


Chapter 1

Advanced Computational Intelligence and Climate Change Adaptation for Sustainability in SMEs of Pakistan: A New Paradigm for Business Resilience

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ABSTRACT

Small and Medium Enterprises (SMEs) are the backbone of Pakistan's economy.

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Yet these businesses face issues because of climate change and restricted flexibility. However, the incorporation of advanced computational intelligence (ACI) techniques like data analytics, machine learning, and predictive modeling improves the environmental sustainability, assesses the environmental risks, maximizes the utilization of resources, and applies the flexible strategies suitable to their working environments. The study presents a new model that integrates digital transformation with environmental sustainability, offering a structure for the SMEs to shift toward climate-proof models. Findings emphasize how information-driven insights can aid decision-making and decrease the carbon footprint. This research highlights the essential role of ACI in authorizing the SMEs to thrive during the weather uncertainty, and the creativity of the ecosystems. Keywords: Advanced computational intelligence, Sustainability Performance, SMEs, Pakistan.

1. INTRODUCTION

ACI or Artificial Intelligence (AI) is rising too rapidly throughout a huge number of industries globally, evolving business operations, improving decision-making, and enhancing sustainability practices (Naeem et al., 2025a; Fateh et al., 2025). AI has been delivering solutions to every issue being asked to resolve and has emerged as an essential tool for firms striving to enhance efficiency, reduce costs, and achieve sustainability goals (Kulkov et al., 2024; Shah et al., 2025). In terms of SMEs, AI delivers unlimited benefits to effectively allocate resources, enhance productivity, and maximize sustainable performance. Compared to large firms that have financial resources allocated to sustainability teams, but in terms of SMEs face significant challenges in combining sustainable actions because of finite fiscal assets, poor technology, and insufficient expertise (Naeem et al., 2025b; Jhanjhi et al., 2025a). Although AI tools like automation, predictive analytics, and resourceful monitoring can remove this research gap by offering cost-effective results for improving the sustainability of environmental, social, and economic. The rising worldwide trend on sustainability outcomes, assisted by global enterprises like the Sustainable Development Goals (SDGs), the Paris Climate Accord and has emphasized the necessity for SMEs to adopt AI tools and methods for long-term success (Ameh, 2024; Shah et al., 2024a).

The SMEs of Pakistan perform an important role in the economic improvement of nations, contributing to the GDP growth rate, employment creation, and industrial evolution in Pakistan (Anser et al., 2024; Shah et al., 2024b, c; Farooq et al., 2023; Farooq & Ahmad, 2023). However, the SMEs of Pakistan tackle a huge amount of challenges, involving energy mismanagement, wastage of resources, high manufacturing costs, and continuous barriers from the government. Sustainability is a

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