



SUPPLY CHAIN 5.0: INTEGRATING ARTIFICIAL INTELLIGENCE, HUMAN INTELLIGENCE, AND DIGITAL INNOVATION FOR SUSTAINABLE VALUE CREATION

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Abstract

Supply Chain 5.0 is a new paradigm in Supply Chain Management, of which AI (Artificial Intelligence), HI (Human Intelligence) and Digital Innovation are at the heart to achieve sustainable performance of the enterprise. The objective of this study was to examine how AI, HI and Digital Innovation (DI) influence on Sustainable Value Creation pertaining to Supply Chain (SC) 5.0. Based on quantitative research design and relying on cross-sectional survey analysis, the number of respondents that were targeted for this study comprised 320 professionals and managers in the manufacturing, transportation and logistics, retail and service sectors of the supply chain. Data collected were analysed using descriptive statistics, Pearson correlation and Multiple regression analysis in SPSS Version 29 in which itemized variables of the study were highlighted on a five point Likert scale. The findings revealed high mean scores for Sustainable Value Creation ($M = 4.37$, $SD = 0.52$), Digital Innovation ($M = 4.34$, $SD = 0.54$), Artificial Intelligence ($M = 4.29$, $SD = 0.57$), and Human Intelligence ($M = 4.21$, $SD = 0.61$). The correlation between Sustainable Value Creation and other elements confirmed that there were meaningful positive correlations between Sustainable Value Creation and Artificial Intelligence ($r = 0.738$; $p < 0.01$), Human Intelligence ($r = 0.691$; $p < 0.01$), and Digital Innovation ($r = 0.781$; $p < 0.01$). The digitization of innovation processes (Digital Innovation), Artificial Intelligence (AI) and Human Intelligence (HI) are determined to be the most important factors for Sustainable Value Creation ($R^2 = 0.726$; $p < 0.001$). The findings showed that with the enhancement of intelligent technologies, sustainable value creation, operational resilience and long-term competitiveness were greater for 'Supply Chain 5.0' especially visibly with human knowledge.

Keywords: Artificial Intelligence, Digital Innovation, Human Intelligence, Industry 5.0, Supply Chain 5.0, Sustainable Value Creation

1. Introduction

Much has changed in the SCM industry, with the introduction of new digital tools, they became more efficient, resilient, and sustainable. As the world is rapidly globalizing, keeping the old models for the supply chain and the customers' expectations as they are, it was time to look at ways to improve the existing models, as frequent stoppages in the market or unforeseen situations are common. With these trends in mind, companies started to explore how they could incorporate data and intelligent solutions into the existing chain. In the era of Industry 5.0, the changes were accelerated by emphasizing the collaboration between the use of high-tech solutions and human skills aimed at achieving sustainable economic, environmental, and social



outcomes. The transition from Industry 4.0 to supply chain automation and digitalization to Supply Chain 5.0 centred on humanization with the deployment of Artificial Intelligence (AI), digital innovation, and human intelligence as influences that bring agility to the organization and value creation for long-term benefits started (Ivanov et al., 2024; Javaid et al., 2023; Leng et al., 2022).

One of the key elements of the evolution of Supply Chain 5.0 is Artificial Intelligence (AI) which promises to help companies leverage big data, forecast customer demand, work with lean stocks, eliminate bottlenecks in logistics, and literally think ahead for decision making with the support of predictive analytics and machine learning. In global supply chains, these factors, like IoT, digital twins, blockchain, cloud-based and autonomous robotics, and big data analytics are positively affecting the visibility, transparency and operational coordination of the supply chain. These digital innovations played a major role in delivering market success for AIS as they helped to facilitate proactive responses to disruption in the supply chain, optimise resource use, and reduce the uncertainty of operation. In the market, these digital innovations have helped AIS reduce operational uncertainty, optimise the use of its resources, and adopt pre-emptive measures in case of a disruption in the supply chain. The actors of the business did not disappear. Still, those who now use intelligent technologies realized that they could contribute to their understanding, creativity, and ethical judgment, drive strategic decisions instead of making them for the actor-creators (Dolgui & Ivanov, 2023; Barykin et al., 2024; Javaid et al., 2023).

