Chapter 11
Impact of Multi-Agent Technology on High-Tech Product Manufacturing Organizations Using a MCDM Analysis

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ABSTRACT

High-Tech Manufacturing (HTM) is a capital-intensive sector requiring substantial national investments. Integrating Multi-Agent Technology (MAT) into HTM presents new growth opportunities by optimizing processes and enhancing decision-making. This study investigates the impact of MAT on HTM using Multi-Criteria Decision-Making (MCDM) techniques, specifically the Analytical Hierarchical Process (AHP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL). A conceptual framework comprising eight factors and forty-five variables is established. AHP identifies the "high-tech manufacturing process" as the most critical factor, followed by product features, market analysis, and marketing decisions. DEMATEL reveals strong interdependencies, with the manufacturing process exerting the most

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influence, while quality management, maintenance integration, and organizational factors are most affected. Findings indicate that effective MAT implementation fosters self-operative manufacturing, enhances quality, reduces maintenance efforts, and improves market targeting.

1. INTRODUCTION

High-tech manufacturing has gained heavy weight in the research agenda over the last two to three decades. Economic expansion has expanded consumer expectations to pick innovative products from the global market. Such ambitions have transformed manufacturing industries worldwide, resulting in production systems with cutting-edge technological advancements and regulations that have created novel products ranging from microchips to enormous helicopter engines. HTM systems are equipped with cutting-edge technologies, such as artificial intelligence, the Internet of Things (IoT), 5G, 3D printing, robots, drones, gene editing, big data, blockchain, nanotechnology, and solar photovoltaics (Unctad, 2023). These innovations or new technologies are derived from an agent-based system. Such systems create a digital automation environment configuring with hardware components and software packages (Khandelwal, 2010). Agent technology has grown in popularity in complex manufacturing environments where agents cooperate, coordinate, and share information within the system while also receiving information from the environment (Chan *et al.*, 2007). Multi-Agent Technology (MAT) refers to the collaboration of entities. It actively participates in handling material production, maintenance, supply chain, logistics, behavior analysis, product marketing, and other activities (Oroojlooy & Hajinezhad, 2022). Whereas high-tech product parameters were active in designing, manufacturing, and marketing. Previous articles published on MAT and HTM advocates that no research has been conducted which described MAT and HTM. In this context this study is novel contribution in which bridging of MAT and HTM is described.

This study focused on analyzing the role of MAT in HTM using multi-criteria decision-making techniques. This study has high practical significance in promoting MAT in HTM systems. In this research, AHP, DEMATEL, and TOPSIS were implemented to analyze the behavior of factors and variables. A conceptual framework of eight factors and forty-five variables to evolve priorities, rankings, and interrelationships was developed. This study attempts to provide insights to improve the implications of MAT in high-tech industries. This provides direction and strategy for decision makers, manufacturers, and market experts to improve the quality standards of HTM. An AHP was used to prioritize and rank the factors and variables. Whereas DEMATEL was used to measure the interrelationships among

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