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Abstract: Artificial intelligence chatbot systems have increased sales and customer engagement through sustainable supply chains. Industry 4.0 internet-based technology shares a lot of new opportunities for the growth of manufacturing organizations. Organizations are adopting these latest technologies to gain sustainability and competitive advantages in the supply chain. Artificial intelligence chatbots are providing help in accomplishing visibility in enhancing sustainability. Innovativeness is also helpful for improving the event's performance through technologies. This study also checks the implementation of artificial intelligence chatbot systems on the sustainability of manufacturing organizations in America. Transparency in the supply chain mediates between artificial intelligence chatbot systems and sustainability. Moreover, Innovativeness mediates between artificial intelligence chatbot systems and sustainability. The present study also supports the dynamic competence theory with 356 respondents from America. The analysis results show that implementing artificial intelligence chatbot systems has a positive significant role in sustainable performance in manufacturing organizations in America. Transparency partially mediates between artificial intelligence chatbot systems and sustainable performance. Moreover, Innovativeness has a partial mediating role relationship between artificial intelligence chatbot systems and sustainable performance. The present study is helpful for regularities, policymakers and business owners.

Keywords: Artificial Intelligence Chatbot, Innovativeness, Sustainable Supply Chain Management, Transparency in Supply Chain and American Organization

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Introduction

The sustainable supply chain is crucial as it reduces manufacturing costs while minimizing environmental outcomes, promoting economic development and creating additional possibilities in local and global markets (Qureshi, M.R 2022). The sustainable process mainly focuses on optimizing the activities relative to the supply chain from raw and finished goods items. This approach aims to achieve the social, economic and environmental factors (Seurin & Müller, 2008). Economic growth poses significant challenges for developing nations, necessitating the pursuit of development for the market's growth. The manufacturing organization helps to promote sustainable development (Qureshi et al., 2023; Alsmairat, M. A. 2023). Sustainable development is a crucial approach used to use their resources while ensuring future generations' well-being

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effectively. All companies in Industry 4.0 use the latest artificial intelligence chatbot like automation, blockchain and others (Saddique et al., 2023). This chatbot usage is in the fourth revolution of industries. Artificial intelligence chatbots have high potential to assist manufacturing organization efficiently. organizations decade, artificial intelligence chatbots have been very useful in manufacturing organization supply chains (Saddique et al., 2021). Many business entrepreneurs use this chatbot system in their supply chain system to enhance operations (Urenna et al., 2022). The latest chatbot system usages also improve its supply chain performance. These artificial intelligence systems have the potential to facilitate automated procurement of raw materials, streamline logistical operations, and enhance the sales performance of manufacturing. This system is very proactive, and responsive activities provide practical solutions to a supply chain inventory (Saddique et al., 2023). Innovativeness in dynamic capabilities assists companies in effectively combining, developing, and reorganizing their competencies to tackle emerging difficulties and adapt quickly to changing business contexts (Teece et al., 1997). Moreover, when considering the function of artificial intelligence chatbots in overseeing the immediate responses to their customer and associated supply chain processes. Firms might be using the artificial intelligence chatbot to address the emerging difficulties of Industry 4.0. Exploring the impact of chatbot consumption on these difficulties may be compelling in future studies. Therefore, to guarantee sustained implementation of artificial intelligence chatbots, more empirical research must be conducted to examine the perspectives and attitudes of consumers towards artificial intelligence chatbots in this particular setting (De Kervenoael et al., 2020). This present study checks the influence of AI chatbot systems on sustainable management. This study uses regression and correlation analysis to show the final result of direct and mediating variables like supply chain transparency and innovation.

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Literature Review and Hypothesis Development:

Chatbots have seen rapid advancement in marketing, education and healthcare. Now, the chatbot with answers and questions has an impressive success rate of over 90% (Trappey et al., 2022). Artificial intelligence systems are crucial in enhancing the consumer experience and facilitating customer engagement for firms. The usage of these latest technologies extrinsic effects customer experience, enhancing customer satisfaction (Chen et al., 2021). Sustainability in the supply chain provides long lasting benefits. These are the following approaches: stakeholder and dynamic competence theories are used in it. Dynamic competence theory is used to identify the capacity for advancements of the latest technologies, like chatbots, to improve values in the supply chain process (Jum, L. 2023). The transparency with chatbots helps to optimization (Piprani et al., 2023). Dynamic theory of competence also identifies process disruption and innovations to minimize the risks through these latest chatbots (Piprani et al., 2023).