Human intelligence was still needed for Supply Chain 5.0 due to the high complexity of supply chain processes, which demanded new critical thinking, leadership, collaboration, innovation, and ethical responsibility. Data and insights were inputted from human experience expertise (e.g. managers, the supply chain) beyond automated processes in supporting decision making. Human centred supply chain approaches strengthened the resiliency of the organizations as all the stakeholders (policymakers, customers, distributors, manufacturers, and suppliers) worked together in a synergic manner. This collective intelligence was a factor in consolidating the capabilities of risk management, encouraging innovation and responsible business practices with the environment and with respect to stakeholders' values. The approach of integrating technological capabilities and human skills into sustainable competitive advantages was determined as a way to achieve the latter, not just automation (Nahavandi, 2019; Xu et al., 2021; Ivanov & Dolgui, 2024).

Background of the Study

The evolution of supply chain management (SCM) has been making constant efforts to get more efficient, more responsive, and more competitive. Supply chain management models started focusing on the reduction of costs, management of inventory, and production efficiency; more modern models added the aspect of resilience, sustainability, and value creation for stakeholders. It was further accelerated by the introduction of Industry 5.0, where intelligent technology is used instead of automation along with human skills and expertise. Artificial Intelligence (AI) has transformed Digital Technologies with the integration of Adaptive, Sustainable and Customer-centric Supply Chain Systems (Javaid et al., 2023; Ivanov et al., 2024).

AI has emerged as a gamechanger for the digital supply chain by providing support for predictive analytics, demand forecasting, optimisation of inventory management, route optimisation and automated decision-making. Concurrently, the use of digital technologies, including the Internet of Things (IoT), blockchain, cloud computing, and digital twins and big data analytics, has heightened visibility, transparency and collaboration in the supply chain network. With these solutions, managers and business partners have real-time information to enhance the operational processes and reduce interruptions. These technologies became essential tools for organisations to gain a competitive edge in the market and enhance efficiency, due to increasing customer demands and market uncertainties (Dolgui & Ivanov, 2023; Barykin et al., 2024).

Researchers stressed that human intelligence would still be critical to attain sustainable supply chain performance, as technology advanced rapidly. Wherever problems in an organisation were too complex to be addressed by automated systems, human skills and knowledge were essential for strategic planning, handling ethical issues, innovation initiatives, relationship building and crisis management. AI was anticipated to enhance human capabilities in Supply Chain 5.0; humans were key collaborators. Such a balanced integration led to more cooperative work between employees and the intelligent systems, leading to improved



organizational learning, increased system resilience, and increased innovation capability (Nahavandi, 2019; Xu et al., 2021; Ivanov & Dolgui, 2024).

The big challenge was the organisations who would like to be competitive that would take environmental and social concerns into considerate; becoming “value generators” in a sustainable way. Governments provided businesses with climate change accounts at both the carbon and product levels to hold them accountable for minimizing climate change-related impacts, increasing resource efficiency and acting ethically in their SC. The capabilities of Supply Chain 5.0, digital innovation and AI have already demonstrated these expectations and helped all organisations to create value, continuously taking the environment into account. Previous research has centred on digital transformation, or on using artificial intelligence or sustainable Supply Chain Management separately, without demonstrating their beneficial or harmful relationship within the framework of Supply Chain 5.0. To fill this knowledge gap, the current study explored and analysed the potential of AI, human intelligence, and digital innovation in creating sustainable values within contemporary supply chain systems (Leng et al., 2022; Ivanov et al., 2024; Javaid et al., 2023).

Research Objectives

1. This study aims to study the impact of Artificial Intelligence (AI) on Sustainable Value creation in Supply Chain 5.0.
2. To assess the impact of human intelligence on sustainable value creation in Supply Chain 5.0.
3. To evaluate the role digital innovation plays in sustainable value creation for Supply Chain 5.0.
4. To understand the synergy between Artificial Intelligence, Human Intelligence and Digital Innovation in creating sustainable value in Supply Chain 5.0.

Research Questions

- Q1. How does Artificial Intelligence impact value creation in Supply Chain 5.0?
- Q2. What is the role of human intelligence in Value creation for sustainable Supply Chain 5.0?
- Q3. What is the impact on sustainable value creation of digital innovation in Supply Chain 5.0?
- Q4. In what way does AI together with human intelligence and digital innovation help to create sustainable value in Supply Chain 5.0?

