Educational Administration: Theory and Practice
2024, 30(6), 812-823
ISSN: 2148-2403
https://kuey.net/

Research Article

The Model of Using Artificial Intelligence in Supply Chain Management in Product Production

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Citation: Amir Ali Ahmadi, et al (2024), The Model of Using Artificial Intelligence in Supply Chain Management in Product Production, *Educational Administration: Theory and Practice,* 30(6), 812-823, Doi: 10.53555/kuey.v30i6.5359

ARTICLE INFO

ABSTRACT

The drive to enhance the effectiveness of the supply chain in the manufacturing of apparel, otherwise known as ECPSC (Efficiency of the Apparel Manufacturing Supply Chain), has gained significant prominence in recent times. This increased focus on efficiency can be attributed to the rising costs associated with logistics as well as the advancements made in Industry 4.0 technologies, such as artificial intelligence. The field of logistics has witnessed noteworthy advancements that have captured the attention of both academics and industry experts, leading them to explore the potential of artificial intelligence tools in the realm of operations management. This particular study adopts a perspective rooted in the concept of dynamic capability (DCV) and theories related to organizational information processing. Its primary objective is to delve into the impact of technologies based on artificial intelligence on both the supply chain and production processes. By doing so, it seeks to minimize the costs associated with the supply chain of apparel products, ultimately aiming to increase the profitability of manufacturing organizations. Furthermore, this study also delves into the analysis of the mediating role played by outbound logistics and distribution network efficiency (DNE) in the relationship between artificial intelligence and ECPSC. In order to achieve these research objectives, the researchers utilized the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach. This approach facilitated the analysis and testing of the conceptual model and hypothesis using a dataset comprised of 300 responses collected from managers and executives within Iran's garment industry. The study yielded a novel finding, indicating that the integration of artificial intelligence has a direct and positive impact on ECPSC-mediated distribution network efficiency as well as organizational performance. Intriguingly, the researchers also discovered that as the level of artificial intelligence integration increases, the strength of the relationship between the aforementioned variables weakens. Additionally, the impact of artificial intelligence on production and business was evaluated and compared through the administration of questionnaires to two distinct groups.

Introduction

Artificial intelligence, as a burgeoning technology, presents tremendous opportunities for businesses to optimize their operations and surpass their competitors in unprecedented ways. Among the various sectors that have gradually embraced artificial intelligence, the clothing industry stands out. This industry, encompassing clothing manufacturing, is globally recognized as one of the most intricate and stringently regulated fields. Manufacturing companies within this industry encounter numerous challenges when it comes to managing their supply chain operations. These challenges include navigating strict regulations, handling a diverse range of products, and ensuring effective inventory management and transportation costs. In recent years, stores have been under immense pressure to fortify their supply chain operations to adapt to the ever-evolving landscape of digitalization, customer-centricity, and affordability.

In light of this context, it is highly recommended that artificial intelligence be leveraged as a critical tool for enhancing, optimizing, and implementing supply chain data operations within the clothing manufacturing sector. Manufacturing companies can utilize AI to achieve their production and delivery goals. To increase efficiency and sustainability while withstanding fierce market competition, companies should focus their strategies on the effective management of the downstream supply chain. Recognizing this need, governments propose the integration of Industry 4.0 technology into the supply chain of apparel products. Industry 4.0 represents a digital movement that aims to revolutionize production processes and final products. By embracing this technology, manufacturing companies can produce high-quality clothes in a faster and more cost-effective manner. Consequently, this literature review delves into the analysis of the benefits, limitations, challenges, and ethical considerations surrounding the utilization of artificial intelligence technology in optimizing and implementing supply chain data operations for clothing manufacturing companies. Additionally, questionnaires pertaining to the supply chain were reviewed within two distinct groups.

Through the utilization of Big Data and Data Mining (BD&DM), artificial intelligence can be employed to identify potential areas for resource rationalization and savings through optimal planning of logistics operations. These logistics operations primarily encompass distribution, transportation, inventory management, as well as ordering and warehousing. By optimizing these processes, energy consumption and other resources such as human capital, financial resources, and time can be significantly reduced. This research contribution aims to bridge the existing research gap by focusing on the logistics dimension. Consequently, the following research questions are addressed: RQ1: In what ways do AI-based technologies within the overall supply chain augment clothing production performance? RQ2: To what extent can the deployment of artificial intelligence technology support the efficiency of manufacturing companies' distribution networks? RQ3: Does the efficiency of distribution logistics serve as a mediator between AI adoption and the efficiency of apparel production supply chain performance?