2.1 Artificial Intelligence in Manufacturing Process Optimization

Artificial Intelligence (AI) is transforming the manufacturing sector by implementing automation and data driven decision making processes. One key area where AI is making an impact is automating customer support through chatbots and virtual assistants. These AI powered tools are created to engage with customers in time handling inquiries, processing orders and offering assistance. The advantages of using technology are

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numerous including round-the-clock customer service availability, response times and a notable decrease in human errors to ensure consistent service quality. In addition, AI systems can efficiently handle volumes of customer interactions while maintaining levels of accuracy and effectiveness.

Imagine a factory where the entire production process is steered by smart, thoughtful decisions, where systems fine-tune themselves and manage tasks autonomously. This is the heart of intelligent manufacturing in the process industry. It's about turning factories into greener, more efficient spaces (Chai TY, 2005). The routine tasks that once tied up operators are now smoothly handled by automated systems, and the production line hums along, guided by its own intelligent controls. Meanwhile, the people in charge, the managers and strategists, find their roles enriched with new layers of intelligence, allowing them to think bigger and bolder.

In terms of optimizing processes, AI has proven to be a resource. Process optimization software utilizes AI to analyze production data for streamlining operations reducing waste and improving product quality. Besides, predictive maintenance technologies predict equipment failures in advance to prevent downtime and lower maintenance expenses. The benefits of optimization are evident, increased efficiency and productivity cost savings through optimized resource allocation and waste reduction. In 2017, Mercedes Benz initiated a new Kaggle contest, inviting the community to find ways to cut down the duration that each vehicle spends on the test bench. The top two performing solutions were made public. The first-place entry employed GBT (XGBoost) to achieve its results, while the runner-up combined various algorithms, including Gradient Boosting Regressor, Random Forest Regressor, and Support Vector Regressor, to form an ensemble. Both approaches achieved R2-Scores greater than 0.55, as noted Daimler (2017).

AI's capabilities also extend to offering expert advice on manufacturing practices. Expert systems, driven by AI utilize a pool of knowledge to provide suggestions effectively mimicking the decision-making abilities of an expert. Pachner et al. (2019) and Lokrantz et al. (2018) tackle a subject that diverges from the earlier focus on optical quality detection. Their research shifts attention to the entire production process rather than just the final visual check to incorporate machine learning solutions. Specifically, Lokrantz et al. (2018) develop a Bayesian network model to pinpoint the underlying reasons for quality discrepancies in two distinct manufacturing processes. A crucial insight from their work is the importance of incorporating expert knowledge when constructing a Bayesian network model for manufacturing processes. Root cause analysis of failures and quality deviations in manufacturing using machine learning.

Adaptive manufacturing, another aspect of AI enables the adjustment of manufacturing methods to accommodate varying product designs thereby improving product customization capabilities and decision making through real time data analysis.

Nevertheless, incorporating AI into manufacturing presents challenges. Concerns regarding data privacy and security, its impact on the workforce and considerations need attention. Looking ahead to the future, emerging AI technologies hold promise, for influencing the manufacturing sector prompting manufacturers to embrace these advancements. The significant impact of AI is vast. Its incorporation into manufacturing operations is set to revolutionize the sector bringing about levels of effectiveness and output.

2.2 Artificial Intelligence Chatbots System and Sustainable Supply Chain Performance

According to the dynamic competency theory, organizations need to improve continuously in growth and minimize uncertainties. Organizations that adopt and use artificial intelligence technology in their operations to enhance their capacity (Panigrahi et al., 2023). Chatbot services have transformed from being just computers to being seen as communication objects through customers. They seem reasonable in using conversational interactions based on user questions and chatbots (Ciechanowski et al., 2019). The chatbots play a crucial role as sustainability tools, aiding in assessing sustainability goals through efficient analysis. It provides a detailed examination of sustainability objectives by segmenting information by department (Aydin et al., 2023; Panigrahi et al., 2023). Thus, firms may optimize their profits while minimizing resource consumption, enhancing operational efficiency, and promoting sustainability using the latest technologies. These latest tools help in the automation of customer assistance, optimize industrial process routes, and give guidance on manufacturing techniques. This novel technology notifies staff of deviations from the usual functioning of the manufacturing system. With latest technology manufacturing organization enhance customer satisfaction, and increase customer acquisition. On above discussion, the following “hypothesis H1, chatbots with artificial intelligence has a positive influence on sustainable management”.

