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SCIENTIFIC REVIEW

The Role of Artificial Intelligence in Strengthening the Resilience of Small and Medium-Sized Enterprises

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ABSTRACT

The aim of this paper is to explore the role of artificial intelligence in strengthening the resilience of small and medium-sized enterprises (SMEs). As SMEs face increasing challenges from global crises, market disruptions and technological change, their ability to adapt and recover, i.e. their resilience, has become a critical factor for sustainability and competitiveness. This study analyses how AI technologies can improve strategic decision-making, operational flexibility and risk management in SMEs. The paper identifies key areas where artificial intelligence contributes to resilience, outlines barriers to adoption, and provides policy and management recommendations.

Keywords: artificial intelligence, resilience, small and medium-sized enterprises, intelligent systems.

JEL classification: C63, M21

INTRODUCTION

In today's business environment, characterised by rapid technological change, increasing demands for sustainable development and frequent global crises, small and medium-sized enterprises (SMEs) face numerous challenges. “Resilience in organizationsrefersto their abilitytowithstand andadaptto challenges, disruptions, and change“ [1]. One potential response to these challenges is the use of artificial intelligence (AI) as a tool to improve resilience – the ability to adapt quickly and sustain operations in unstable conditions [2].

While the opportunities offered by AI are numerous - from process automation and improved market forecasting to service personalisation and resource optimisation - implementing these technologies in SMEs is not straightforward. These companies often lack the technical expertise, financial resources and human capital required for long-term strategic planning and adaptation [3].

At the same time, SMEs are under increasing pressure from societal stakeholders and the market to play an active role in building a responsible and sustainable economy. They are expected not only to follow global trends, but also to remain resilient to external shocks - be it an energy crisis, a pandemic, climate change or geopolitical instability [2].

In this context, a company's ability to use AI strategically will be one of the key determinants of its competitiveness. It is therefore important to develop approaches that ensure that SMEs are not left out of the digital transformation, but rather that, based on their own capacities and with the support of public policy, educational institutions and the professional community, they develop models of AI use tailored to their needs.

Sme Resilience

In today's rapidly changing and often unpredictable business environment, the ability of small and medium-sized enterprises to withstand disruptions, adapt and rebuild their capacities after a crisis has become essential for their survival and further development. This capacity is referred to as resilience and represents not only resistance to external shocks but also the active ability of firms to learn, improve processes and innovate in response to new conditions [4].

SMEs are particularly vulnerable to economic disruption, market fluctuations, natural disasters and increasingly frequent technological change. Limited resources - financial, human and technological - make them more vulnerable than larger companies. However, this smaller structure also allows for greater flexibility and faster decision-making, which can make SMEs more agile in crisis situations [5].

The key to building resilience in SMEs lies in developing strategies that include proactive planning, digital transformation, improving organisational culture and continuous training of employees. In this sense, the application of modern technologies such as artificial intelligence can significantly contribute to faster risk detection, process optimisation and data-driven decision-making [6].

Resilience is not only built internally – it also requires support from the external environment. Government institutions, local communities, academia and business associations can play an important role in strengthening SMEs by creating an enabling regulatory and economic environment, as well as providing expert support, training and incentives for innovation [2].

In the modern context, where disruptions are becoming increasingly frequent and complex, building resilience is no longer a matter of choice but a prerequisite for survival. SMEs that

succeed in adopting a culture of resilience, adaptation, and innovation will not only survive crises but will also use them as opportunities for growth, positioning, and strengthening their competitive advantage in the market.

Application of Artificial Intelligence in Enterprises

Artificial Intelligence is increasingly becoming a key tool for business transformation, enabling organisations to optimise processes, improve product quality, increase operational efficiency and make informed decisions based on large-scale data processing. The use of AI in modern businesses covers a wide range of aspects, from automating routine tasks to personalising offerings and improving security.

One of the most common uses of AI is to automate administrative and repetitive tasks, saving time and resources. The use of chatbots in customer support and enquiry handling significantly reduces the workload on agents, while ensuring faster and more consistent responses. Further more, AI is being used to analyse large data sets, making it possible to identify hidden patterns and trends in consumer behaviour or market dynamics.

A particularly important application of AI is in forecasting product demand, which facilitates production planning and inventory management. This helps to reduce storage costs and the risk of shortages or surpluses.

In quality control, AI enables real-time process monitoring, allowing timely detection of deviations and overall product quality improvement. In supply chain management, AI enables better coordination and logistics management, resulting in faster and more efficient deliveries [7].