Significance of the Study

The research in this paper advances in this stream because it investigates the confluence of Artificial Intelligence, human intelligence, and digital innovation in value creation for sustainability. The results provide a fact basis for organizations interested in developing strategies that are not all technology-driven but human-oriented and intelligent within the supply chain. The results can assist business managers and professionals in the supply chain to maximize operational efficiency, enhance resilience, create informed and decision-making for the business and embrace sustainable business using the advanced digital technologies. The study may contribute to the policy makers as a reminder to encourage digital transformation and innovation toward sustainable industrial development. The study offers an excellent reference for future researchers to build on, as it adds to the theoretical understanding of Supply Chain 5.0 and suggests areas for additional research to be conducted on the sustainable and intelligent supply chain ecosystems.

Research Hypotheses

- H1. The results of this study indicated a strong positive impact of Artificial Intelligence on Sustainable Value Creation in Supply Chain 5.0.
- H2: Human Intelligence contributed significantly to increasing Sustainable Value Creation in Supply Chain 5.0.
- H3. Digital Innovation had a significant positive impact on Sustainable Value Creation in Supply Chain 5.0.
- H4. The results indicated a positive and significant overall effect of the four variables of Artificial Intelligence, Human Intelligence, and Digital Innovation on Sustainable Value Creation in Supply Chain 5.0.



2. Literature Review

Artificial Intelligence in Supply Chain 5.0

One of the most significant enablers helping to make Supply Chain 5.0 a reality is Artificial Intelligence (AI). AI technologies like machine learning, predictive analytics, natural language processing, and intelligent automation enable organizations to analyse tremendous volumes of data and make accurate predictions for demand, stock, procurement, and logistics planning. AI-aided supply chain visibility gave them real-time data analysis and allowed them to take proactive measures to manage uncertainty throughout operations, the researchers said. These proved to be major strengths in the improvement of organizational competitiveness and in boosting customer satisfaction in the decision-making process (Ivanov, 2023; Javaid & Haleem, 2020).

AI has emerged as a key player in enhancing the resilience of the supply chain, with recent studies indicating its substantial impact on predictive forecasting, intelligent scheduling, and flexible logistics management. The adoption of AI technology improved the ability to predict disruptions, route smartly to avoid such events, and cut down operating expenses by learning from past and on-the-fly information. However, this concept of the Internet of Things (IoT) was seamlessly wrapped up in these AI models, and companies began to develop smart and transparent supply chain ecosystems that act efficiently and respond to market and environmental fluctuations in good time (Dolgui & Ivanov, 2023; Barykin et al., 2024).

The researchers noted that while AI has come to the fore, there are problems in the supply chain that can't be solved using AI. The importance of ethical concerns, data quality, cybersecurity risks, algorithm transparency and skills and competencies gaps in the workforce to AI use were also cited. From the literature reviewed it became clear that the added value of AI could be enhanced by taking into account human expertise, strategic leadership and responsible governance. Supply Chain 5.0 saw the technology of AI as a "collaborative technology" which enhances human ability and does not replace the human decision maker (Ghobakhloo et al., 2023; Ivanov, 2023).

Human Intelligence Sustainable Supply Chain Management.

Automated systems were not quite the answer to the entire issue either, as many of the decisions made were dependent on the creative mind and ethical considerations, negotiation, and contextual understanding that automated systems could not easily supersede – and so human intelligence played a vital part in Supply Chain 5.0. Managers and members of the supply chain could make sense of the complicated business scenario during times of uncertainty, evaluate various options, and reach mutually agreeable solutions. The importance of integrating technological intelligence with human intelligence, skills, leadership, and organisational learning (OL) to achieve sustainable supply chain performance (SCP) was highlighted (Nahavandi, 2019; Ivanov, 2023).