2.3 “Mediating Role of Transparency”

Learning and intelligence capabilities of the latest chatbots enable enterprises to maintain agility and proactively respond to changing user demands and preferences while remaining adaptable. These latest technologies help to enhance efficient decision-making (Tseng et al., 2018). The organization uses the latest technologies (chatbots) are help to provide transparency to streamline the supply chain operation and deduct needs changes in the market to gain competitive advantages (DelGiudice et al., 2020). Furthermore, these also help to track the inventories and keep updated with every operation to gain sustainability (Wang & Hu, 2020). This transparency minimized the hazard and enhanced efficiency (Piprani et al., 2023). These technologies also improve and track productivity (Pillai et al., 2022). It is also helpful to exchange information efficiently (Huq et al., 2016; Chowdhury et al., 2020). Transparency also minimizes risk mitigation (Venkatesh et al., 2020). With transparency in terms of productivity, organizations are improving their skills (Afshar et al., 2020). An efficient process facilitates smooth operations and reduces interruptions (Irfan et al., 2021). Chatbot technology has a helpful effect on performance by optimizing processes through smart contracts. This optimization reduces operational expenses, enhances security measures, and improves cooperation efficiency (Chowdhury et al., 2020; Nwagwa et al, 2023). Furthermore, integrating the latest technologies fosters transparency and trust, enhancing process techniques to promote overall performance. In the above discussion, Hypothesis H2: Artificial intelligence chatbots have positive influences on transparency. H3: There is a significant impact SC transparency on supply chain. H4: There is partial Significant mediating SC transparency between artificial intelligence chatbots and sustainable performance

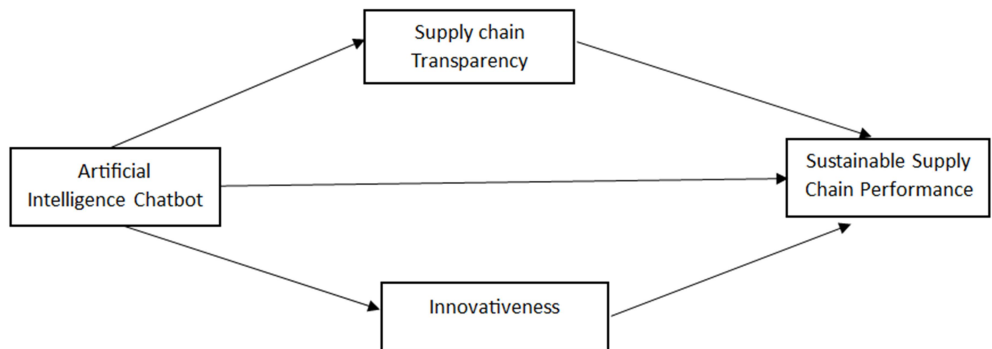
2.4 Mediation Role of Innovativeness in Process

The previous studies suggest that chatbots provide a unique and practical approach to engaging with consumers, partners, and workers, enabling smooth communication and

sharing of information and using AI-driven service advancements, using extensive data and powerful processing capabilities in transforming several segments like insurance, healthcare and others (Chowdhury et al., 2020). These latest technologies are used in service innovation to anticipate significant changes in organizational capabilities. The transformational capacity of this phenomenon is poised to fundamentally alter several sectors and unlock new opportunities for expansion and progress. Chatbots may significantly improve organizational intellectual capital—using artificial intelligence-enabled industrial robots to enhance productivity and creativity. The organization with manufacturing sections seems to have invested in more innovations through advanced technologies (Pillai et al., 2022). The automated system enhances operations flow smoothly. The latest technologies are essential to innovativeness (Piprani et al., 2023). For sustainable business and gain competitive advantages due to innovation (Deng et al., 2023). Blockchain network in the system process also helps to gain innovativeness (Tariq et al., 2021). The impact of corporate culture and advantage of competitiveness has been favorable, with innovativeness as mediator relationship. The results suggest that the presence of a green innovation culture inside organizations Furthermore, the presence of green innovation also partially mediates between competitive advantage and culture. In the above discussion, Hypothesis H5: The positive influences of artificial intelligence chatbots on innovativeness. H6: There is a significant influence of innovativeness (I) on sustainable SCP. H7: There is a partial significant mediation of innovativeness in between SSCP and AI chatbots.

