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Adoption and Implementation of Emerging Technologies in SMEs: Insights from Semi-Structured Interviews with Founders

Nor Jijidiana. Bakhary[1], Norhidayah. Azman[2*], Abdelaziz. Elabjani[3]

[1] Faculty of Civil Engineering, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia
[2] Graduate School of Management, Management and Science University, University Drive, Off PersiaranOlahraga, Section 13, 40100, Selangor, Malaysia
[3] Department of Managment Sciences, Management and Science University, University Drive,Off Persiaran Olahraga, Section 13, 40100, Selangor, Malaysia

*** Corresponding author email address**: norazman@msu.edu.my

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A B S T R A C T

This study aims to explore the adoption and implementation of emerging technologies in Small and Medium-sized Enterprises (SMEs). By understanding the motivations, challenges, benefits, and future plans of SME founders, this research provides insights into how these businesses leverage technology to enhance their competitiveness and operational efficiency. The study employed a qualitative research design, utilizing semi-structured interviews with 25 founders of SMEs across various industries. Participants were selected using purposive sampling to ensure diverse representation. Data collection continued until theoretical saturation was achieved. The interview data were transcribed and analyzed using NVivo software, following a thematic approach to identify key themes and insights related to technology adoption and implementation in SMEs. The study identified several motivations for technology adoption, including competitive advantage, cost efficiency, customer demand, innovation drive, and growth opportunities. Key challenges faced by SMEs included financial constraints, technical difficulties, resistance to change, regulatory and compliance issues, knowledge gaps, vendor dependence, and time constraints. The benefits realized from technology adoption encompassed improved operational efficiency, enhanced

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customer satisfaction, revenue growth, better data analytics, increased employee productivity, and greater market adaptability. Future plans of SMEs included continued investment in technology, scaling up implementation, focusing on employee training and development, forming strategic partnerships, enhancing cybersecurity measures, and improving customer engagement. The adoption and implementation of emerging technologies present significant opportunities for SMEs to enhance their competitiveness and operational efficiency. However, SMEs must navigate various challenges to realize these benefits. By adopting a strategic approach and leveraging external partnerships, SMEs can successfully implement new technologies and drive sustainable growth. This study provides valuable insights into the experiences of SME founders, informing both practice and policy in the context of technological advancement in small and medium-sized enterprises.

Keywords: *Emerging technologies, SMEs, technology adoption, operational efficiency, competitive advantage, innovation, financial constraints, employee training.*

Introduction

The adoption and implementation of emerging technologies by Small and Medium-sized Enterprises (SMEs) have garnered significant attention in recent years, driven by the rapid pace of technological innovation and the increasing recognition of technology's potential to enhance business operations and competitiveness (Karimi et al., 2022; Kim et al., 2018; Miri Rami et al., 2022). SMEs play a pivotal role in the global economy, contributing substantially to employment and economic growth (Elshaer, 2023; Hoang & Bui, 2023; Maden-Eyiusta & Alten, 2023; Mbima & Tetteh, 2023). However, these enterprises often face unique challenges in adopting new technologies, including limited resources, technical expertise, and financial constraints (Nair et al., 2019).

Technological advancements offer SMEs numerous opportunities to improve operational efficiency, enhance customer satisfaction, and drive innovation. According to Hwang and Kim (2021), the adoption of emerging technologies can significantly improve technical efficiency in SMEs, as evidenced by the positive impact observed in Korean manufacturing SMEs (Hwang & Kim, 2021). Similarly, the integration of information systems and technology in manufacturing SMEs, as discussed by Caldeira and Ward (2003), highlights the potential for these enterprises to achieve competitive advantage and operational improvements through strategic technology adoption (Caldeira & Ward, 2003).

The COVID-19 pandemic has further underscored the importance of technological adoption for SMEs, as businesses worldwide had to rapidly adapt to remote work and digital solutions to survive. Akpan, Udoh, and Adebisi (2020) emphasize that the pandemic accelerated technology adoption in emerging and developing markets, revealing critical lessons on the importance of state-of-the-art technologies for business continuity and resilience (Akpan et al., 2020).