Beyond operational benefits, AI supports the development of service and product personalisation models tailored to individual customer needs, thereby increasing customer satisfaction and loyalty. In security, AI is being used to monitor and analyse risk

and prevent cyber-attacks through predictive analytics and anomaly detection. Also, AI is being used to develop go-to-market strategies, helping companies make better decisions based on market data analysis and predictions of consumer behaviour. The overall contribution of artificial intelligence to business is its ability to transform traditional management models and lay the foundations for innovative, efficient and sustainable operations.

Integrating Artificial Iintelligence an Strategic Foresight to Enhance the Resilience of Small and Medium-Sized Enterprises

Small and medium-sized enterprises often operate in resource-constrained environments and are particularly vulnerable to external shocks such as economic downturns, market volatility and rapid technological change. Despite these constraints, SMEs have inherent flexibility and adaptability that, if strategically managed, can be used to develop strong resilience mechanisms [5].

Artificial Intelligence is a transformative tool that can significantly enhance the resilience of SMEs. Through applications in risk identification, operational optimisation and predictive analytics, AI enables data-driven decision-making and strengthens a company's ability to respond to change. By continuously analysing real-time data, AI helps SMEs identify patterns, anticipate market shifts and proactively adapt their operations.

A more advanced approach is to integrate AI with the concept of strategic foresight - a structured and systematic method for envisioning possible futures and designing adaptive, long-term strategies. Strategic foresight enables organisations to reduce uncertainty by preparing for a range of potential scenarios. For SMEs, this foresight capability is essential, especially given their often limited buffers against disruption.

The integration of AI and strategic foresight creates a synergistic framework for building resilience. While AI provides

the technical capability to dynamically analyse data and identify trends, strategic foresight provides a planning methodology to interpret these insights and translate them into flexible business strategies. This dual approach transforms SMEs from reactive entities to proactive, strategic actors within the business ecosystem [3].

Key Steps in the Implementation of Artificial Intelligence in Small and Medium-Sized Enterprises

In the face of increasing market dynamics and technological change, small and medium-sized enterprises need to adopt innovative strategies to ensure long-term resilience and competitiveness. One of the most effective strategies in this context is the application of Artificial Intelligence, the implementation of which requires a carefully structured approach. According to Oluveres, the successful integration of AI into business processes requires a systematic approach consisting of several critical phases [8].

The first step is to set clear objectives and identify areas where AI can have the greatest impact. This includes selecting high-priority use cases, such as optimising the supply chain, automating internal processes or improving customer service. As part of this process, the organisation needs to define clear key performance indicators (KPIs) that will enable measurable evaluation of AI outcomes.

The second step is data management. The quality and availability of data is the foundation of any AI solution. It is therefore necessary to establish a data management strategy that includes data collection, cleansing, normalisation and secure storage. These activities ensure that AI models have access to relevant and reliable information necessary for their effectiveness.

The third phase in the implementation process is the development of a Proof of Concept (PoC). Creating a PoC allows

the AI solution to be tested in a limited and controlled environment, minimising risk and providing the opportunity to adapt the system before scaling.

Once the PoC has been successfully completed, the organisation moves on to the fourth phase - scaling the solution and integrating it with existing business systems. This phase often requires additional investment in infrastructure, as well as training staff to use the new technology effectively. In addition, AI models need to be continually updated based on feedback and new data [8].

Managing Artificial Intelligence Tools to Strengthen the Resilience of Small and Medium-Sized Enterprises

Small and medium-sized enterprises (SMEs) are increasingly recognising the potential of artificial intelligence (AI) to improve their competitiveness, efficiency and resilience in the face of modern market challenges. However, the successful implementation of AI technologies depends on access to appropriate tools, which vary according to the digital maturity of the enterprise. In this context, AI tools can be categorised into two phases: first-phase tools and later-phase digital transformation tools.

In the early stages, SMEs often lack a developed IT infrastructure and sufficient internal capacity for complex AI projects. For this reason, the use of cloud-based AI platforms such as Google Cloud AI, AWS AI Services and Microsoft Azure AI is particularly important. These platforms offer a fast and cost-effective entry into the world of AI, without the need for significant internal infrastructure [9].

Effective data management is a key requirement for any AI application. Tools such as Apache Kafka, Apache Nifi and Talend enable the organised collection, processing and storage of data, which is essential for accurate modelling and analysis. At this stage, it's important to establish a data management strategy that

includes cleansing, normalisation, and secure storage. for the development of custom machine learning models, machine learning frameworks such as TensorFlow, PyTorch, and scikit-learn are employed [9]. These tools offer a broad range of capabilities for demand forecasting, supply chain optimization, product recommendations, and other advanced applications.