Methodology

This present research shows the impact of AI chatbots on the sustainable performance of industrial enterprises in the United States. It is also investigating the mediation innovativeness (I) and transparency. Respondents' personal information was confidential throughout the data collection method (Saddique et al., 2021; Sharif et al, 2022). The surveys were sent through Google Forms to many corporations in the United States. Data consists of a sample size of 356. The findings of the collected data are given below.



Conceptual Model

3.1 Items and variable detail

Table

Variable	Items	Reference
Artificial Intelligence Chatbot	"4"	(Sheehan et al, 2020)
SC Transparency / Visibility	"7"	(Morgan et al., 2018)
Innovativeness	"6"	(Fernando et al., 2018)
Sustainable SC Performance	"6"	(Sun et al., 2022)

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3.2 Demographic Status

Table

"Particular"	"Characters"	"F"	"%"
"Gender"	Female	112	31.46
	Male	244	68.53
"Ages"	Less than 25	65	18.25
	26-35	152	42.65
	36-45	61	17.13
	46-55	42	11.79
	Above than 55	36	10.11
"Education level"	Less than Intermediate	62	17.41
	Intermediate	121	33.98
	Less than Post Graduate	153	42.97
	Above than post-Graduation	20	5.60
"Work Experience"	< 1 Years	59	16.57
	<5 Years	124	34.83
	< 10 Years	95	26.68
	> than 10 Years	78	21.91

Explanation: Table 3.2 The survey findings indicate the demographic status of the 356 respondents. Of the total, 244 individuals were male (68.53%), while 112 were female (31.46%). The ages of the participants were categorized into five distinct groups: 42.65% respondents between range of ages is 26 to 35, while 10.11% were beyond the age of 55. The qualification categories are categorized into four distinct groups. Most respondents, comprising 42.97%, have university graduation degrees, while a minor proportion of respondents, 5.60%, have completed post-graduate studies. Based on work knowledge, it is distinct in four categories. Most are less than five years of experience, accounting for 34.83% of the total. Conversely, the most minor proportion of respondents, 21.91%, have more than ten years of experience.

3.3 Analysis of Reliability

Table

"Study Variables"	"Cronbach's Alpha"
Artificial Intelligence Chatbot	0.82
Supply Chain Transparency	0.86
Innovativeness	0.84
Sustainable Supply Chain Performance	0.91

Explanation: In Table 3.3, the reliability above scale was examined through Cronbach's alpha. The aforementioned findings exceeded 0.70, indicating that the

measurements demonstrated data dependability and reliability and were appropriate for further investigation.

3.4 Correlation

"Variables"	1	2	3	4
1. Artificial Intelligence Chatbot	1			
2. Supply Chain Transparency	0.145**	1		
3. Innovativeness	0.314**	0.356**	1	
4. Sustainable Supply Chain Performance	0.175**	0.46**	0.294**	1

* Significant = 0.05, **Significant = 0.01.

Explanation: Table 3.4 shows the correlation among significant between artificial intelligence chatbot and supply chain transparency with (r=0.145, p= 0.00), the correlation shows significant between artificial intelligence chatbot and innovativeness with (r=0.314, p= 0.00), whereas the correlation shows significant between artificial intelligence chatbot and sustainable supply chain performance with ("r=0.175", "p= 0.00"), Moreover, correlation shows significant among supply chain transparency on innovativeness with (r=0.35, p= 0.00), whereas the correlation shows significant between supply chain transparency and sustainable supply chain with (r=0.46, p= 0.00) and the correlation shows significant between innovativeness and sustainable supply chain with (r=0.29, p= 0.00).

3.5. Regression Analysis

3.5.1. Model between Artificial Intelligence Chatbot and Sustainable SCP.

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"Variable"	"R ² "	"beta"	"t"	"sig"
Artificial Intelligence Chatbot	0.12	0.287	8.46	0.000

Variable Dependent: Sustainable SCP "**p < 0.05".

Explanation: Table 3.5.1 presents the results of a regression study of an artificial intelligence chatbot on sustainable SCP. The statistical significance of the model is shown by an "ANOVA" p-value of 0.05. The correlation coefficient (R-square) of 0.12 shows a positive association between the increase in artificial intelligence chatbots and sustainable SCP by 1.2%. The significant value of the coefficient is reported as 0.00, suggesting a robust correlation between artificial intelligence chatbot and sustained performance since it falls below the predetermined threshold of 0.05. The beta coefficient of 0.287 indicates a significant association among AI chatbot & sustainable SCP. Therefore, hypothesis 1 is confirmed.

