

Manufacturing Sector Performance

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ABSTRACT

This study conducts a systematic review of literature on the determinants of banking performance, covering both financial and non-financial perspectives in conventional and Islamic banking. Using the PRISMA-based Systematic Literature Review (SLR) method, 15 key articles from 2015 to 2024 were analyzed. Findings show that indicators such as ROA, CAR, and LDR remain dominant, while organizational culture, workforce diversity, and Islamic values are gaining attention. However, most studies use cross-sectional data and focus on large national banks. Inconsistencies were noted in the effects of innovation and zakat. This study highlights the need for a multidimensional approach that integrates financial and non-financial factors to build an inclusive and sustainable banking performance evaluation model.

INTRODUCTION

The manufacturing sector has become the backbone of economic growth in many countries. In the era of industry 4.0, the pressure on efficiency, competitiveness, thirst, and operational operations has increased significantly. Recent research shows a shift in focus from pure production efficiency to the integration of digital technology, sustainability, and human resource capabilities. However, the literature on manufacturing sector performance is still fragmented and lacks integration in viewing multidimensional aspects.

Along with the development of the industrial era 4.0, the orientation of the manufacturing sector is shifting from mass production efficiency to data-based automation, intelligent systems, and inter-process connectivity (Gaufan et al.,

2025). This change raises various new challenges in performance measurement because the traditional quantitative output-based approach is no longer adequate to describe the dynamics of complex and autonomous manufacturing processes.

Recent research suggests that performance indicators are not only measured by productivity or production volume alone, but must also include adaptive responses to market changes, innovative capabilities, and sustainability (Toldy et al., 2025). However, there are not many studies that develop performance models that reflect these multidimensional indicators in an integrated manner.

With increasing environmental awareness and global regulations on carbon emissions, the manufacturing sector is faced with the demand to adopt more efficient and environmentally friendly energy systems. A study by Nohra et al. (2025) showed that waste energy recovery technology can significantly improve operational efficiency. However, literature on its impact on long-term financial and operational performance is still limited.

Much research in manufacturing is still partial – focused on optimizing a single process component such as control, material, or logistics (Li et al., 2025). This results in a lack of comprehensive understanding of manufacturing systems as complex and interdependent entities. This fragmentation limits the development of holistic performance improvement strategies.

Human capabilities as a key pillar of successful digital manufacturing transformation have not received much attention. While technological innovation is growing rapidly, human resource development through approaches such as self-regulated learning (SRL) is only just beginning to be explored, as shown by Kittel and Seufert (2023). There is no consensus yet on how to integrate SRL into measuring or improving performance on the production floor.

The adoption of artificial intelligence (AI) technology and predictive systems has become the backbone of modern production lines. However, there are still few studies that quantitatively measure the impact of AI implementation on the overall performance of manufacturing organizations (Gao et al., 2025). Existing research tends to focus on technical reliability, rather than the long-term effects on organizational effectiveness and adaptation.

The majority of studies use short-term experimental or simulation approaches. The lack of longitudinal and real industry practice-based studies is one of the critical gaps that hampers the development of evidence-based strategic policies for the manufacturing sector (Mitran et al., 2025). This is exacerbated by the limited representative data from small and medium industries (SMEs).

Many studies on sustainability only focus on environmental or social aspects separately from operational performance. In fact, the integration of both aspects is the main determinant of future manufacturing success. An integrative approach is needed that is able to connect environmental performance and operational efficiency directly and sustainably (Nohra et al., 2025).

Manufacturing sector performance studies are generally still in the domain of industrial engineering or operations management, with little involvement from the fields of work psychology, vocational education, and

information systems. In fact, manufacturing performance is the result of the interaction between humans, technology, and information systems (Kittel & Seufert, 2023). The absence of an interdisciplinary perspective is what makes the solutions offered tend not to be comprehensively applicable.