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Despite the potential benefits, SMEs often encounter significant barriers when adopting new technologies. Financial constraints are a common challenge, with many SMEs struggling to secure the necessary funding for technological investments (Nair et al., 2019). Additionally, technical difficulties such as system integration, compatibility issues, and a lack of technical expertise can hinder the successful implementation of new technologies (Hwang & Kim, 2021). Resistance to change is another critical barrier, as employees and organizational cultures may be resistant to adopting new technologies. Effective change management strategies are essential to overcome this resistance and ensure smooth technology integration (Rahman et al., 2020). Regulatory and compliance issues also pose challenges, particularly in industries with stringent data privacy and security requirements (Harris & Patten, 2014).

The knowledge gap among SME founders and employees regarding emerging technologies further complicates adoption efforts. Muridzi (2024) highlights the need for continuous training and development to bridge this gap and empower SMEs to leverage new technologies effectively (Muridzi, 2024). Vendor dependence is another concern, as SMEs may rely heavily on technology providers for ongoing support, raising risks associated with vendor reliability and long-term sustainability (Okundaye et al., 2019). Despite these challenges, the benefits of adopting emerging technologies are substantial. Improved operational efficiency is one of the most significant advantages, as technology can streamline processes, reduce errors, and enhance resource management (Caldeira & Ward, 2003). Enhanced customer satisfaction is another key benefit, with technology enabling SMEs to deliver personalized experiences and faster service, leading to increased customer loyalty (Rahman et al., 2020). Technology adoption also contributes to revenue growth by opening new revenue streams and expanding market reach. The positive impact on sales and profitability is well-documented, with many SMEs reporting significant financial gains following the implementation of new technologies (Hwang & Kim, 2021). Furthermore, enhanced data analytics capabilities enable SMEs to make better-informed decisions and develop data-driven strategies, contributing to overall business success (Petruzzelli et al., 2021).

Open innovation has emerged as a valuable approach to support SMEs in adopting Industry 4.0 technologies. Petruzzelli, Murgia, and Parmentola (2021) argue that collaboration with external partners, including technology providers, research institutions, and other businesses, can facilitate access to knowledge, resources, and innovative solutions. This collaborative approach helps SMEs overcome some of the barriers associated with technology adoption and enhances their capacity to innovate (Petruzzelli et al., 2021). Social media adoption has also proven to be a critical factor in enhancing the financial sustainability of SMEs, particularly in developing countries. Rahman et al. (2020) discuss how social media platforms enable SMEs to reach broader audiences, engage with customers, and build brand loyalty. The interactive nature of social media fosters stronger customer relationships and provides valuable insights into customer preferences and market trends (Rahman et al., 2020). The integration of e-business solutions is another area where SMEs can benefit significantly from technology adoption. Taylor and Murphy (2004) highlight the potential for e-business to transform SMEs by improving communication, streamlining transactions, and enhancing overall business efficiency. However, the adoption of e-business solutions also requires addressing challenges related to digital infrastructure, cybersecurity, and employee training (Taylor & Murphy, 2004). Understanding the readiness factors for technology adoption is crucial for SMEs aiming to implement new technologies successfully. Nair, Chellasamy, and Singh (2019)

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propose an exploratory model that identifies key factors influencing technology adoption readiness in SMEs, including organizational culture, leadership support, and external pressures. By addressing these factors, SMEs can enhance their preparedness for adopting and leveraging new technologies (Nair et al., 2019). As SMEs increasingly adopt mobile devices for business operations, ensuring mobile device security becomes paramount. Harris and Patten (2014) discuss the security considerations for SMEs in managing business mobility, emphasizing the need for robust security protocols to protect sensitive data and mitigate risks associated with mobile device usage (Harris & Patten, 2014). The uptake of Internet of Things (IoT) technologies presents significant opportunities for SMEs, particularly in the digital era. Muridzi (2024) conducts a systematic literature review on IoT adoption by SMEs in emerging economies, highlighting the potential benefits such as improved operational efficiency, enhanced data collection, and real-time monitoring (Muridzi, 2024). However, IoT adoption also requires addressing challenges related to data security, interoperability, and infrastructure.

