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AI-DRIVEN SUSTAINABILITY REVOLUTIONIZING MANUFACTURING SUPPLY CHAINS FOR A GREENER FUTURE

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Abstract

Advances in real-time data analysis, predictive maintenance, and resource optimization have been made possible by AI technologies, particularly big data analytics. Nonetheless, issues including poor data quality, inadequate infrastructure, and shortages of skilled agricultural workers continue to exist. Future developments in AI for agriculture will bring with them both benefits and difficulties, such as the need for fair access to AI technology and ethical problems. This study looks at how AI and big data analytics might enhance the sustainability of the manufacturing supply chain. Because of environmental concerns and the growing demand for healthcare, manufacturing supply chains are realizing the need of eco-friendly operations. It goes on to describe how AI and big data analytics may change these ramifications. Big data analytics is given top priority in this research for demand forecasting, inventory management, and procurement. In conclusion, big data analytics and AI are a huge help to sustainability, which is revolutionizing industrial supply chains for a greener future.

Keywords: AI-Driven, Sustainability, Revolutionizing, Supply Chains, Greener Future, Artificial Intelligence, Big Data.

1. INTRODUCTION

AI in agricultural supply chain management has transformed the industry, improving efficiency, decision-making, and data-driven practises. Kumari et al. explain that AI's machine learning algorithms and big data analytics simplify supply chain processes. AI drives innovation and strategic planning in supply chains, making this progression a paradigm shift. AI can help the agriculture industry satisfy the food needs of a rising global population and adapt to climate change. Leong et al. demonstrate AIoT's disruptive potential in agriculture. AI and IoT help optimise resource utilisation, production management, and labour reliance. AIoT improves the agricultural supply chain from precision farming to predictive analytics and decision support systems, not only automation.

AI affects agricultural supply networks in several ways. Singh emphasises the significance of AI and ML in digital transformation, creating value throughout supply chain management. Inventory management, demand forecasting, and logistics real-time decision-making are examples. AI and ML in agriculture go beyond operational efficiency to develop resilience and adaptation in a dynamic global market. AI in agricultural supply networks raises ethical and practical issues. Data privacy, labour consequences, and the digital divide need consideration. However, AI integration might cut costs, boost efficiency, and strengthen supply chains, making it appealing to the agriculture industry.

1.1. Importance of Supply Chain Sustainability

Sustainable supply chain management reduces environmental impact by reducing greenhouse gas emissions, deforestation, and waste. It also offers cost savings by optimizing transportation routes, green packaging, and energy-efficient production. AI has revolutionized supply chain management by predicting demand patterns, optimizing inventory levels, and ensuring transparency. Blockchain and AI-powered technologies offer traceability and visibility, helping companies meet sustainability criteria and identify unethical practices. This approach can improve brand image, market position, and environmental impact.

1.2. Objective of the Study

- To examine how Manufacturing Supply Chain firms are using Big Data Analytics (BDA) and Artificial Intelligence (AI) to enhance Environmental Performance (EPI) and integrate green supply chains (GSCC).
- To analyse the relationship between Manufacturing Supply Chain firms' EP and the incorporation of BDA and AI technology.
- To reach a conclusion about the strategic use of BDA and AI in manufacturing supply chains to enhance operational efficiency while simultaneously improving environmental responsibility.

2. LITERATURE REVIEW

Shobhana, N. (2024) Concluded Supply chains are essential in today's economic world because they connect company activity. Global companies are investing in digital technologies to improve supply chains and operational efficiency. One option is to use AI to improve all business operations. Artificial intelligence (AI) is the imitation of human intellect by technology, mostly computers. AI might add $15.7 trillion to the global economy by 2030. Big data, machine learning, cloud computing, blockchain, chatbots, and ChatGPT are AI technologies with many applications in numerous industries, improving productivity and consumer pleasure. Details on AI-powered supply chains across industries and their pros and cons are explored.