Given the gaps in the literature on manufacturing performance, future research should emphasize the development of a multidimensional performance evaluation framework. The integration of digital technology, human competencies, and sustainability is an urgent need. Interdisciplinary, longitudinal, and contextual studies will enhance the understanding of how the manufacturing sector can sustainably enhance competitiveness in a changing global landscape.

METHODOLOGY

Literature search was conducted through scientific databases such as ScienceDirect, Springer, and PLOS ONE for the period 2020–2025. Keywords used include: manufacturing performance, smart manufacturing, manufacturing sustainability, industrial efficiency, AI in manufacturing, self-regulated learning in industry A total of 25 scientific articles were critically reviewed, and the 10 most relevant ones were selected for thematic analysis.

Research method is descriptive-qualitative through Systematic Literature Review (SLR) to identify and synthesize various determinants of manufacturing sector performance. For further development into quantitative-explanatory research, a model for testing the relationship between variables using Structural Equation Modeling (SEM-PLS) will be used.

RESULTS

1. Material Innovation and Product Efficiency. Toldy et al. (2025) developed a flame-retardant smart polymer material with high thermal performance, which directly contributes to improving the safety and durability of manufactured products, particularly in the transportation and energy sectors. Toldy et al., 2025 – Composites Part A
2. Energy Efficiency and Sustainability Technologies. Nohra et al. (2025) developed a thermogenerator system for waste heat recovery from a factory diesel engine. The results showed an energy efficiency increase of up to 27%, supporting the green industry agenda. Nohra et al., 2025 – Elsevier
3. Artificial Intelligence (AI) in Production Anomaly Detection Gao et al. (2025) developed the AI framework AnDR-BLIP2 to detect visual anomalies on production lines in real-time. The application of this model improves the response speed of product inspection without manual labeling. Gao et al., 2025 – Journal of the Franklin Institute

4. GNN-Based Supply Chain Analytics Li et al. (2025) applied graph neural networks (GNN) to analyze entity relationships in the automotive supply chain. This approach improves information flow and logistics efficiency. Li et al., 2025 – Expert Systems with Applications
5. HR Competence: Self-Regulated Learning (SRL) Kittel & Seufert (2023) emphasize that self-regulated learning (SRL) in the workplace contributes to employee flexibility and adaptability to new systems. However, quantitative studies on its correlation with work output are still minimal. Kittel & Seufert, 2023 – PLOS ONE
6. Gaufan, K. B., Aremu, M. B., Alyazidi, N. M., & Nasir, A. (2025). Robust fractional-order sliding mode control for robotic manipulator system with time-varying disturbances. *FranklinOpen*.
<https://www.sciencedirect.com/science/article/pii/S2773186325000775>
7. Kittel, A. F. D., & Seufert, T. (2023). It's all metacognitive: The relationship between informal learning and self-regulated learning in the workplace. *PLOS ONE*, 18(5), Direct link to article
8. Artificial Intelligence untuk Efisiensi Energi. AI digunakan untuk memantau konsumsi energi secara real-time, memungkinkan penghematan biaya dan keberlanjutan produksi. Javaid et al., 2022
9. Ohra et al. (2025) developed a thermoelectric-based waste heat recovery system in an HVAC unit that converts waste heat into electrical energy. This solution contributes to energy efficiency and reduced operating costs. Nohra et al., 2025 – Materials Science for Energy Technologies
10. AI-Based Product Quality Detection
Gao et al. (2025) introduced an artificial intelligence-based AnDR-BLIP2 system that automatically detects product visual defects without retraining (zero-shot learning), improving production quality control. Gao et al., 2025 – Journal of the Franklin Institute
11. Collaborative Robotics (Cobots). Zafar et al. (2024) showed that cobots support the efficiency of repetitive tasks while maintaining safety in collaborative work with humans. Zafar et al., 2024 – Computers in Industry
12. Virtual Commissioning for Production Planning Yang et al. (2024) showed that virtual commissioning helps reduce the risk of system errors before actual implementation. Yang et al., 2024 – Digital Engineering
13. Augmented Reality (AR) for Industrial Training Wang et al. (2022) found that AR-based training accelerated workers' understanding of complex work

instructions on a production line. Wang et al., 2022 – Journal of Manufacturing Systems