Besides, the concept of Industry 4.0 was expanded to Industry 5.0, and instead of full automation, the emphasis was shifted to collaborative intelligence: humans and smart technologies cooperating to achieve common objectives. This allowed for a continuous learning, empowerment, innovation, and knowledge-sharing journey to take place in the value chain networks. Subjects stressing work and digital skills were more flexible, more effective at problem solving, and more resilient when it came to disruption. Trust was boosted with the involvement of humans and adequate decision-making for sustainable goals (Villar et al., 2023; Kumar et al., 2025).

The literature has emphasised the central role of human intelligence for AI's ethical governance, for engaging with people, and in a transformational direction of the organization. With their expertise, AI-driven decisions achieved legal compliance, environmental standards, and corporate social responsibility (CSR) objectives. Supply chain experts ensured that AI-driven decisions were not only legally compliant but also aligned with environmental norms and corporate social responsibility (CSR) goals. The risks around algorithmic bias was reduced, while transparency, accountability, and fairness were improved in the digital supply chain due to human oversight. In Sustainable Supply Chain 5.0 ecosystems, human Intelligence has to be irreplaceable (Ivanov, 2023; Ghobakhloo et al., 2023).

Digital Era: Development And Creation of Sustainable Added Value



Among the advanced technologies introduced to make modern supply chains are the Internet of Things (IoT), Blockchain, Cloud Computing, Digital Twins, Robotics, and Big Data Analytics. These technologies facilitated relationships, operational visualization and sharing amongst supply chain partners, and real-time tracking and intelligent use of resources. They point out that digital innovation helped organizations cut waste, streamline production workflows, enhance delivery quality, and add robust transparency to the supply chain across global operations (Javaid et al., 2023; Ivanov, 2023).

The potential for sustainable value creation via digital technologies and Supply Chain 5.0 was achieved by the efficiencies of economic factors, environmental and social factors. Smart Digital platforms enabled data-driven decision-making, which increased energy efficiency, reduced carbon emissions, promoted product traceability, and promoted Circular Economy practices. Organizations saw digital innovation as a way to bolster resilience and foster long-term competitive advantages by improving sustainable operations and stakeholder relationships (Barykin et al., 2024; Chen & Kumar, 2024).

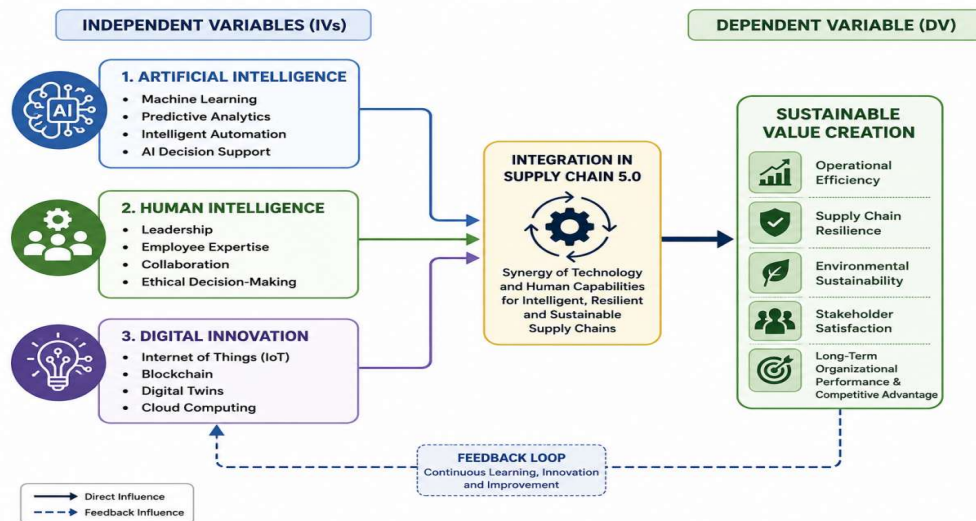
Recent research has revealed that digital innovation, without the support of intelligence and Artificial Intelligence in a correct and integrated Supply Chain 5.0 model, is not enough to build sustainable organisational performance. Smart technologies, leadership, and sustainable business models resulted in more agile, innovative, and value-creating organisations. Accordingly, this embedded approach is one of the most significant avenues for the future evolution of a supply chain towards enhanced resilience, sustainability, and continuous innovation in evolving global markets (Kumar et al., 2025; Ivanov, 2023).

