

Industry 4.0 in small and medium enterprises: a state-of-the-art science mapping review

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Abstract

Purpose – This study comprehensively reviews the Fourth Industrial Revolution, which refers to Industry 4.0 (IR 4.0) applications in small and medium enterprises (SMEs). Multinational companies and big corporations have the capacity and resources to implement IR 4.0, but SMEs are limited due to financial constraints, expertise and lack of resources. Even so, IR 4.0 is required as technologies evolve and market demand has changed how firms do business.

Design/methodology/approach – To uncover the potential of IR 4.0 and critical determinants of SMEs' adoption of IR 4.0, this study presents a bibliometric analysis to evaluate the current research streams in IR 4.0 adoption among SMEs through bibliographic coupling. Furthermore, this review provides a glimpse of the future by analyzing prospective trends on IR 4.0 in SMEs.

Findings – Bibliographic coupling produces five clusters: (1) challenges and barriers in IR 4.0 implementation among SMEs, (2) technological adoption of IR 4.0, (3) opportunities and benefits of IR 4.0, (4) business model innovation and (5) implication of IR 4.0 on SMEs technologies. On the contrary, co-word analysis produces three clusters: (1) technologies in IR 4.0, (2) strategy and management of IR 4.0 among SMEs and (3) IR 4.0 model for SMEs.

Research limitations/implications – Implications are directly related to business owners, policymakers and technology developers meeting the needs of the industry and SMEs, which are the focus of this review.

Originality/value – The findings contribute significantly to the body of knowledge by presenting a state-of-the-art science mapping approach to uncover the knowledge structure and intellectual linkage of IR 4.0 adoption within SMEs.

Keywords IR 4.0, Small and medium enterprise, Multinational companies, Digital transformation, Web of Science, Bibliometric analysis

Paper type Literature review

1. Introduction

The transformation from Industry 3.0 to the fourth Industrial Revolution, which refers to Industry 4.0 (IR 4.0), primarily lies in adopting conventional automation toward tools and technologies for smart manufacturing (Madhavan *et al.*, 2022). Small and medium enterprises (SMEs) lag behind big corporations and multinational companies (MNCs) in benefitting from IR 4.0. Most SMEs need help to adjust their operation to transform into IR 4.0 (Holopainen *et al.*, 2024). The literature has identified that the main challenges to IR 4.0 among SMEs include financial resources, knowledge resources and technology awareness (Horváth and Szabó, 2019; Mittal *et al.*, 2018; Masood and Sonntag, 2020). The lack of these resources has made transformational shift difficult. SMEs must cater to day-to-day

operations and meet customer demand (Kumar *et al.*, 2020; Masood and Sonntag, 2020). Furthermore, SMEs face hindrances as they struggle to decide toward digital transformation based on the IR 4.0 framework (Ghobakhloo *et al.*, 2022). SMEs' uptake of these technologies should be encouraged and developed to sustain the holistic business supply chain, ultimately leading to national economic growth.

IR 4.0 is powered by cyber-physical systems (CPS), creating a modular production system, resulting in the mass production of customized products (Nascimento *et al.*, 2019) and the proliferation of smart manufacturing (Zheng *et al.*, 2018; Mittal *et al.*, 2018). Integrating CPS with the Internet of Things (IoT) will enable communication between infrastructure, human actors, physical objectives, processes and machines across

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