Khang, A. (2024) Intended to research and showcase the use of AI to revolutionise the agricultural supply chain. The goal is to improve efficiency, sustainability, and flexibility to a changing environment and growing population. This study provides vital information for new and existing companies who want to start an intelligent and sustainable digital revolution in agriculture and food supply chains. These results may help these companies use technology to improve efficiency, productivity, and sustainability. Digitization may simplify operations, optimise resource allocation, eliminate waste, and increase supply chain traceability for farm companies, ensuring long-term success.

Gupta, C. P. (2023) examined how integrating AI with supply chain management may improve efficiency and green supply chains. Supply chain AI integration is well studied. AI-driven technologies' acceptance and influence on supply chain, operational, and logistical efficiency are assessed. According to study, AI may reduce supply chain networks' environmental impact in several ways. Demand forecasting, resource optimization, and energy-efficient transportation routing are tested. Waste, energy, carbon emissions, and operational expenses should decrease. It also examines AI's role in supply networks' ‘greening’ and ‘sustainable’ transformation. The research shows that AI might power supply networks to unprecedented economic viability and environmental awareness and deliver vital insights for a more sustainable supply chain management business.

Tsolakis, N. (2023) added digitalization would revolutionize supply chain practices utilizing modern technologies. Lack of real-world data obscures digital technology's operational benefits. This study examines how AI and BCT improve supply chain performance, sustainable development, and data monetization. Thailand's tuna fish supply chain was experimentally examined to identify end-to-end activities, monitor material and data processing, and consider AI and BCT use. We analyzed business processes and system-level interactions to identify how AI and BCT may enable supply chain material, data, and information flows. The mapping indicates that digital supply chain management requires AI and BCT, yet sustainability and data monetization rely on system stakeholders' goals. We later established a common architecture for AI and BCT-enabled food supply chains to digitally manage crucial data to generate value. Academics and practitioners may find sustainable, data-monetizing digital solutions via empirical modelling.

Belhadi, A. (2021) Described Resilience and effectiveness of supply chains have become increasingly important after pandemics and crises. Digitization, integration, and globalization of the supply chain have raised awareness of AI in SCRes and SCP development. AI, SCRes, and SCP's direct and indirect effects on a volatile supply chain are examined in this study. We used organizational information processing theory for supply chain AI. Assessment of the framework using structural equation modelling. Survey data came from 279 firms of various sizes, sectors, and nationalities. AI impacts SCP temporarily, but we suggest harnessing its information processing talents to construct SCRes for long-term SCP. This is one of the first experiments to optimize AI benefits for continuous SCP. Longitudinal studies may disclose more about the phenomenon.

3. RESEARCH METHODOLOGY

In the research paper "Big Data Analytics and AI for Green Supply Chain Integration and Sustainability in Manufacturing Supply Chain Companies," we looked into the ways in which BDA-AI technologies impact Environmental Preservation (EP), Green Supply Chain Integration (GSCC), and Environmental Performance Improvement (EPI). Using a comprehensive conceptual model, the relationships and interdependencies between the variables were examined.

3.1.Sample Size

The research had 170 respondents. Research analysis is made possible by a large and representative sample size, which also relies on the invaluable participation of survey instrument completers.

3.2.Data Collection Source

The possible respondents in this inquiry were given access to 200 Manufacturing Supply Chain businesses. Eighty-one surveys were completed and returned. Because of incomplete replies, thirteen surveys were eliminated. As a result, the research had 170 responses.

4. DATA ANALYTICS

Table 1 shows the demographics of study participants. According to the poll, 70% of participants were male and 30% female. More over half of the participants (50.5%) had management experience from 1 to 5 years, although 41.6% had more than 5 years. By Manufacturing status, 53.5% worked for public businesses, 38.6% private, and 7.7% other. According to Manufacturing company workers, 29.7% worked in manufacturing supply chain businesses with 500 to 1000 seats, 23.8% in 1000 to 2000 seats, and 11.9% in 200 or less seats. Table 1 data was utilized to analyses and interpret survey participants' demographics.