Conceptual Framework Model

A conceptual framework was used to show the relationships among the study variables in relation to Supply Chain 5.0. As part of this framework, the independent variables were: Artificial Intelligence (AI), Human Intelligence (HI), and Digital Innovation (DI); and the dependent variable was Sustainable Value Creation (SVC). The framework suggested a positive impact of the effective application of AI technologies and human expertise. It advanced digital innovations on sustainable value creation through operational performance, supply chain resilience and transparency, innovation, and organizational competitiveness in the long term. AI brought intelligent decision-making and process automation; HI brought leadership, creative thinking, collaboration, and ethical judgement; and digital innovation provided the backbone of organizational capabilities through digital twinning, cloud, blockchain, and the Internet of Things. The overall structure was conceived to take for granted that these three capacities act synergistically to create a human-centric, technology-driven, and sustainable environment of Supply Chain 5.0, which can provide greater value and organizational performance sustainability.

Figure1

Conceptual Framework Model





3. Research Methodology

Research Design

The approach of this study was quantitative research, and the design used was a cross-sectional survey to analyze the impact of the development of Artificial Intelligence, Human Intelligence, and Digital Innovation on Sustainable Value Creation with Supply Chain 5.0. The quantitative approach allowed for collecting measurable data from supply chain practitioners and managers and to analyse the relationships between the variables of the study statistically. The cross-sectional design was conducted once and captured a true snapshot of organisational perceptions of integrating intelligent technologies and human capabilities in the modern supply chain.

Target Population

The target population was managers in the various departments of the supply chain and logistics, procurement experts, and managers involved in operations and production, as well as digital transformation managers among manufacturers, retailers, logistics and distribution companies, and service companies that have turned to digital supply chain technologies. The professionals had real-life experience in AI, digital innovation, and human-centric supply chain practices, fitting the study criteria.

Samples and Sampling Process

The study gathered responses from 320 respondents from organizations that were proactively implementing Supply Chain 5.0 technologies and Digital transformation projects. The number of respondents (320) was adequate to obtain good statistical power of the sample and to ensure reliable inferences about the relationships among the variables studied, allowing for correlation and multiple regression analyses. Purposive sampling was used for the respondents, as they were required to have professional experience in supply chain, digital technologies, and organizational decision processes. To make the data collected as relevant as possible and of high quality, individuals who were not directly engaged in the activities of the supply chain were not included.

Data Collection Instrument

The structured questionnaire had two parts and was used for collecting primary data. The first part collected demographic data such as Gender, Age, Educational Qualification, Organizational Experience and Job Position. The second section aimed to assess the research constructs, with measurement items validated from relevant literature and recently published studies on Supply Chain 5.0 and Industry 5.0. This questionnaire was used to measure four competencies – AI competencies, HI competencies, Digital Innovation competencies and Sustainable Value Creation competencies – in multiple indicators. The answers were obtained using a five-point Likert scale, which ranged from Strongly Disagree (1) to Agree (5) Strongly. These higher scores reflected greater acceptance of each of the constructs.

Measurement of Variables

Organizations' use of intelligent technologies was measured with Artificial Intelligence, such as predictive analytics, machine learning, intelligent automation, and AI-supported decision-making. Human Intelligence measured leadership capability, employee knowledge, collaboration, moral judgment, and knowledge of the organization. Digital Innovation measured technological adoption, as well as the use of the Internet of Things (IoT), blockchain, digital twins, cloud computing, and the digital integration of supply chain activities. Operational efficiency, environmental sustainability, supply chain resilience, stakeholder satisfaction, and organizational competitiveness in the long term were measured by Sustainable Value Creation.

Data Collection Procedure

The questionnaire was disseminated through professional networks, contacts within the organisations and Internet-based survey tools. A brief explanation of the purpose of the study and that participation was voluntary to the participants. The respondents were asked to answer the questions in an anonymous format such that true answers and response bias are minimized. Data collection was terminated when the number of 320 completed questionnaires was reached. Coded responses were carefully examined to guarantee completeness and consistency in preparation for statistical analyses.