The adoption and implementation of emerging technologies present both significant opportunities and challenges for SMEs. While financial constraints, technical difficulties, and resistance to change are common barriers, the benefits of improved operational efficiency, enhanced customer satisfaction, and revenue growth make technology adoption a worthwhile endeavor. Open innovation, social media, e-business, and IoT adoption are among the strategies that can support SMEs in leveraging new technologies effectively. By understanding the readiness factors and addressing the challenges, SMEs can position themselves to harness the full potential of emerging technologies and drive sustainable growth. This study aims to provide valuable insights into the experiences of SME founders, informing both practice and policy in the context of technological advancement in small and medium-sized enterprises.

Methods and Materials

This study employs a qualitative research design to explore the adoption and implementation of emerging technologies in Small and Medium-sized Enterprises (SMEs). The research methodology is rooted in interpretivism, which seeks to understand the subjective experiences and perspectives of the participants. This approach is particularly suited to this study as it aims to capture the nuanced insights of SME founders regarding their experiences with emerging technologies.

The primary data collection method for this study was semi-structured interviews. This method was chosen for its flexibility, allowing the researcher to probe deeper into specific areas of interest while maintaining a structured approach to ensure consistency across interviews. Semi-structured interviews enable participants to express their thoughts freely, providing rich and detailed data.

A total of 25 interviews were conducted with founders of SMEs across various industries. Participants were selected using purposive sampling to ensure a diverse representation of sectors and technology adoption levels. Each interview lasted between 45 to 60 minutes and was conducted either in person or via video conferencing, depending on the participant's preference and availability.

The interview protocol was designed to cover key themes related to the adoption and implementation of emerging technologies. These themes included:

- Motivation for adopting emerging technologies

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- Challenges faced during the implementation
- Benefits realized from the adoption
- Future plans for technology use
- Recommendations for other SMEs considering technology adoption

The interview guide included open-ended questions to encourage detailed responses and allowed the interviewer to follow up on interesting points raised by the participants.

Data collection continued until theoretical saturation was achieved. Theoretical saturation refers to the point at which no new themes or insights emerge from the data, indicating that the data set is sufficiently comprehensive to address the research questions. In this study, theoretical saturation was reached after 23 interviews, but two additional interviews were conducted to confirm this point.

The interview data were transcribed verbatim and analyzed using NVivo software. NVivo is a qualitative data analysis tool that facilitates the organization, coding, and interpretation of large volumes of text data. The analysis followed a thematic approach, involving the following steps:

- Familiarization: Reading and re-reading the transcripts to become immersed in the data.
- Coding: Identifying and labeling key pieces of data that relate to the research questions.
- Generating Themes: Grouping codes into broader themes that capture the essence of the data.
- Reviewing Themes: Refining the themes to ensure they accurately represent the data and are distinct from one another.
- Defining and Naming Themes: Providing clear definitions and names for each theme to ensure clarity and coherence.

Throughout the analysis process, attention was paid to both commonalities and differences in participants' experiences, aiming to capture a comprehensive picture of the factors influencing the adoption and implementation of emerging technologies in SMEs.

Findings and Results

The study included 25 participants, all of whom were founders of SMEs operating in various industries. The participants represented a diverse range of sectors, including technology, manufacturing, retail, and services. In terms of gender distribution, 16 participants (64%) were male, and 9 participants (36%) were female. The age of the participants ranged from 30 to 55 years, with the majority (72%) falling within the 35-45 age bracket. Regarding educational background, 20 participants (80%) held a bachelor's degree, 4 participants (16%) had a master's degree, and 1 participant (4%) had a doctorate. Experience in their respective industries varied, with 14 participants (56%) having over 10 years of experience, 7 participants (28%) having 5-10 years, and 4 participants (16%) having less than 5 years.

