International Journal of Sociotechnology and Knowledge Development
Volume 18 • Issue 1 • January-December 2026

ISM-MICMAC Analysis of Advanced Manufacturing Technology Adoption Enablers and Barriers

Irvin Paul Rendon
Cebu Technological University, Philippines

Cyre Paclipan
https://orcid.org/0009-0000-5789-2028
Cebu Technological University, Philippines

Francis Villamor
https://orcid.org/0009-0002-8999-2685
Cebu Technological University, Philippines

Rose Ann Campita
Cebu Technological University, Philippines

Clifford John Orquia
Cebu Technological University, Philippines

Fritz Bacalso
Cebu Technological University, Philippines

Celbert Mirasol Himang
https://orcid.org/0000-0002-5663-3304
Cebu Technological University, Philippines

Received: September 16th, 2025 | **Accepted:** December 6th, 2025

ABSTRACT

Advanced manufacturing technologies have a positive impact on the efficiency of firms, facilitating product design and fabrication, improving connectivity among resources, and optimizing planning processes. Consequently, the adoption of these technologies has garnered increasing interest in the field. However, the literature has not fully explored the interrelationships among the enablers and barriers that influence adoption decisions. This study investigates these factors using interpretive structural modeling and cross-impact matrix multiplication applied to a classification analysis, complemented by bootstrap resampling to provide statistical validation of the results. The findings indicate that corporate structure as an enabler and economic barrier significantly drives adoption decisions. These results highlight the need for stakeholders to address these factors to ensure the successful implementation of advanced manufacturing technologies.

KEYWORDS

Advanced Manufacturing Technology, Barriers, Enablers, Technology Adoption, Interpretive Structural Modelling, MICMAC Analysis

INTRODUCTION

Industrial technology applications have seen significant advancements through the integration of artificial intelligence (AI) and agent-based systems. Artificial neural networks have shown great potential for modeling input-output relationships and identifying patterns in various industrial settings, including nuclear power plants and manufacturing facilities (Uhrig, 1994). More recent studies demonstrate the integration of AI and machine learning in smart factories and cyber-physical production systems, showing improvements in predictive maintenance, process optimization, and overall digital transformation (Chatterjee et al., 2023; Li et al., 2021). These technologies enable

DOI: 10.4018/IJSKD.400142

real-time monitoring, early detection of equipment failures, and more efficient production scheduling, thereby enhancing operational flexibility, productivity, and responsiveness to market demands.

Along these lines, the development of industrial agent-based applications has led to improved robustness, scalability, and reconfigurability in production and service sectors (Leitão et al., 2013). These technologies have been successfully applied in diverse fields, such as spacecraft autonomy, satellite communication, and navigation systems (Olive et al., 2007). Furthermore, the industrial information technology landscape encompasses a wide range of areas, including communication systems, security, sensor networks, embedded systems, and enterprise integration (Zurawski, 2004). As these technologies continue to evolve, they promise to enhance productivity and provide competitive advantages across industrial domains.

An emerging trend in the context of industrial technology points toward advanced manufacturing technologies (AMT), which encompass innovative processes and products that revolutionize traditional manufacturing systems by enhancing product quality, labor productivity, and business competitiveness (Khan & Nasser, 2017). AMT includes metallic joining, additive manufacturing, composites, and digital manufacturing systems (Vitug, 2020). These technologies combine scope and scale capabilities in manufacturing environments (Singh & Shishodia, 2013), enabling companies to meet 21st-century customer demands for speed, accuracy, cost, and ease of use services (Marri et al., 2007).

AMT implementation is particularly crucial for small- and medium-sized enterprises (SMEs) seeking to improve quality, flexibility, and efficiency in response to globalization pressures (Marri et al., 2007). However, adopting AMT presents challenges, requiring careful consideration of justification criteria, especially for SMEs (Marri et al., 2007). Despite these challenges, AMT offers significant potential for manufacturing companies to gain a competitive advantage in global markets (Khan & Nasser, 2017; Marri et al., 2007). Recent literature emphasizes the integration of Industry 4.0 technologies—including the Internet of things, robotics, and AI—in AMT adoption to enhance digital readiness and manufacturing flexibility (Stornelli et al., 2021; Wong & Ngai, 2023).

The adoption of AMTs has constantly grown in the literature. For one, AMT adoption is influenced by various factors, including firm size, productivity, and export orientation (Bartelsman et al., 1998). The adoption process is characterized by interactive learning and knowledge accumulation, with a firm’s AMT assets playing a crucial role (Sohal et al., 2006). Successful AMT implementation can lead to significant improvements in quality, productivity, and competitiveness, particularly for micro, small, and medium-sized enterprises (Singh et al., 2013).

However, high investment costs and lack of awareness can hinder adoption, especially in developing countries (Singh et al., 2013). The decision to adopt AMT is based on anticipated benefits and costs, while considering uncertainty, information, and adjustment factors (Arvanitis & Hollenstein, 2001). Additionally, complementarities between different AMT functional groups and learning from previous technology vintages influence adoption patterns (Arvanitis & Hollenstein, 2001). Overall, AMT adoption is a complex process that can significantly impact firm performance and competitiveness in the manufacturing sector.

Contemporary research also highlights the role of digital infrastructure, cyber-physical integration, and sustainability considerations in shaping adoption patterns (Chatterjee et al., 2023; Li et al., 2021). Strong digital infrastructure, including high-speed connectivity and integrated information systems, provides the foundation for real-time data exchange and coordinated operations. Cyber-physical integration enables seamless interaction between physical processes and digital models, supporting adaptive and automated workflows. At the same time, sustainability considerations, such as energy efficiency and resource optimization, increasingly guide managerial decisions.

Recent literature has involved the adoption of AMTs. Gertler (1995) outlined the details on proximity, organization, and intricacies in the development and adoption of AMTs, pointing out that the proximity of users to producers is a critical construct in terms of successful adoption. On the other hand, Hanes et al. (2019) proposed a framework to measure adoption rates and savings in energy consumption when using advanced energy-efficient manufacturing technologies. Similarly,

21 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/article/ism-micmac-analysis-of-advanced-manufacturing-technology-adoption-enablers-and-barriers/400142

Related Content

Keeping Track of Notes - Implications for Mobile Information and Communication Technology in Homecare Practice

Carljohan Orre (2005). *The Interaction Society: Practice, Theories and Supportive Technologies (pp. 93-121).*

www.irma-international.org/chapter/keeping-track-notes-implications-mobile/30360

Sporting Safe in the Liminal Sphere: “Tactics” and Facebook

Santosh Khadka (2014). *Emerging Pedagogies in the Networked Knowledge Society: Practices Integrating Social Media and Globalization (pp. 206-216).*

www.irma-international.org/chapter/sporting-safe-in-the-liminal-sphere/96062

Leveraging Temporal Markers to Detect Event from Microblogs

Soumaya Cherichiand Rim Faiz (2017). *International Journal of Knowledge Society Research (pp. 54-67).*

www.irma-international.org/article/leveraging-temporal-markers-to-detect-event-from-microblogs/183681

Impact of High-Tech Industries Over Time

Benjamin Yeo (2022). *International Journal of Sociotechnology and Knowledge Development (pp. 1-15).*

www.irma-international.org/article/impact-of-high-tech-industries-over-time/301264

Developing Knowledge Societies: A Case of Women in Kanungu District

Peace T. Kyamureku (2021). *Developing Knowledge Societies for Distinct Country Contexts (pp. 139-157).*

www.irma-international.org/chapter/developing-knowledge-societies/266862