Data Analysis Techniques

All the information collected was analyzed using the Statistical Package for the Social Sciences (SPSS) Version 29. Characteristics of respondents and construct distributions were reported using descriptive statistics such as frequencies, percentages, means, and standard deviations. Pearson correlation analysis was used to determine the relationships between the study variables. To differentiate the contributions of AI, HI, and Digital Innovation to Sustainable Value Creation, multiple regression was conducted. Statistical significance was considered at the 5% level. The analytical procedures provided empirical data from testing the proposed hypotheses and evaluating the conceptual framework.

4. Results and Analysis

Descriptive Statistics of the Study Variables

The descriptive analysis examined respondents' perceptions regarding Artificial Intelligence (AI), Human Intelligence (HI), Digital Innovation (DI), and Sustainable Value Creation (SVC) in Supply Chain 5.0.

Table 1

Descriptive Statistics of the Study Variables (N = 320)

Variable	Mean	Standard Deviation
Artificial Intelligence	4.29	0.57
Human Intelligence	4.21	0.61
Digital Innovation	4.34	0.54
Sustainable Value Creation	4.37	0.52

The results indicated that the Sustainable Value Creation had the highest mean score ($M = 4.37$, $SD = 0.52$), indicating that participants were very confident with the creation of long-term value for the company through the implementation of Supply Chain 5.0. Hence, the relatively small standard deviation reflects the uniformity of the opinions of the respondents towards the sustainability outcomes. The results revealed positive attitudes among the organization on the use of advanced technologies and sustainability programs. The second-highest mean ($M = 4.34$, $SD = 0.54$) revealed that organizations will proactively invest in the emerging technology solutions to enhance their performance, particularly in relation to IoT, Cloud Computing, Blockchain, and Digital Twins. AI also had a high mean score ($M = 4.29$, $SD = 0.57$), suggesting the use of AI was widely regarded as valuable for improving the accuracy of forecasts, inventory management, logistics optimization, and strategic decision making. HI had a mean of 4.21 ($SD = 0.61$), with good levels of agreement on its importance for employee competence, leadership, creativity, and ethical judgment in Supply Chain 5.0. Respondents felt that human intelligence was an important factor in organizational sustainable performance, although it was slightly less than the technology-related variables.

Correlation Analysis

Pearson correlation analysis examined the relationships among Artificial Intelligence, Human Intelligence, Digital Innovation, and Sustainable Value Creation.

Table 2

Correlation Matrix

Variables	AI	HI	DI	SVC
Artificial Intelligence (AI)	1			
Human Intelligence (HI)	0.618	1		
Digital Innovation (DI)	0.674	0.592	1	
Sustainable Value Creation (SVC)	0.738	0.691	0.781	1

Note: $p < 0.01$

Based on correlation analysis, the study variables were correlated with each other and it was concluded that all the variables are significantly positively correlated. There was a positive and significant correlation between the Sustainable Value Creation and AI ($r = 0.738$, $p < 0.01$) which means that the higher the use of AI is, the better the sustainable outcomes of the organizations are. AI enabled organizations saw an increase



in operational efficiency, resilience, and value creation. The link between Human Intelligence and the Sustainable Value Creation was found to have a significant positive correlation ($r = 0.691$, $p < 0.01$). This finding revealed how the knowledge, leadership, work collaboration among employees and the decision making process was positively affecting the sustainability of the organisation. Digital Innovation was found to be significantly related to Sustainable Value Creation with the highest correlation value ($r = 0.781$; $p < 0.01$). The results showed that the positive effect of technological innovations was high in sustainable operational performance, as a result of more transparency, automation of operations, better use of resources and more flexibility of the organisation. Correlations between independent variables were kept as low as 0.80, which is considered the threshold for multicollinearity.

Multiple Regression Analysis

Multiple regression analysis examined the influence of Artificial Intelligence, Human Intelligence, and Digital Innovation on Sustainable Value Creation.

Table 3

Model Summary

R	R²	Adjusted R²	Std. Error
0.852	0.726	0.723	0.344

The obtained result in regression model was the correlation coefficient (R_s) at 0.852 that shows a strong relationship between the independent variables and Sustainable Value Creation. The total of Artificial Intelligence, Human Intelligence and Digital Innovation accounted for 72.6% of the variance in Sustainable Value Creation (coefficient of determination $R^2 = 0.726$). The value adjusted R^2 (0.723) was very close to the original value of R^2 indicating that the regression model was fairly stable. The small standard error (0.344) also indicated that the standard error of the data observed was very similar to the model's.