Table 1: Demographics of Respondents

Characteristics	Sub - Characteristics	Respondents	Respondents Percentage
Gender	Male	119	70%
	Female	51	30%
Manager's Experience	≤ 1 year	14	8%
	>1 & ≤ 5 years	85	50%
	> 5 years	71	42%
Companies status	Public	90	53%
	Private	66	39%
	Others	14	8%
Number of seats	<200	20	12%

	> 200 and ≤ 500	38	22%
	> 500 and ≤1000	51	30%
	>1000 and ≤ 2000	41	24%
	>2000	20	12%
	Total	**170**	**100%**

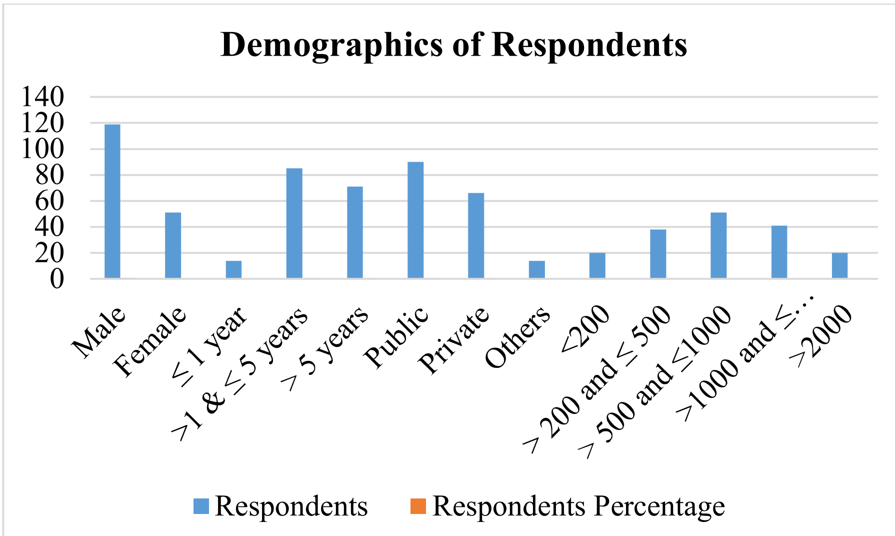

Figure 1: Demographics of Respondents

Our research study's measurement methodology is in Table 2. They demonstrate the reliability and validity of our operationalization measurement techniques. A strong alpha coefficient of 0.970 and excellent internal consistency indicate measurement item dependability in Big Data Analytics-AI (BDA-AI). A composite reliability (ρc) of 0.940 supports this design. Increased alpha (0.925) and ρc (0.965) values suggest strong dependability and consistency in Environmental Performance (EP). EPI and GSCC provide reliable alpha and ρc values. Though Green Digital Learning Orientation (GDLO) has lower alpha and ρc values, it nevertheless shows reliable performance. Our measuring instruments are robust and internally consistent, improving our confidence in the quality and validity of our data for future analysis and interpretation.

Table 2: Measurement of model

Construct	Alpha	RhoA	Composite reliability (ρc)	Average
BDA-AI	0.970	0.920	0.940	0.945
EP	0..925	0.960	0.965	0.953
EPI	0.957	0.933	0.945	0.945
GSCC	0.903	0.907	0.905	0.905
GDLO	0.900	0.892	0.883	0.891