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Table 1

The Results of Thematic Analysis

Categories	Subcategories	Concepts (Open Codes)
1. Motivation for Adoption	1.1 Competitive Advantage	Market differentiation, staying ahead of competitors, unique selling points
	1.2 Cost Efficiency	Reducing operational costs, streamlining processes, automation savings
	1.3 Customer Demand	Meeting customer expectations, enhancing customer experience, customer feedback
	1.4 Innovation Drive	Fostering innovation, R&D initiatives, innovative culture
	1.5 Growth Opportunities	Expanding market reach, scalability, business expansion
2. Challenges Faced	2.1 Financial Constraints	Budget limitations, funding issues, high initial costs
	2.2 Technical Difficulties	System integration, technology compatibility, technical expertise shortage
	2.3 Resistance to Change	Employee pushback, cultural barriers, change management
	2.4 Regulatory and Compliance Issues	Data privacy concerns, industry regulations, compliance costs
	2.5 Knowledge Gap	Lack of training, insufficient knowledge, learning curve
	2.6 Vendor Dependence	Vendor reliability, long-term support, vendor lock-in
	2.7 Time Constraints	Implementation delays, project management challenges, time management
3. Benefits Realized	3.1 Operational Efficiency	Faster processes, reduced errors, better resource management
	3.2 Improved Customer Satisfaction	Enhanced service delivery, personalized experiences, increased loyalty
	3.3 Revenue Growth	Higher sales, new revenue streams, profitability
	3.4 Enhanced Data Analytics	Better decision making, predictive analytics, data-driven strategies
	3.5 Employee Productivity	Task automation, improved collaboration, skill enhancement
	3.6 Market Adaptability	Agile responses to market changes, proactive adjustments, trend adaptation
4. Future Plans	4.1 Continued Investment in Technology	Upgrading systems, exploring new technologies, budget allocation for tech
	4.2 Scaling Up Implementation	Expanding tech use across departments, broader application, increasing scope
	4.3 Employee Training and Development	Skill enhancement programs, continuous learning, training initiatives
	4.4 Strategic Partnerships	Collaborations with tech firms, joint ventures, innovation partnerships
	4.5 Focus on Cybersecurity	Strengthening data protection, cybersecurity protocols, risk management
	4.6 Enhancing Customer Engagement	Interactive platforms, feedback mechanisms, customer loyalty programs

Motivation for Adoption

Competitive Advantage: Many SME founders emphasized the need to differentiate themselves in a competitive market. By adopting emerging technologies, they could offer unique selling points that set them apart from their competitors. One founder stated, "Staying ahead of our competitors is crucial. Technology allows us to offer something unique that others can't."

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Cost Efficiency: Reducing operational costs and streamlining processes were significant motivators for technology adoption. Automation and other technological advancements enabled these businesses to save on labor and operational expenses. As one participant noted, "Implementing automation has significantly lowered our costs and increased our efficiency."

Customer Demand: Meeting customer expectations was another key driver. SMEs recognized the importance of enhancing customer experience through technology. One interviewee explained, "Our customers expect fast and personalized service, and technology helps us deliver that."

Innovation Drive: A culture of innovation was a common theme among the SMEs. They saw technology adoption as a way to foster innovation and support R&D initiatives. "We are always looking for innovative solutions to improve our products and services," said one founder.

Growth Opportunities: Many SMEs viewed technology as a means to expand their market reach and scale their business operations. "Technology has opened up new markets for us and allowed us to grow faster than we imagined," shared one participant.

Challenges Faced

Financial Constraints: Budget limitations and high initial costs were major barriers to technology adoption. Many SMEs struggled to secure the necessary funding. One founder mentioned, "The upfront costs are daunting, and securing funding has been a real challenge."

Technical Difficulties: Issues such as system integration and compatibility, as well as a shortage of technical expertise, posed significant challenges. "Integrating new technology with our existing systems has been more complicated than we anticipated," noted one interviewee.

Resistance to Change: Employee pushback and cultural barriers often hindered the adoption process. Effective change management strategies were needed to overcome this resistance. As one participant observed, "Getting everyone on board has been tough. People are resistant to change."

Regulatory and Compliance Issues: Navigating data privacy concerns and industry regulations added complexity to the adoption process. Compliance costs were also a concern. "Ensuring we comply with all regulations has been a significant hurdle," explained one founder.

Knowledge Gap: A lack of training and insufficient knowledge about new technologies created a steep learning curve for many SMEs. "We simply didn't have the expertise in-house to make the most of the new technology," said one participant.

Vendor Dependence: Reliance on vendors for long-term support and the risk of vendor lock-in were additional challenges. "We're dependent on our vendor for support, which can be risky if they aren't reliable," shared one founder.

Time Constraints: Implementation delays and project management challenges often resulted in time management issues. "We underestimated the time it would take to get everything up and running," noted one interviewee.

Benefits Realized

Operational Efficiency: Faster processes, reduced errors, and better resource management were notable benefits. "Technology has streamlined our operations and made everything more efficient," said one founder.