Regression Coefficients

Table 4

Regression Coefficients

Predictor	B	Std. Error	Beta	t	p-value
Artificial Intelligence	0.301	0.051	0.324	5.90	0.000
Human Intelligence	0.247	0.048	0.274	5.15	0.000
Digital Innovation	0.389	0.046	0.418	8.46	0.000

The regression analysis showed that all the independent variables had significant regression coefficients affecting Sustainable Value Creation. In the case of Artificial Intelligence, the standardized beta coefficient was 0.324 ($p < 0.001$), meaning that the higher the AI technologies, the better the performance of the organisation in sustainable organisations. Human Intelligence also had a significant and positive impact ($\beta = 0.274$, $p < 0.001$). The results showed that managerial competence, leadership, ethics and teamwork remained to be significant factors in the sustainability of an organisation. In complex decision making, human judgment and context was introduced to intelligent technologies. Digital Innovation proved to be the best predictor of Sustainable Value Creation ($\beta = 0.418$, $p < 0.001$). Sustained investment in cutting-edge digital technologies had the greatest effect on sustainable organizational outcomes, the result showed. Blockchain, Internet of Things, Cloud Computing, Robotics and Digital Twins greatly furthered the operational flexibility, transparency, resilience and competitiveness of Supply Chain 5.0 ecosystems.

Hypothesis Testing

Table 5

Summary of Hypothesis Testing

Hypothesis	Relationship	Beta	p-value	Decision
H1	Artificial Intelligence → Sustainable Value Creation	0.324	0.000	Supported
H2	Human Intelligence → Sustainable Value Creation	0.274	0.000	Supported
H3	Digital Innovation → Sustainable Value Creation	0.418	0.000	Supported



Results of hypothesis testing showed support for all three hypotheses. The proposition that the capabilities needed to enhance operational excellence and sustainability were enabled by Artificial Intelligence resulted in Sustainability Value Creation showing a positive influence. The regression coefficient was very high, indicating that AI was a key technology enabler in Supply Chain 5.0. Human Intelligence also had a strong positive impact on the Sustainable Value Creation. The results emphasized the need for people in their daily roles to be experts at what they do, creative, collaborative, and leaders to sustain their organizations. The findings reinforced the human-centric vision of Industry 5.0 – in which smart technologies enhance and complement people's skills.

5. Discussion

The results clearly showed that the use of Artificial Intelligence (AI) has the potential to greatly contribute to Sustainable Value Creation in the field of Supply Chain 5.0. AI benefits are benefits, such as better operational planning, more precise forecasts, optimisation of inventories, better coordination of logistics and making better decisions. AI's role in the supply chain was also seen to boost efficiency and resilience for companies, with predictive analytics helping them to anticipate market fluctuations and operational challenges. The results were comparable to the findings of the recent studies on the benefits of using AI for better digital supply chain performance, such as better supply chain visibility, real-time decision making, and adaptability of human-centric industrial ecosystem (Bag et al. 2024; Sharma et al. 2025; Ciano et al. 2024).

They also showed that Human Intelligence still had a significant positive effect on Sustainable Value Creation, suggesting that managerial skills of employees, managerial creativity and problem solving with fellow employees, and ethical decision making, were still strong managerial competencies that had an impact on the success of the organisation. The respondents noted that although operational efficiency was a benefit of the use of digital technologies, they valued human knowledge, understanding and leadership in strategic decision making. This finding further solidified the concept of 'human first' with Industry 5.0, where technology supports and complements, not replaces, humans. Just like in this study, other studies have recently shown that companies with a successful application of intelligent technologies in their processes, and where employees actively participate in digital transformation projects, are more resilient, innovative, and competitive in the future (Bravi et al., 2024; Calabrese et al., 2024; Sony et al., 2025).