To address these research questions, the present study adopts a dynamic capability perspective (DCV) that emphasizes an organization's ability to adapt to environmental changes through optimal resource reconfiguration. Additionally, the study employs organizational information processing theory (OIPT), which focuses on aligning an organization's information processing capabilities with its business needs. To further investigate these research questions, a structural equation modeling (SEM) approach is utilized, using data collected from various companies operating within the supply chain of apparel products. These companies consist of manufacturers, distributors, retailers, and other relevant stakeholders. The utilization of SEM enables a comprehensive analysis of the relationships among artificial intelligence adoption, distribution logistics efficiency, and apparel production supply chain performance efficiency. By employing these research methodologies, this study aims to contribute to the existing body of knowledge in the field of supply chain management within the clothing manufacturing industry (manufacturer, wholesaler, distributor, retailer, etc.).The organization of the article is as follows: Section 2 presents the supply chain of apparel products and advanced artificial intelligence technologies. Section 3 is dedicated to the conceptual model and research hypothesis development. which is briefly stated in section 4, research methods and data analysis tools. A presentation of the results of the analysis is presented in Section 5 before discussing the findings of the study and its contributions in Section 6. Finally, the results and future work are presented in Section 7.

2- The background and importance of the study:

-The supply chain of apparel products and advanced artificial intelligence technologies

In this section, we delve into the examination of research pertaining to the utilization of artificial intelligence within the supply chains of apparel products. Through this analysis, we aim to identify any potential gaps within the existing body of research. In order to provide a comprehensive and thorough review, we have partitioned the literature into two distinct areas. The initial segment focuses on the adoption of AI technology and the decision-making processes pertaining to its quality, relative significance, relationships, and usability within the realm of supply chain management. The subsequent section delves into the transformative impact of artificial intelligence technology on the supply chains of apparel products.

Apparel manufacturing companies operate within a highly regulated environment, characterized by a wide array of products and a global supply chain that necessitates efficiency and precision. Over the course of time, the apparel and textiles sector has undergone substantial changes as it endeavors to keep pace with evolving market dynamics, technological advancements, and consumer demands. One notable innovation that has garnered considerable attention in recent years is artificial intelligence (AI) technology, which holds the potential to revolutionize the apparel manufacturing industry. As the apparel industry becomes increasingly data-driven, the integration of artificial intelligence into supply chain management emerges as a viable solution to overcome challenges such as intricate regulations, product complexities, and inefficiencies. Among the potential advantages offered by AI technology are more precise demand planning, effective inventory management, efficient shipping, and enhanced customer experiences. However, it is worth noting that the implementation of AI within the pharmaceutical supply chain is still in its nascent stages and thus necessitates further exploration.

To fully comprehend the value and potential limitations associated with AI technology in optimizing and implementing supply chain data, it is imperative for pharmaceutical companies to gain a comprehensive understanding. Consequently, the significance of this study lies in its ability to illuminate the diverse range of

ways in which artificial intelligence technology can be harnessed to enhance pharmaceutical supply chain management practices, bolster efficiency, and reduce costs.

Table1-Companies using artificial intelligence

-ECHO GLOBAL LOGISTICS	Optimizing transportation and logistics needs
-HAVI	Supply chain management and logistics
-C3	Inventory optimization
-SYMBIOTIC	Design, build and test
- TTEC	Optimizing the customer experience
-UPTAKE	The goal of failure prediction is to reduce failure
- COYOT LOGESTICS	Forecasting events related to the supply chain
- ZEBRA TECHNOLOGIES	Faster and more efficient processing of packages
- EPICOR SOFTWARE	Improve the way customers interact with your apps
- LIVEPERSON	Conversation platform based on artificial intelligence