3.5.2. Model Between Artificial Intelligence Chatbot and Supply Chain Transparency

Variable	R ²	B	t	sig
Artificial Intelligence Chatbot	0.02	0.231	9.89	"0.00"

Variable Dependent: Supply Chain Transparency, *"*p < 0.05"*.

Explanation: Influence AI Chatbots on SC Transparency is shown in Table 3.5.2. The significance value of the "ANOVA is < 0.05", suggesting may be considered significant results. The R-squared value of 0.02 indicates that the Artificial Intelligence Chatbot has a 2% impact on supply chain transparency. Statistical significance of the coefficient is 0.000, which is below the threshold of 0.05, suggesting a significant association. The beta coefficient, with a value of 0.231, signifies the influence of AI Chatbot on SC transparency. Thus, Hypothesis 2 is seen to be acceptable.

3.5.3. Model between SC Transparency and Sustainable SCP

Variable	R ²	B	t	sig
Supply Chain Transparency	0.19	0.351	9.31	0.000

Dependent Variable: Sustainable Supply Chain Performance, **p < 0.05*.

Explanation: The regression analysis findings examining the influence of SC Transparency on sustainable SCP are shown in Table 3.5.3. The "ANOVA < 0.05". "R-squared" =.19 shows significant association between the increase in SC Transparency and the corresponding increase in Sustainable SCP by 19.0% indicating a statistically significant correlation between the variables since it falls below the predetermined threshold of 0.05. The beta coefficient of 0.351 suggests a positive association among SC Transparency & sustainable SCP. Assumption, Hypothesis# 3 has been approved.

3.5.4: The Analysis of Mediation

"Table 3.5.4": "Mediation analysis using through Bootstrap"

"Relationships"	"β"	"p"	"Bootstraps@95%"		"Hypotheses"
			"LL"	"UL"	
<i>AIC → SCT → SSCP</i>					
"Direct effect"	"0.191	***	0.13	0.375"	
"Indirect effect"	"0.316	***	0.23	0.421"	

"Note": AIC=Artificial Intelligence Chatbot, SCT=Supply Chain Transparency, SSCP=Sustainable Supply Chain Performance, ****p<0.01*

Explanation: One thousand bootstraps evaluated the variable representing the mediating hypothesis at a 95% confidence level to determine the upper and lower bounds. Supply Chain Transparency is an intermediary between The Artificial Intelligence Chatbot

and the sustainable functioning of the supply chain. Hypothesis H4 is verified since impact indirect (“0.316, LL= 0.23, UL = 0.421, P=0.00”) less direct effect (“ $\beta = 0.191$, P=0.00”). Additionally, “0” is absence within the both limits further supports this conclusion. Supply chain transparency partial mediate association among AI chatbots & sustainable SCP.

3.5.5. Model Between Artificial Intelligence Chatbot and Innovativeness in Process Optimization

Variable	R ²	B	t	sig
Artificial Intelligence Chatbot	0.029	0.28	9.175	0.000

Dependent variable: Innovativeness, “*p < 0.05”.

Explanation: The result evaluates artificial intelligence chatbots on innovativeness. In Table 3.5.5, the Significance “ANOVA = 0.05”. “R-squared = .029 suggests marginal increase unit one in the artificial intelligence chatbot variable is associated increases of 2.9% with innovativeness. Beta coefficient 0.28 signifies Artificial Intelligence Chatbot's influence on the innovativeness level seen in the optimized process. Thus, Hypothesis H5 is deemed valid.

3.5.6. Model between Innovativeness in Process Optimization and Sustainable Supply Chain Performance

Variable	R ²	B	t	sig
Innovativeness in Process Optimization	0.87	0.221	9.61	0.000

Dependent Variable: Sustainable Supply Chain Performance, *p < 0.05.

Explanation: According to Table 3.5.6, the regression analysis demonstrates the influence of innovativeness in process optimization on performance of sustainable performance. The significance value “ANOVA = 0.05”. “R-squared = .87 is used, signifying that a single-unit change in innovativeness would result in an 87% Sustainable SCP. Beta coefficient 0.221 suggests a positive association between innovativeness and sustainable supply chains. Acceptance of Hypothesis H6 has been confirmed.