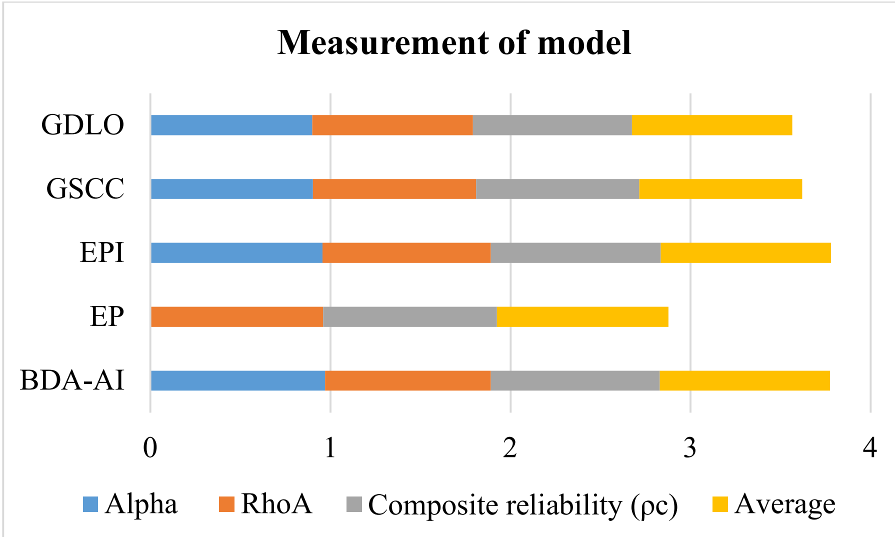

Figure 2: Measurement of model

Table 3 shows this study's constructs' discriminant validity. Discriminant validity guarantees each notion examines a separate research model. Table 3 highlights components with significant association coefficients and AVE values. A correlation coefficient below the square root of the average variance extracted (AVE) values for each idea is usually required for discriminant validity. This study indicates discriminant validity since all concept pairings have correlation coefficients below the square root of the average variance extracted (AVE). BDA-AI had modest correlations with EP, EPI, GSCC, and GDLO, indicating a separate dimension. EP, EPI, GSCC, and GDLO provide similar results, showing their differences.

Table 3: Discriminant validity

	BDA-AI	EP	EPI	GSCC	GDLO	CR	Aver age
BDA-AI	0.890					0.8	0.945
						40	
EP	0.729	0.9				1.2	
		93				65	0.950
EPI	0.597	0.7	0.9			1.2	
		51	31			41	0.945
GSCC	0.561	0.7	0.7	0.90		1.2	
		69	09	06		05	0.905
GDLO	0.780	0.5	0.3	0.50	0.85	0.7	
		83	59	03	9	82	0.890

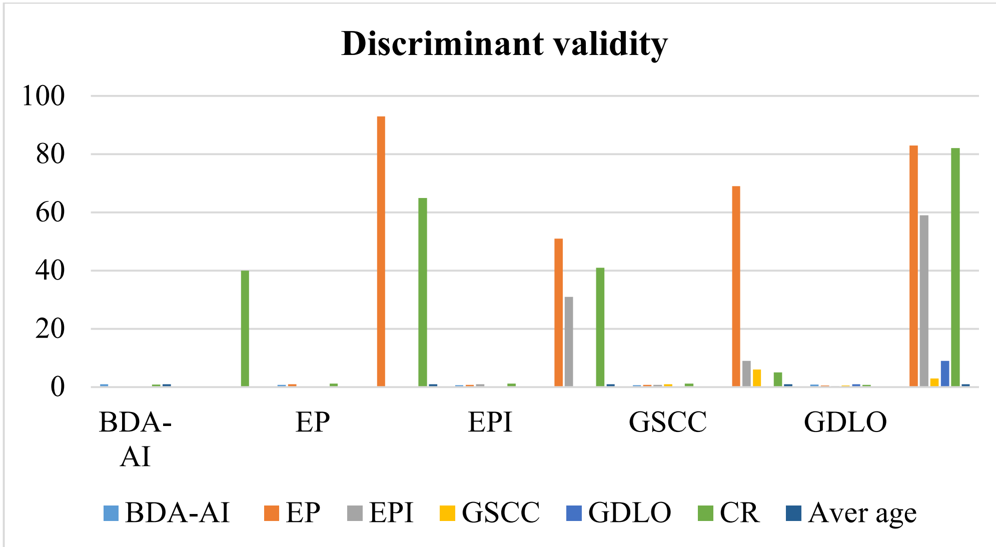

Figure 3: Discriminant validity

5. CONCLUSION

Sustainable business practices are becoming standard globally. AI is transforming how organisations handle supply chains, which are crucial to sustainability. AI streamlines processes, reduces waste, boosts transparency, and cleans supply chains. A better supply chain management and environmental and social impact need sustainability and AI technology. Finally, this comprehensive study examines how BDA and AI might improve industrial supply chain sustainability. The study's conceptual framework highlights energy, waste, and transportation emissions, explaining industrial supply networks' massive environmental effect. Data-driven solutions are needed since BDA and AI may change things, according to the report. BDA inventory, demand forecasting, and procurement optimisation reduce inventory, waste, and supply shortages, saving money and the environment. According to studies, BDA and AI may help industrial supply chains improve healthcare, reduce environmental impact, and save resources for future generations. The study's rigorous measuring method and discriminant validity analysis improve data reliability. Manufacturing increases environmental responsibility and operational efficiency, but data-driven healthcare operations need multidisciplinary collaboration. BDA and AI can improve and green healthcare systems, says study.

