

Abstract

Analyzing the Barriers to Implementing Industry 4.0 for Enhanced Traceability in the Agri-Food Supply Chain [†]

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[†] Presented at the International Conference on Industry 4.0 for Agri-food Supply Chains: Addressing Socio-economic and Environmental Challenges in Ukraine, Leicester, UK and Online, 24–25 July 2023.

Keywords: traceability; Industry 4.0; agri-food supply chain; fuzzy set theory; severity value

In recent times, Industry 4.0 has gained significant recognition due to its potential to revolutionize diverse sectors. It involves integrating intelligent technologies to enable digitalization within supply chains. The agri-food supply chain benefits from Industry 4.0 by providing avenues to enhance traceability and tackle the socio-economic and environmental challenges aligned with sustainable development goals. Implementing Industry 4.0 technologies, such as security measures, transparency enhancements, and traceability systems, can greatly enhance quality and environmental monitoring, precision agriculture, process automation, and more. Emphasizing the socio-economic perspective, Industry 4.0 contributes to the economic growth and competitiveness of the agri-food industry. These technologies foster consumer trust by improving traceability and transparency, leading to increased demand and improved market access for agricultural products. This, in turn, strengthens the revenue and profitability of agri-food businesses, facilitating economic development and job creation. Nonetheless, various barriers hinder the widespread adoption of Industry 4.0 in the agri-food supply chain.

Further, the literature highlights various research gaps. To close these gaps, this study develops various research questions: How can the agricultural sector leverage Industry 4.0 in the agri-food supply chain for implementing traceability? How can stakeholders in the agriculture sector effectively integrate Industry 4.0 into their operations? What barriers are there to the adoption of Industry 4.0 in the agri-food supply chain for implementing traceability? Which barriers must be prioritized for successfully adopting Industry 4.0 in the agri-food supply chain? How are the identified barriers related to each other? From the aforementioned research questions, the study formulates the following research objectives: (i) to identify the barriers to implementing Industry 4.0 for enhanced traceability in the agri-food supply chain; (ii) to obtain the severity values of the identified barriers; (iii) to rank the barriers based on their influence, and suggest strategies for the successful implementation of Industry 4.0 for enhanced traceability in the agri-food supply chain; and (iv) to investigate the interrelationships among the barriers. The study develops a framework by integrating various theories and methodologies based on the research objectives. It combines an evidential reasoning approach with fuzzy set theory, triple bottom line theory, and stakeholder theory.

This study explores these barriers in Ukraine's agri-food supply chain, specifically with the goal of enhancing traceability. By comprehending and addressing these challenges, the study aims to leverage Industry 4.0 technologies to improve traceability, promote transparency, and address key socio-economic and environmental concerns within Ukraine's agri-food industry. A comprehensive list of barriers was identified from the literature and further validated by the experts. The developed framework ranks the barriers based on



Citation: Sarkar, B.D.; Sharma, I. Analyzing the Barriers to Implementing Industry 4.0 for Enhanced Traceability in the Agri-Food Supply Chain. *Eng. Proc.* **2023**, *40*, 3. <https://doi.org/10.3390/engproc2023040003>

Academic Editor: Hana Trollman

Published: 17 July 2023



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the severity values of various perspectives, and also provides the overall ranking of the barriers. The developed framework uses numeric and subjective data. Hence, quantitative and qualitative attributes can be modeled under volatile, uncertain, complex, and ambiguous environments. This helps to monitor, improve business, develop strategies, and achieve clarity and transparency in the overall system. The obtained hierarchy of the barriers helps decision makers identify significant areas that need more attention. The research findings will contribute to academic knowledge and offer valuable insights to practitioners, managers, and policymakers in Ukraine. These insights will assist them in navigating challenges and fostering a supportive environment for adopting Industry 4.0 solutions. Ultimately, this endeavor will improve traceability, transparency, and sustainability within Ukraine's agri-food industry, effectively addressing critical socio-economic and environmental concerns.

However, other barriers may be discovered in future studies. To study the changing behavior of the barriers, belief degrees could be used instead of changing the severity values. The study focuses on environmental, economic, and social dimensions to develop a hierarchy; other dimensions, like operational, technical, political, and legal, could be used to establish a hierarchy of barriers.

Author Contributions: Conceptualization, methodology, software, formal analysis, investigation was done by B.D.S., and original draft preparation, writing, review and editing was carried out by I.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no conflict of interest.

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