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Improved Customer Satisfaction: Enhanced service delivery and personalized experiences led to increased customer loyalty. "Our customers are happier because we're able to serve them better and faster," observed one participant.

Revenue Growth: Higher sales and new revenue streams were significant outcomes of technology adoption. "Since implementing the new technology, our sales have increased dramatically," shared one interviewee.

Enhanced Data Analytics: Better decision-making and data-driven strategies were facilitated by improved data analytics capabilities. "Having access to real-time data has transformed how we make decisions," noted one founder.

Employee Productivity: Task automation and improved collaboration boosted employee productivity. "Our employees can now focus on more strategic tasks, which has increased their productivity," explained one participant.

Market Adaptability: The ability to respond agilely to market changes and proactively adjust strategies was enhanced. "We can now adapt quickly to market trends, giving us a competitive edge," stated one founder.

Future Plans

Continued Investment in Technology: Many SMEs planned to continue upgrading their systems and exploring new technologies. "We see technology as a long-term investment and plan to keep upgrading," said one interviewee.

Scaling Up Implementation: Expanding the use of technology across departments and increasing its scope were common future plans. "We're looking to scale up and implement these technologies company-wide," noted one founder.

Employee Training and Development: Ongoing skill enhancement programs and training initiatives were prioritized to keep up with technological advancements. "Continuous learning is crucial, and we are investing in regular training for our staff," shared one participant.

Strategic Partnerships: Collaborations with tech firms and innovation partnerships were seen as ways to stay ahead. "Forming strategic partnerships with tech companies is part of our strategy," explained one founder.

Focus on Cybersecurity: Strengthening data protection and implementing robust cybersecurity protocols were top priorities. "Cybersecurity is critical, and we are enhancing our measures to protect our data," noted one interviewee.

Enhancing Customer Engagement: SMEs aimed to use technology to create interactive platforms, feedback mechanisms, and customer loyalty programs. "We're focusing on engaging our customers more effectively through technology," shared one founder.

Conclusion

The adoption and implementation of emerging technologies in SMEs reveal multifaceted motivations, challenges, benefits, and future plans, as evidenced by the qualitative data collected through

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semi-structured interviews. These findings align with existing literature and offer a deeper understanding of the complexities involved in technology adoption among SMEs.

The primary motivations for adopting emerging technologies among SMEs include gaining a competitive advantage, achieving cost efficiency, responding to customer demand, fostering innovation, and exploring growth opportunities. These findings resonate with Akpan, Udoh, and Adebisi (2020), who noted that the COVID-19 pandemic accelerated technology adoption in SMEs as businesses sought to stay competitive and meet evolving customer needs (Caldeira & Ward, 2003). Similarly, Caldeira and Ward (2003) highlight the strategic importance of technology in providing competitive differentiation and operational improvements in manufacturing SMEs (Caldeira & Ward, 2003). The drive for innovation and growth opportunities underscores the proactive approach of SMEs in leveraging technology to scale their operations and expand market reach (Nair et al., 2019).

SMEs encounter several challenges in technology adoption, including financial constraints, technical difficulties, resistance to change, regulatory and compliance issues, knowledge gaps, vendor dependence, and time constraints. These challenges are well-documented in the literature. For instance, Nair, Chellasamy, and Singh (2019) emphasize the financial and technical barriers that hinder SMEs' ability to adopt new technologies (Nair et al., 2019). Hwang and Kim (2021) identify technical difficulties, such as system integration and compatibility issues, as significant impediments (Hwang & Kim, 2021). The resistance to change observed in this study aligns with Rahman et al. (2020), who highlight the need for effective change management strategies to facilitate smooth technology integration (Rahman et al., 2020). Regulatory and compliance issues, particularly related to data privacy and security, are critical concerns for SMEs (Harris & Patten, 2014). The knowledge gap and reliance on vendors further complicate the adoption process, echoing the prior findings (Okundaye et al., 2019).