2-1 Artificial intelligence

Artificial intelligence (AI) is a discipline within the realm of computer science that employs deep learning and machine learning algorithms, among other techniques, to acquire knowledge and infer information in an effort to replicate human intelligence (Han Kok et al., 2020). These neural networks make predictions by automatically establishing connections between input and output variables, thus generating diverse solutions for both simple and intricate problems. The integration of AI technology has become pervasive in everyday life, ranging from the implementation of autonomous vehicles to the utilization of mobile facial recognition software. While numerous industries have reaped considerable benefits from the adoption of AI and machine learning capabilities, the textile and apparel sector has not fully capitalized on these advancements. In the realm of supply chain management (SCM) for apparel manufacturing, AI has emerged as a powerful tool. By leveraging AI techniques, businesses can optimize their processes, enhance operational efficiency, and improve decision-making throughout the apparel supply chain [1] [2] [3] [4]. However, the integration of AI into SCM necessitates a socio-technical process that is shaped by the sensemaking and interpretation of AI systems by human actors [5]. Big data and AI are harnessed to develop data-driven solutions, personalize offerings, and enhance company operations within the apparel supply chain. The incorporation of AI into SCM facilitates automated monitoring, learning, and knowledge sharing, thereby bolstering supply chain performance and adaptability. AI algorithms find application in demand forecasting, logistics, manufacturing, and decision support systems, while blockchain technology also finds utility in SCM. All in all, artificial intelligence plays a crucial role in the optimization and improvement of various facets of supply chain management in the context of apparel manufacturing.

A fundamental assumption underlying artificial intelligence is the notion that human intelligence can be precisely defined in a manner that facilitates its replication and performance by computers, irrespective of the complexity of the task at hand. The overarching objective of AI is to attain the ability to reason, learn, and perceive. In essence, AI exerts a profound influence on enhancing performance across diverse domains. Virtually every industry endeavors to automate certain tasks by harnessing sophisticated machinery, and this transition will transpire once machines are able to emulate human intelligence with clarity. Furthermore, AI technology possesses the potential to fundamentally transform and elevate the efficiency and quality of products. From rudimentary to intricate tasks, from tasks requiring precision, this technology possesses the capacity to fulfill a wide array of functions. The purpose of a machine is to acquire knowledge, engage in cognition, and experience sensations. It serves to automate the manufacturing industry and labor. By collecting copious volumes of data and employing cutting-edge data analysis techniques, algorithms, and AI, organizations can effectively analyze vast datasets originating from multiple sources in order to attain specific objectives or outcomes (Monteiro and Barata, 2021). This phenomenon has already materialized in various other domains, such as medicine and agriculture, but it is imperative to exercise caution in order to maintain trust and credibility.

- Use of artificial intelligence, supply chain supply areas:

The use of artificial intelligence in supply chain management provides the possibility of improving many existing processes. These improvements can be seen in many areas of the supply chain, including:

• Demand forecasting
• Improving the stability and performance of the supply network
• Improve warehouse management
• Improving delivery and distribution processes
• Improving the quality of goods and products
• Improving the ability of communication between suppliers and customers
• Improving the ability to respond to customer needs

Artificial intelligence (AI) can enhance the management of supply chains in the manufacturing of products through various means. Firstly, AI can optimize processes and enable faster and more accurate decision-

making, leading to increased operational efficiency. Additionally, AI utilizes machine learning to make quick and precise determinations concerning the optimal sequence of the production line, resulting in improved agility and accuracy. Moreover, AI tools can collect and analyze real-time data, allowing for the identification of patterns and trends in consumer behavior. This information can then inform manufacturing decisions. Furthermore, AI can be integrated into supply chain management at all stages, thereby enhancing efficiency and transforming the entire process. By incorporating AI into supply chain management, organizations can minimize operational uncertainty, enhance overall performance, and achieve greater transparency and sustainability in logistics operations.

The utilization of artificial intelligence (AI) within supply chain management (SCM) for product manufacturing offers numerous advantages. AI enables machines to perform tasks that enhance efficiency and accuracy along the production line. This optimization of supply chain processes leads to improved profitability, reduced waste, and increased agility. Additionally, AI can analyze data and make predictions regarding demand, optimize logistics and transportation routes, and identify inefficiencies in the supply chain. These capabilities result in improved responsiveness, reduced delivery times, and lower costs. Moreover, AI facilitates a heightened level of personalization within the supply chain and fosters better synergy between people and machines. Through the integration of AI into SCM, companies can achieve better coordination at all stages of the supply chain, thereby enhancing overall performance. In summary, AI in SCM enhances productivity, efficiency, and decision-making capabilities, making it a valuable tool for product manufacturing within the supply chain.