REFERENCES

1. Alshawi, A. (2022). Artificial Intelligence for Sustainability: Opportunities and Challenges. Artificial Intelligence for Renewable Energy and Climate Change, 1-31.
2. Belhadi, A., Mani, V., Kamble, S. S., Khan, S. A. R., & Verma, S. (2021). Artificial intelligence-driven innovation for enhancing supply chain resilience and performance under the effect of supply chain dynamism: an empirical investigation. Annals of Operations Research, 1-26.
3. Elufioye, O. A., Ike, C. U., Odeyemi, O., Usman, F. O., & Mhlongo, N. Z. (2024). AI-DRIVEN PREDICTIVE ANALYTICS IN AGRICULTURAL SUPPLY CHAINS: A REVIEW: ASSESSING THE BENEFITS AND CHALLENGES OF AI IN

FORECASTING DEMAND AND OPTIMIZING SUPPLY IN AGRICULTURE. Computer Science & IT Research Journal, 5(2), 473-497.
4. Gupta, C. P., Kumar, V. R., & Khurana, A. (2023, December). Artificial Intelligence integration with the supply chain, making it green and sustainable. In 2023 7th International Conference on Electronics, Materials Engineering & Nano-Technology (IEMENTech) (pp. 1-5). IEEE.
5. Gupta, C., & Khang, A. (2024). Cultivating Efficiency-Harnessing Artificial Intelligence (AI) for Sustainable Agriculture Supply Chains. In Agriculture and Aquaculture Applications of Biosensors and Bioelectronics (pp. 372-388). IGI Global.
6. Hassan, M., Wahab, N. A. B. A., & Nor, R. B. M. (2023). The role of artificial intelligence in waste reduction in the beverage industry: a comprehensive strategy for enhanced sustainability and efficiency. AI, IoT and the Fourth Industrial Revolution Review, 13(11),
7. Kaledio, E., Russell, E., Oloyede, J., & Olaoye, F. (2023). Transformative Trends and Sustainable Practices in Modern Manufacturing: A Comprehensive Exploration.
8. Kumari, N., Chaudhary, D., Kaur, H., & Yadav, A. L. (2023). Artificial Intelligence in Supply Chain Optimization 2023 International Conference on IoT, Communication and Automation Technology (ICICAT), Gorakhpur, India, 2023, pp. 1-6, doi: 10.1109/ICICAT57735.2023.10263631.
9. Norgren, A., & Janzon Hägglund, W. (2023). Implementing Artificial Intelligence in Supply Chain Management: A Qualitative Study of How Manufacturing Companies Can Implement AI to Improve Supply Chain Management.
10. Rahman, A. (2023). AI revolution: shaping industries through artificial intelligence and machine learning. Journal Environmental Sciences and Technology, 2(1), 93-105.
11. Richey Jr, R. G., Chowdhury, S., Davis-Sramek, B., Giannakis, M., & Dwivedi, Y. K. (2023). Artificial intelligence in logistics and supply chain management: A primer and roadmap for research. Journal of Business Logistics, 44(4), 532-549.
12. Shobhana, N. (2024). AI-Powered Supply Chains Towards Greater Efficiency. In Complex AI Dynamics and Interactions in Management (pp. 229-249). IGI Global.
13. Singh, P. K. (2023). Digital transformation in supply chain management: Artificial Intelligence (AI) and Machine Learning (ML) as Catalysts for Value Creation. International Journal of Supply Chain Management,
14. Tsolakis, N., Schumacher, R., Dora, M., & Kumar, M. (2023). Artificial intelligence and blockchain implementation in supply chains: a pathway to sustainability and data monetisation? Annals of Operations Research, 327(1), 157-210.
15. Vishwakarma, L. P., & Singh, R. K. (2022). Application of Artificial Intelligence (AI) in Supply Chain: An Overview. Artificial Intelligence of Things for Smart Green Energy Management, 191-212.
16. Momin, U. (2023). NREGA-Catalyst for Fostering Inclusive Growth. International Journal for Multidimensional Research Perspectives, 1(4), 63-72.
17. Momin, M. U. An Analysis of the Challenges and Opportunities Encountered by Small and Medium Enterprises (SMES) in the Context of the Indian Economy.
18. Momin, U., Mehak, S. T., & Kumar, M. D. (2023). Strategic Planning and Risk Management in the Stratup, Innovation and Entrepreneurship: Best Practices and Challenges. Journal of Informatics Education and Research, 3(2).