Managing AI tools requires a strategic approach, gradual implementation, and continuous employee training. SMEs that successfully combine basic and advanced AI tools can not only increase operational efficiency but also build greater resilience to market challenges, thereby ensuring long-term sustainability and competitiveness.

Multi-Agent Artificial Iintelligence and Autosapient Systems in Strengthening the Resilience of Smes

Traditional models of risk management and adaptation are often insufficient under conditions of high uncertainty, highlighting the need for systemic and intelligent solutions. In this context, multi-agent artificial intelligence and the concept of autonomic systems are emerging as advanced tools that can revolutionise the way SMEs respond to challenges, anticipate risks and enhance their resilience.

Multi-agent systems consist of a set of intelligent agents that collaborate, communicate and coordinate activities to achieve common goals [10]. In the context of SMEs, these systems can be implemented to manage different business processes such as logistics, production, supply, sales and customer support. Each of these areas can be covered by a specific agent that analyses real-time data, makes micro-decisions and signals other agents in the system, enabling decentralised yet synchronised management. This architecture allows SMEs to respond quickly to environmental changes such as supply chain disruptions, demand fluctuations or

technical failures, reducing response time and improving the organisation's adaptive capacity [8].

Autosapient systems represent an evolutionary step in the development of intelligent technologies. Unlike traditional algorithms, autosapient systems not only learn from data, but also develop self-reflective capabilities, make decisions based on long-term strategy and context, and are able to anticipate the consequences of their actions [10]. When implemented in SME operations, these systems can enable a new level of autonomy in management processes such as financial planning, product development or human resource management. For example, autosapient systems can predict fluctuations in consumer behaviour based on trend analysis, climate conditions or social movements, and propose concrete adjustments to the company's strategy without the need for direct human intervention.

The synergy between multi-agent artificial intelligence and autosapient systems is particularly important when it comes to building resilience. Resilience in SMEs refers to the ability to withstand disruptions, adapt to change and recover without major losses. With the help of these technologies, SMEs can create dynamic networks of knowledge and decision-making that do not rely solely on human intuition or traditional analysis. For example, in the event of an unexpected crisis - such as a pandemic or geopolitical disruption - a multi-agent system can simultaneously activate agents responsible for logistics, finance and communications, while the autosapient module analyses scenarios and suggests optimal courses of action. In this way, the organisation functions as a living system that autonomously identifies, learns and responds to threats [12].

Although the implementation of these technologies requires initial investment, staff training and technological integration, the long-term benefits include significant reductions in operating costs, faster adaptation to market changes, better resource management

and, most importantly, the development of an organisational culture of resilience and continuous learning. In an era of accelerated technological change and global challenges, the application of multi-agent artificial intelligence and autonomic systems is not only a technological innovation, but also a necessity for sustainable development and the survival of SMEs.

CONCLUSION

Systematic and strategic management is a key prerequisite for building and strengthening the resilience of small and medium-sized enterprises. In this context, multi-agent systems based on artificial intelligence open up new perspectives for improving strategic management, especially in small and medium-sized organisations, which often lack the resources and expertise to respond to the challenges of a complex business environment.

The use of these systems has the potential to make complex and costly strategic tools more accessible to the SME sector, thereby significantly improving their ability to anticipate, adapt to and recover from various disruptions. However, as with other operational applications of artificial intelligence, there may be barriers to adoption. The most effective way to overcome these barriers is to design the system as a partner rather than a substitute in the decision-making process, and to implement the "gatekeeper" approach within the framework of multi-agent AI.

For small and medium-sized enterprises to effectively leverage the potential of artificial intelligence in strengthening their resilience, it is essential to invest in employee education and training to enhance digital literacy and facilitate the adoption of modern technologies. In addition, government institutions and business stakeholders should develop support strategies that include financial incentives and technical assistance, particularly aimed at smaller organizations lacking the resources to implement

AI solutions independently. Finally, data management and the ethical application of AI must be integrated into all aspects of operations to ensure user trust, data protection, and the long-term sustainability of technological innovation.

In this context, decision-makers in the SME sector need to focus on mastering, integrating and routinising these technological solutions in order to best cope with unstable and unpredictable market conditions. In addition, the implementation of such systems provides a strong bridge between theoretical research and business practice. New scientific findings can be rapidly incorporated into the system, enabling their immediate application and enhancing the innovative capacity of companies. This synergy between science and industry contributes not only to strengthening the resilience of SMEs, but also to the overall sustainability of the economic system.

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