14. Smart Logistics and Energy. Cimini et al. (2022) emphasize energy-based logistics efficiency as a key indicator in sustainable manufacturing logistics. Cimini et al., 2022 – CIE Journal
15. AI for Energy Efficiency Monitoring. Javaid et al. (2022) utilized AI to monitor and manage energy consumption in heavy industrial production systems. Javaid et al., 2022 – Sustainable Energy Tech

DISCUSSION

Recent advancements across multiple domains demonstrate the growing integration of material innovation, artificial intelligence (AI), and sustainability technologies in industrial systems. Toldy et al. (2025) pioneered the development of a flame-retardant smart polymer that enhances thermal stability and product safety, particularly within transportation and energy sectors. This aligns with the broader industrial push toward sustainable and efficient materials. Similarly, studies by Nohra et al. (2025) highlight significant progress in energy efficiency through thermoelectric waste heat recovery systems, achieving up to 27% improvement in energy utilization—an innovation that directly supports the green industry agenda. These findings underscore the intersection between material science and sustainability as critical levers for improving industrial performance and environmental responsibility.

The integration of AI has further accelerated innovation in production efficiency and quality assurance. Gao et al. (2025) developed the AnDR-BLIP2 framework, enabling real-time anomaly detection without manual data labeling, which significantly enhances manufacturing accuracy and reduces downtime. Li et al. (2025) expanded the use of AI through graph neural networks (GNN) to optimize supply chain analytics, improving logistics transparency and operational decision-making. Beyond production, Javaid et al. (2022) demonstrated that AI systems can monitor and regulate industrial energy consumption, promoting both cost savings and sustainability. These applications reveal AI's growing role in bridging data intelligence with real-world industrial processes.

In the context of human and system collaboration, emerging technologies like collaborative robots (Zafar et al., 2024), virtual commissioning (Yang et al., 2024), and augmented reality-based training (Wang et al., 2022) redefine efficiency and workforce adaptability. Cobots enhance productivity in repetitive tasks while ensuring safety, and virtual commissioning allows simulation-based planning to reduce system errors. Moreover, Kittel and Seufert (2023) emphasized self-regulated learning (SRL) as a crucial factor in employee adaptability, though its quantitative relationship with productivity remains

underexplored. Together, these developments suggest that future industrial systems will rely on the synergy between intelligent automation, sustainable design, and human learning to achieve resilient and adaptive manufacturing ecosystems..

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The reviewed studies collectively demonstrate that the convergence of advanced materials, artificial intelligence, and sustainable technologies is reshaping modern manufacturing. Innovations such as flame-retardant polymers, thermoelectric energy recovery systems, and AI-driven quality inspection are not only improving efficiency and safety but also promoting environmental responsibility. Moreover, the integration of digital tools—such as virtual commissioning, collaborative robotics, and augmented reality—fosters smarter, safer, and more adaptive production environments. These developments indicate a clear trajectory toward Industry 5.0, where human intelligence and technological innovation work synergistically to create sustainable, efficient, and intelligent manufacturing ecosystems.

Recommendation

Future research and industrial practice should focus on strengthening interdisciplinary collaboration between material scientists, AI engineers, and human resource experts to achieve holistic improvements in production systems. Quantitative studies are needed to explore how human learning strategies, such as self-regulated learning (SRL), correlate with measurable productivity outcomes in technology-driven environments. Additionally, industries are encouraged to invest in scalable AI frameworks and renewable energy technologies that balance performance optimization with sustainability. By doing so, companies can enhance competitiveness while contributing to global efforts toward greener and more resilient industrial development.

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