19. Mahajan, T., Momin, U., Khan, S., & Khan, H. ROLE OF WOMEN'S ENTREPRENEURSHIP IN SOCIAL AND ECONOMIC DEVELOPMENT OF INDIA.
20. Yadav, S., Sudman, M. S. I., Dubey, P. K., Srinivas, R. V., Srisainath, R., & Devi, V. C. (2023, October). Development of an GA-RBF based Model for Penetration of Electric Vehicles and its Projections. In 2023 International Conference on Self Sustainable Artificial Intelligence Systems (ICSSAS) (pp. 1-6). IEEE.
21. Sakthivel, M., Sudman, M. S. I., Ravishankar, K., Avinash, B., Kumar, A., & Ponnusamy, M. (2023, October). Medical Image Analysis of Multiple Myeloma Diagnosis Using CNN and KNN Based Approach. In 2023 International Conference on Self Sustainable Artificial Intelligence Systems (ICSSAS) (pp. 92-97). IEEE.
22. Faisal, L., Rama, V. S. B., Roy, S., & Nath, S. (2022). Modelling of electric vehicle using modified sepic converter configuration to enhance dc–dc converter performance using matlab. In Smart Energy and Advancement in Power Technologies: Select Proceedings of ICSEAPT 2021, Volume 2 (pp. 643-653). Singapore: Springer Nature Singapore.
23. Faisal, L., Rama, V. S. B., Yang, J. M., Wajid, A., & Ghorui, S. K. (2022, May). Performance and simulation analysis of ipmsyncrm (internal permanent magnet synchronous reluctance motor) for advanced electric vehicle design. In 2022 3rd International Conference for Emerging Technology (INCET) (pp. 1-6). IEEE.
24. Mohd, R., & Faisal, L. (2022). Smart Agricultural Practices using Machine Learning techniques For Rainfall Prediction: A case Study of Valkenburg station, Netherlands. Mathematical Statistician and Engineering Applications, 71(4), 8451-8462.
25. Wani, A. A., & Faisal, L. (2022). Design & development of novel hybrid set of rules for detection and type of malignant or non-malignant tumor in human brain based on svm using artificial intelligence classifier. Mathematical Statistician and Engineering Applications, 71(4), 10253-10276.
26. Mohammed, A. H. (2021). Fish schooling and sorensen trust based wireless sensor network optimization. International Journal, 9, 6.
27. Mohammed, A. H. DDoS Malicious Node Detection by Jaccard and Page Rank Algorithm in Cloud Environment.
28. Mohammed, A. H. (2021). Invasive Weed Optimization Based Ransom-Ware Detection in Cloud Environment.
29. Choudhuri, S. S., Bowers, W., & Siddiqui, M. N. (2023). U.S. Patent No. 11,763,241. Washington, DC: U.S. Patent and Trademark Office.
30. Zanzaney, A. U., Hegde, R., Jain, L., Choudhuri, S. S., & Sharma, C. K. (2023, September). Crop Disease Detection Using Deep Neural Networks. In 2023 International Conference on Network, Multimedia and Information Technology (NMITCON) (pp. 1-5). IEEE.