The most immediate impact on Sustainable Value Creation was digital innovation and investments in emerging technology like IoT, blockchain, cloud computing, digital twins and integrated digital platforms are having an impact on the performance of the organisation. Digital innovations were effective in improving the transparency of the supply chain, and in making information more available, utilising resources and improving coordination amongst the supply chain. The results found that technological modernization was a strategic demand of the organization for achieving sustainable competitive advantage. Empirical studies have shown that digitally connected supply chains are more flexible, sustainable and resilient and the ability of digital technologies to track the processes in real-time, manage resources intelligently, and continuously optimise processes (Mastrocinque et al., 2024; Del Giudice et al., 2024; Mariani et al., 2025).

The similarity between the AI, HI, and DI approaches of the proposed Integrated Supply Chain 5.0 provides solid empirical evidence. Therefore, the ability to use technology, along with a human approach and digital transformation, in a collaborative way, instead of only relying on technological investments, was necessary to achieve sustainable value creation. This big picture emerged from shifting from technology-driven value chains to human-value, resilient, and sustainable operational systems. Recent studies also showed that Supply Chain 5.0, with a balanced combination of increasing the usage of intelligent automation, collaborative decision-making, and innovations based on environmental aspects, for these companies, led to a favourable outcome in the organization (Paul et al., 2024; Rane et al., 2025; Frederico et al., 2024).

It also confirmed that the sustainable generation of value in Supply Chain 5.0 was achieved thanks to the synergic fusion of AI, HI and Digital Innovation. Organisations that successfully integrated the enabling technologies, increased their in-house capability, and implemented digital infrastructure were able to achieve an improved operational performance, resilience and sustainability. Further findings were that technology investment, coupled with leadership, ethical control, and continuous learning within an organisation, was



significant in bringing about the desired organisational outcomes. Fewer trusted human-AI collaborations, responsible digital transformation, and sustainability-focused innovation would be crucial components for future supply chains to flourish in intricate global markets (Gupta et al., 2025; Khan et al., 2024; Bragazzi et al., 2025).

6. Conclusion

The purpose of this study is to analyse and research the impacts of AI, HI, and digital innovation on Sustainable Value Creation in Supply Chain 5.0. The results showed that all three variables had positive and statistically significant effects on sustainable organizational performance, and that among the three, digital innovation was stronger. The results indicated that the organizations that managed to create better sustainable value were the ones that implemented a mix of intelligent technologies, human skills, collaborative decision-making, and cutting-edge digital systems. Lastly, it was discovered that Supply Chain 5.0 is not only a technological innovation; it is also a human management approach that allows for operational efficiency, operational resilience, transparency, and competitiveness in the long run. The findings were also used to enhance the understanding of Sustainable Value Creation, with empirical evidence that the successful integration of AI, HI, and DI was essential for achieving sustainable value creation in the SC.

7. Recommendations

Investment needs to be put into growing the use of Artificial Intelligence, digital infrastructure, and new technologies such as the Internet of Things (IoT), blockchain, cloud, and digital twins for increased visibility, reduced operating costs, and sustainable performance throughout the supply chain. In the meantime, HR managers need to dedicate time and resources to continuous training and development initiatives, leadership training and development, and the upskilling of digital skills to facilitate the effective integration of humans and AI. It is also crucial that organizations establish ethical governance and foster innovative organizational cultures that enable them to utilize AI responsibly and sustainably. Enabling policies, investments, and cooperation among industry stakeholders are needed to advance digital transformation and the implementation of Supply Chain 5.0 practices by policymakers.

8. Future Research Directions

The scope of Supply Chain 5.0 should be broadened by continuing research on other organizational and technological considerations, including (but not limited to) digital leadership, innovation capability, supply chain resilience, environmental sustainability, and organizational culture. Researchers should also use longitudinal and mixed method designs to investigate the change of organizations over time, and for greater understanding of technology adoption. Future findings may be improved by conducting comparative studies of the various industries, countries, and sizes of organizations. Emerging technologies, like generative Artificial Intelligence, autonomous systems, quantum computing, and advanced digital ecosystems, could play a role in boosting sustainable value creation in the future supply chain networks. However, this is something that could be explored in future research.

Contribution of Authors

All the authors participated in the ideation, development, and final approval of the manuscript, making significant contributions to the work reported.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this article.

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Informed Consent

Informed consent was obtained from all participants.

Data Availability

The datasets generated during and analysed during the current study are available from the corresponding author on reasonable request.



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