


Chapter 9

Transforming MSME Supply Chains Through Industry 4.0: Review of Sustainable Applications and Emerging Challenges

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ABSTRACT

While MSMEs in supply chains are increasingly adopting green practices to achieve sustainability goals, many of these efforts remain ineffective. There is significant potential for Industry 4.0 technologies (I4.0T) to enable ethical and sustainable supply chains, yet most former studies have overlooked the practical challenges MSMEs face when trying to enable sustainable supply chains. This study maps out literature focused on supply chains of MSME and their use of I4.0T, examining its role in achieving sustainability based on key I4.0T, challenges, and opportunities. Applying a systematic literature review (SLR), 174 sources from SCOPUS, Web of Science, and EBSCO were screened, with 93 articles meeting this study's inclusion criteria. The findings highlight research gaps that informed a proposed framework linking MSME I4.0T adoption with sustainable supply chain performance. Yet while offering valuable insights, this study may have overlooked critical factors requiring future research, adopting broader methodologies such as meta-analysis.

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INTRODUCTION

Pressure on organizations to adopt sustainable practices is increasing, escalating the need for innovative strategies that address economic, environmental, and social challenges (Ejsmont et al., 2020). Micro, small and medium enterprises (MSMEs) are facing sustainability challenges due to rapid technological advancements (Bahulikar et al., 2023; Machado et al., 2021). Industry 4.0 technologies (I4.0T) can play a crucial role in ensuring sustainable, innovative and productive performance in complex and emerging markets, while reducing environmental footprints, including optimizing energy consumption, waste emissions, and production processes (Pandey, 2023; Pandya et al., 2024). By adopting I4.0T, all types of firms can achieve cost savings, long-term sustainability goals, and improved operational quality (Fragapane et al., 2022), which enhances corporate reputation and competitiveness (Sariyer et al., 2021). Organizations that strategically adopt I4.0T have been known to attain greater benefits such as optimizing energy consumption, and waste emissions, compared with those adopting regulations alone (Khan et al., 2024). Yet most I4.0T research has only focused on large enterprises (Mittal et al., 2018), with limited evidence of its application for sustainability benefits among the MSMEs, especially in developing and emerging economies (Rayar & Vijaya Kumar, 2023).

Significance and Challenges of MSME Supply Chain

Digital transformation via I4.0T is known to enhance MSME competitiveness and sustainability in complex, evolving, and dynamic business environments (Jamwal et al., 2021; Rayar & Vijaya Kumar, 2023) by improving operations, value chains, and marketing strategy (Arromba et al., 2021; Beltrami et al., 2021; Pandey, 2023; Pandya et al., 2024). Relevant I4.0T such as the internet of things (IoT) and machine learning (ML) can enhance supply chain responsiveness and efficiency while reducing costs (Jamwal et al., 2021; Patil et al., 2024), enabling MSMEs to better meet customer demands, optimize operational efficiency, expand market access that confirm sustainability (Jamwal et al., 2021).

Yet despite such benefits, there has been minimal research into how I4.0T can support MSMEs in becoming more sustainable (Beltrami et al., 2021) highlighting the need for further research on emerging trends, challenges, and opportunities in this field (Pandya et al., 2024).

Concepts and Definitions of I4.0T

This section introduces the key concepts that interconnect I4.0T and MSMEs. There is no universally accepted definition of I4.0T (Bettioli et al., 2024). Also known

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