differentiation through Predictive Analytics

Predictive analytics is another important avenue through which SMEs can strengthen their competitive advantage using AI. By applying historical data, machine learning algorithms and statistical modeling to forecast future events, SMEs using AI-based predictive systems can anticipate market trends, customer preferences, inventory needs and financial risks, giving them a meaningful edge in decision-making (OECD, 2021). Armed with this analysis, SMEs can better anticipate customer needs, adapt their offerings accordingly, and stay ahead in service delivery (OECD, 2021; Kopka & Fornahl, 2024).

Adesina et al. (2024) noted that incorporating predictive analytics into product development cycles can accelerate market entry, reduce operational risk, and help align products more closely with consumer preferences, ultimately increasing revenue. In manufacturing SMEs, for example, AI-driven predictive maintenance reduces downtime and extends equipment longevity, improving cost efficiency, reliability, and ultimately client trust and brand differentiation (Peretz-Andersson et al., 2024).

Agbonyin et al. (2024) further showed, in a study published in the *International Journal of Computer Engineering & Technology*, how combining predictive analytics with Internet of Things telematics data can provide real-time business intelligence that supports strategic planning and sustainable growth. These insights help SMEs not only stay ahead of market changes but also make customer interactions more personalized and precise than was previously possible outside large enterprises. While predictive analytics requires an initial investment in AI tools and data management systems, it allows SMEs to automate difficult decisions, reduce guesswork — a persistent constraint for companies of this size — and focus resources where they will have the greatest impact. As the OECD (2021) observed, this shift from reactive to proactive decision-making represents one of the most significant developments in SME competitiveness, particularly in markets defined by volatility and rapid innovation. Recent national survey data reinforce just how quickly this shift is happening: generative AI adoption in the United States has outpaced the early diffusion rates of both the personal computer and the internet, underlining how little time SMEs have to adapt before proactive, data-driven decision-making becomes the norm rather than the exception (Bick et al., 2024).

CHAPTER 5

Conclusion and Recommendation

5.1 Conclusion

The integration of AI into SMEs is transforming traditional business practices through the automation of processes, predictive decision-making and data-driven operations. This transformation is full of potential, but it also brings a range of challenges spanning technological, organizational, financial, ethical and cultural domains. The evidence gathered in this study illustrates both the scale and the interdependence of these challenges, while also pointing to the substantial opportunities AI offers for driving innovation, improving operational effectiveness, and ultimately becoming a source of competitive advantage for SMEs.

Technological readiness remains one of the major obstacles to AI implementation in SMEs. For many SMEs, legacy infrastructure still forms the backbone of their data processing capabilities, but it falls short of what modern AI applications require — high-speed internet, state-of-the-art computing systems and scalable, on-demand cloud platforms are often simply unavailable. Compounding this, many older ERP and CRM systems are not designed to integrate with AI tools, and the lack of proper data governance frameworks leaves many SMEs with inconsistent data, even though consistent data is critical to training effective AI models.

Workforce readiness is another area of concern. A shortage of senior AI specialists, combined with SMEs' inability to offer competitive salaries, limits their capacity to build AI solutions in-house. While many SMEs rely on junior talent and partnerships with educational institutions, the limited scale of structured upskilling and cross-functional collaboration continues to constrain the widespread implementation of AI. Many employees still lack the confidence and know-how to work directly with AI systems, which feeds into a broader cultural resistance to change — fear of job loss, limited understanding of what AI can do, and reluctance to move away from familiar ways of working all act as cultural barriers that slow the pace of adoption.

Leadership is critical to navigating these challenges. Organizations with visionary, proactive leadership are better positioned to manage AI-driven change: by articulating a clear AI strategy, allocating resources appropriately, and fostering a culture of innovation, leaders help ensure that technological integration stays aligned with business objectives. Without strong leadership, AI initiatives tend to become fragmented, change management falters, and morale suffers.