3.5.7. Analysis of Mediation

“Table 5”: “Mediation analysis using through Bootstrap”

“Relationships”	“ β ”	“p”	Bootstraps@ 95%		“Hypotheses”
			“LL”	“UL”	
AIC → I → SSCP					
“Direct effect”	“0.124	***	0.034	0.342”	
“Indirect effect”	“0.290	***	0.034	0.432”	

Note: AIC=Artificial Intelligence Chatbot, I=, Innovativeness, SSCP =Sustainable Supply Chain Performance, ***p<0.01

Explanation: A 95% confidence interval was used to test the mediation hypothesis, with 1000 bootstraps used to define lower and upper limits. The relationship between artificial intelligence Chatbot and Sustainable SCP is mediated by innovativeness in process optimizations. This mediating role has an indirect impact, as shown by a coefficient of 0.290, a lower limit of 0.034, an upper limit of 0.432, and an implication level of 0.01. The observed effect is statistically significant, as beta is 0.124 and p is 0.01. Hypothesis H7 has been confirmed. The research determines a partial positive association between using artificial intelligence chatbots and sustainable SCP regarding innovativeness.

Discussion

The use of industry 4.0-based technologies has brought about a fundamental change in the manufacturing industry. The organizations have seen remarkable transformations in their logistics and supply chain operations. Industry 4.0-based disruptive technologies have enhanced the supply chain transparency and Innovativeness in information system for all type of organizations logistics and supply chain-related operations. The supply chain transparency has facilitated stakeholders in optimizing supply chain efficiency of performance. Similar to other technologies enabled by the internet, AICs are also becoming more prevalent in the manufacture of supply chains that are allocating funds to the latest technologies to progress users' experiences. Artificial intelligence chatbots used by supply chain experts and logistics management might inform their strategic decision-making processes (Zhang et al, 2023). Quantitative ways may be used to assess the efficacy of artificial intelligence chatbots. Automated industrial control systems aid customers, streamline activities, save expenses, and manage workers and inventory optimally. AICs may oversee warehouse automation to optimize warehousing operations, enabling consumers to promptly choose items without unnecessary time wasted on unsuccessful efforts to locate them—the use of AIC in logistics and SCP. The chatbots contribute in providing efficient result. AICs facilitate expeditious decision-making by providing access to knowledge and information. The current study has shown that the use of AICs not only improves SCT but also facilitates the achievement of process innovations. These both contribute to the attainment of SSSP. The study has also observed the mediating impact of SC Transparency and Innovativeness, and it has shown that there is an influence of Manufacturing SMEs will see enhanced agility and responsiveness in supply chain operations via the use of AICs. AICs aid suppliers in optimizing supply chain management by monitoring inventory levels, delivery schedules, and customer demand. AICs facilitate inventory management, shipping coordination, and customer preference prediction for enterprises (Deloitte et al., 2022). The use of AIC in logistics and SC leads to the development of various Innovativeness that fundamentally transform the way firms manage their logistics and SC operations (Al-Shboul et al., 2022).

Managerial and Theoretical Implications

The current logistics and SC management identify new prospects in the industry 4.0 environment. Given the increasing fascination with AI-driven technology, managers of manufacturing organizations are seeking effective modifications in their production processes. The theoretical uses are also helpful for improving the SSCP through AI Chatbots. These findings are helpful for managers who use the chatbot in the supply chain

to increase transparency and innovativeness. Experienced managers also understand the relationship between AI, SCT, I and SSCP. Policymakers have also developed methods to facilitate using AI chatbots in SSCP.

Conclusion and Future Directions

This study checks the influence of AIC on SSCP with the mediation of I and SCT. Additionally, this study observes the relationship between (AICs) and their influence on SSCP (Wamba et al., 2020). the latest technologies help enhance the innovation process and help to provide transparency in their system. It shows that there is a positive influence on each other. (Wamba et al., 2020). These studies emphasized the need for sustainable SCP and urged firms to use new strategies that enhance efficiency, waste reduction, and eco-friendly issues. The technological advancements result in enhanced product design, optimization of processes, competitive advantages, and overall performance. This conduct suggests that long-term visibility and transparency positively impact its sustainable performance (Sun et al., 2022). In recent decades, knowledge has emerged as a potent instrument when organizations are compelled to innovate. strategies promote artificial intelligence& enhance supply chain transparency is an efficient approach to enhancing long-term supply chain sustainability. The analysis results show that implementing artificial intelligence chatbot systems has a positive significant role in sustainable performance in manufacturing organizations in America. Transparency partially mediates between artificial intelligence chatbot systems and sustainable performance. Moreover, Innovativeness has a partial mediating role relationship between artificial intelligence chatbot systems and sustainable performance.

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