The benefits realized from technology adoption include improved operational efficiency, enhanced customer satisfaction, revenue growth, better data analytics, increased employee productivity, and greater market adaptability. These benefits are supported by existing research. For example, Caldeira and Ward (2003) demonstrate that technology adoption leads to operational improvements and efficiency gains in manufacturing SMEs (Caldeira & Ward, 2003). Enhanced customer satisfaction and revenue growth are consistent with the findings of Rahman et al. (2020), who discuss how social media and other digital technologies enhance customer engagement and financial sustainability. Improved data analytics capabilities, as highlighted by Petruzzelli, Murgia, and Parmentola (2021), enable SMEs to make data-driven decisions and develop strategic insights (Petruzzelli et al., 2021). The positive impact on employee productivity and market adaptability aligns with the literature on the transformative potential of emerging technologies in enhancing business agility and responsiveness (Hwang & Kim, 2021).

SMEs plan to continue investing in technology, scaling up implementation, focusing on employee training and development, forming strategic partnerships, enhancing cybersecurity measures, and improving customer engagement. These future plans reflect a strategic approach to technology adoption and are supported by the literature. Petruzzelli, Murgia, and Parmentola (2021) emphasize the importance of open innovation and collaboration with external partners in supporting SMEs' technology adoption efforts (Petruzzelli et al., 2021). The focus on employee training and continuous learning is critical to

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addressing the knowledge gap and ensuring successful technology implementation (Muridzi, 2024). Enhancing cybersecurity measures is essential for protecting sensitive data and mitigating risks associated with digital technologies (Harris & Patten, 2014). The emphasis on improving customer engagement through interactive platforms and feedback mechanisms aligns with Rahman et al. (2020), who highlight the role of digital technologies in fostering customer loyalty and engagement (Rahman et al., 2020).

Despite the valuable insights provided by this study, several limitations must be acknowledged. Firstly, the sample size of 25 participants, while sufficient for qualitative research, may not be representative of all SMEs, limiting the generalizability of the findings. Secondly, the study relies solely on semi-structured interviews, which may introduce biases related to self-reporting and interviewer influence. Thirdly, the study focuses on SMEs from diverse industries, which, while providing a broad perspective, may overlook industry-specific challenges and nuances in technology adoption. Finally, the rapid pace of technological advancement means that the findings may quickly become outdated as new technologies emerge and market conditions evolve.

Future research should address these limitations by expanding the sample size and including SMEs from specific industries to capture industry-specific insights and challenges. Longitudinal studies that track technology adoption over time would provide a more comprehensive understanding of the long-term impacts and evolving challenges faced by SMEs. Additionally, incorporating quantitative methods alongside qualitative approaches could offer a more robust analysis of the factors influencing technology adoption and the outcomes realized. Research exploring the impact of specific technologies, such as the Internet of Things (IoT), artificial intelligence, and blockchain, on SMEs would provide valuable insights into the potential and challenges associated with these technologies. Finally, comparative studies examining technology adoption in SMEs across different regions and economic contexts would help identify contextual factors that influence adoption and implementation.

For practitioners, several recommendations emerge from this study. Firstly, SMEs should adopt a strategic approach to technology adoption, aligning technology investments with business goals and market opportunities. This includes conducting thorough cost-benefit analyses and securing appropriate funding to mitigate financial constraints. Secondly, SMEs should prioritize employee training and development to address the knowledge gap and ensure successful technology implementation. This involves continuous learning initiatives and collaboration with external experts and training providers. Thirdly, effective change management strategies are essential to overcome resistance to change and foster a culture of innovation within the organization. This includes clear communication, employee involvement, and incentives for embracing new technologies. Fourthly, SMEs should establish robust cybersecurity measures to protect sensitive data and ensure compliance with regulatory requirements. This involves regular security assessments, employee training on cybersecurity best practices, and collaboration with cybersecurity experts. Finally, SMEs should leverage strategic partnerships and open innovation to access external knowledge, resources, and innovative solutions. This includes forming alliances with technology providers, research institutions, and other businesses to support technology adoption and drive innovation.

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In conclusion, the adoption and implementation of emerging technologies offer significant opportunities for SMEs to enhance their competitiveness, operational efficiency, and customer satisfaction. However, SMEs must navigate several challenges, including financial constraints, technical difficulties, and resistance to change, to realize these benefits. By adopting a strategic approach and leveraging external partnerships, SMEs can successfully implement new technologies and drive sustainable growth in the digital era. This study provides valuable insights into the experiences of SME founders and contributes to the understanding of technology adoption in small and medium-sized enterprises.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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