Financial limitations emerge as a consistent and recurring theme throughout this study. SMEs typically operate on thin margins, leaving little room for AI budget experimentation, infrastructure upgrades or talent development, and because AI assets are intangible and their returns hard to

predict, access to external funding remains a further barrier. This financial constraint undermines SMEs' ability to scale pilot AI projects into full-fledged solutions, and although both public policy initiatives and fintech solutions could ease the situation, they remain far from widespread, particularly in developing regions (Comunale & Manera, 2024).

Ethical and privacy-related concerns are becoming more pressing as AI adoption grows. Reliance on third-party AI vendors raises new questions about data ownership, algorithmic transparency and compliance with data protection legislation, while many SME leadership teams lack the legal knowledge and formal governance mechanisms needed to prevent the use of biased or noncompliant AI systems. Algorithmic bias, in particular, can produce unintended discriminatory outcomes that put brand integrity and customer trust at risk (Comunale & Manera, 2024).

Despite these challenges, AI offers SMEs an important opportunity to strengthen their competitive position. Through AI-driven predictive analytics, generative content tools and customer interaction platforms, SMEs can offer more personalized products and services while improving customer satisfaction and reading market trends more accurately — an ability that is especially valuable in fast-moving markets, where agility and responsiveness translate directly into competitive advantage. AI ultimately allows SMEs to shift from a reactive to a proactive posture, building greater resilience and supporting sustained innovation.

5.2 Recommendations

Enabling successful and sustainable AI adoption in SMEs requires several strategic and operational measures, outlined below.

First, SMEs should focus on modernizing their digital infrastructure. This requires laying a foundation of high-speed connectivity, cloud-based storage and scalable computing power that can support AI applications and integrate them into everyday business workflows. In practice, this means transitioning from older ERP and CRM systems toward AI-compatible solutions, or integrating APIs so that AI tools can operate alongside existing systems as needed.

Second, SMEs should build an AI-ready organizational culture. Leadership needs to take an active role in shaping this culture by articulating a clear vision for AI, managing expectations, and encouraging openness to change. Being transparent about the goals and benefits of AI, and implementing a structured change management process, helps ease employee resistance. Programs that appoint “AI ambassadors” — internal advocates who help bridge communication gaps between management and employees — can further support this transformation.

Third, closing the talent gap requires a hybrid model that combines external expertise with the development of talent from within. While hiring senior AI experts can be difficult, SMEs can grow junior talent through structured training and mentorship, and partnerships with universities and

research centers can help build a pipeline of emerging talent. Establishing cross-functional teams that draw on IT, operations and business units helps ensure AI projects move forward with technical efforts aligned to strategic goals.

Fourth, financial barriers need to be addressed from both directions. Internally, SMEs should adopt multi-phase investment planning for AI, beginning with small-scale pilots that demonstrate value before building further internal capability. Externally, governments and financial institutions should design financing models tailored to SME needs, such as innovation grants, concessional loans and subsidies for AI adoption. Financial education programs can also help SMEs build a stronger business case for AI, improving their access to capital.

Fifth, ethical AI practices and robust data governance should be built into an SME's AI strategy from the outset. This means introducing policies that address data ownership, user consent, data security and compliance with local and international regulations such as the GDPR, along with regular audits of AI systems to detect algorithmic bias and safeguard fairness and accountability. Explainable AI (XAI) tools can further enhance transparency and build trust in automated decision-making.

Sixth, customer engagement should be treated as a primary advantage of adopting AI. SMEs can use AI-powered bots to strengthen customer service in the near term, while considering AI-driven personalization for marketing and sales outreach. These tools can significantly improve customer satisfaction by enabling immediate, accurate and contextually relevant interactions, while AI-enabled analytics can also support predictive insight into customer behavior, product optimization and customer lifetime value.

Finally, SMEs should position AI as a long-term strategic asset rather than a short-term fix, one that strengthens competitive advantage over time. Embedding AI within market-facing and operational processes allows SMEs to become more agile and to differentiate themselves as market trends shift, with predictive analytics in particular supporting more accurate demand forecasting, inventory management and risk management. SMEs that embrace AI in this way are well positioned to become technology innovators in their own industries.

In conclusion, AI adoption is a multi-faceted journey for SMEs, but a genuinely achievable one. It requires coordinated action across leadership, infrastructure, workforce, finance, ethics and customer engagement. Approaching AI as a strategic transformation rather than a purely technical upgrade can help SMEs unlock new levels of efficiency, innovation and resilience in an increasingly digital economy.

5.3 Managerial Implication

The findings of this research carry several key implications for SME managers and decision-makers seeking to deploy AI as an enabler of growth and innovation. The central takeaway for managers is that AI adoption is not simply a technical undertaking — it requires leadership, cultural readiness and a clear vision. Managers need to shift from a reactive to a strategic mindset, treating AI implementation not just as a tool for cost optimization but as a lever for competitive advantage and continued market relevance.

Effective change management in AI implementation depends on leadership taking a digital-first approach: communicating changes clearly and helping employees feel included in the transition. Designating internal “AI ambassadors” to advocate for AI’s benefits and reduce employee pushback can support this process. At the same time, business leaders should prioritize incremental AI adoption, identifying areas where even small changes can have an outsized impact — such as automating customer service or inventory management — and building outward from there.

On the human resources side, managerial attention should focus on identifying and developing internal talent that understands both how AI systems work and what outcomes the organization wants from them. This can include partnerships with academic institutions, internal training initiatives and cross-functional team-building. In particular, managers should promote hybrid roles that combine domain-specific knowledge with digital and analytical skills.

From a financial perspective, managerial planning should incorporate AI investment into the broader strategic budgeting process — preparing cost-benefit analyses to justify AI investment to stakeholders and pursuing external funding sources such as grants, loans and partnerships. Managers must also stay current with the evolving regulatory and ethical landscape around data protection and algorithmic fairness, which is not only a legal necessity but also a strategic one for preserving brand image and customer confidence in AI tools built to such standards.

Finally, data quality, governance and security should be treated as the bedrock of AI readiness, since AI systems cannot deliver accurate or reliable insights without trustworthy data. This underscores the need for a proactive data strategy, supported by well-defined governance protocols and consistent adherence to data privacy regulations.

5.4 Future research

This study has surfaced several important aspects of AI adoption in SMEs while also pointing to avenues for future research. One direction is to explore industry-specific challenges and opportunities for AI adoption; a more detailed analysis of AI adoption across manufacturing, retail,

healthcare and service-based business models could help clarify the contextual factors that shape success. Industry- and region-specific replication would meaningfully extend this study's findings, particularly in settings that differ from the manufacturing-heavy contexts this study draws on most heavily.

A more complex, and ultimately valuable, direction would be longitudinal studies of AI's long-term impact on SMEs, tracking effects on profitability, market share and customer satisfaction over time. Future research should also examine the interplay between AI technologies and organizational behavior, particularly how leadership style, employee engagement and corporate culture shape AI-driven transformation.

The evolving landscape of generative AI also presents a rich area for further analysis. Future research could examine how tools such as ChatGPT affect creativity, marketing strategy and customer communication in SMEs, along with the ethical and operational risks they introduce. Because generative AI is diffusing so rapidly, this is a fast-moving area where findings could quickly become dated, reinforcing the need for continued monitoring rather than a single point-in-time study.

Further research is also needed into the policy frameworks and public-sector interventions that can facilitate AI adoption in SMEs. Assessing the impact of government-sponsored programs, funding schemes and training initiatives could yield valuable lessons for building more supportive ecosystems. Such work would be especially valuable because policy discussion to date says little about how these measures specifically affect the SME segment.

As AI continues to evolve, combining perspectives from engineering, management, law and psychology will become increasingly important. A more holistic, cross-disciplinary approach to future research will help set the direction for new frameworks within the SME landscape, ensuring that AI development supports both equity and sustainability.

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