The integration of artificial intelligence (AI) into supply chain management (SCM) for product manufacturing faces several challenges. Firstly, there is a need to establish the economic feasibility of AI adoption and develop a comprehensive implementation plan. This plan must account for the development of core capabilities and system trust to ensure cohesive behavior across all stages of the supply chain. Secondly, the integration of AI into SCM is not solely a technical process but also a social one, influenced by human sensemaking and interpretation of AI systems. Effectively managing the relationship between people and technology is crucial to minimize conflict and ensure that AI enhances human capabilities rather than replacing them. Additionally, dynamic supply chain processes require technology that can handle increasing complexity, and AI has the potential to significantly improve overall performance. However, companies must be prepared to address the challenges and seize the opportunities that AI presents. This includes understanding the various applications of AI in supply chain management and its impact on decision-making.

2.2 In what way does artificial intelligence technology bring about a revolution in the modeling of apparel production supply chains? The modeling of apparel manufacturing supply chains is being revolutionized by the integration of artificial intelligence technology, which introduces novel methodologies and enhances operational efficacy. Contemporary advancements in apparel manufacturing encompass digital garment printing, 3D fitting, prototyping, and no-sew technologies [20]. Artificial intelligence and machine learning are employed to investigate consumer behavior and perception, make informed business decisions, and devise data-centric solutions employing product-related data [21]. Furthermore, artificial intelligence techniques such as artificial neural networks (ANN) are implemented to optimize the supply chain by scrutinizing supplier performance metrics and selecting the most suitable supplier in a timely manner [22] [23]. The adoption of artificial intelligence positively impacts the correlation between information sharing and the integration of supply chains [24]. Overall, AI technology augments efficiency, diminishes costs, and presents opportunities for comprehensive data management within the realm of the apparel manufacturing supply chain.

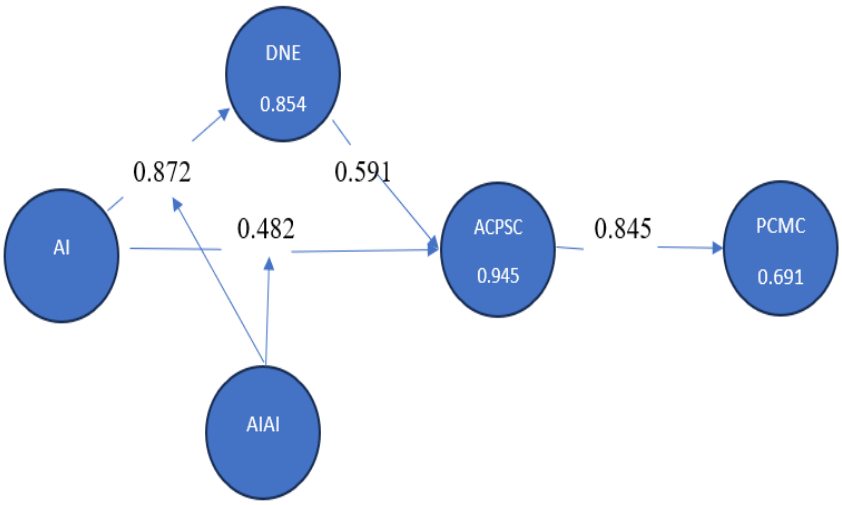


Figure 1- Modeling

3 research hypothesis

The current study presents a conceptual research model that draws upon the emerging literature in the field of artificial intelligence-based technology, as well as two established approaches in the areas of supply chain management and sustainability, namely the Dynamic Capability View (DCV) and the Organizational Information Processing Theory (OIPT). This model aims to illustrate the dynamic relationship between artificial intelligence-based technology and the performance of the apparel manufacturing supply chain (ACPSC), with mediation from distribution network efficiency (DNE) and the efficiency of the ACPSC. Ultimately, this relationship leads to improved performance in clothing production (PCMC).

3-1Research Context:

The garment industry has long been a cornerstone of many economies, particularly Iran, contributing to approximately 20% of the industrial GDP and generating a turnover of nearly 12 billion DH dollars. Notably, between 2000 and 2009, the GDP growth rate of non-apparel sectors in Iran was comparatively sluggish, indicating that the apparel industry experienced significant growth during this period. To further bolster the industry, it is crucial to support the development of apparel value chains, encompassing production, storage, processing, distribution, retail, transportation, and logistics. This comprehensive approach can enable the industry to maximize its production and export capabilities, thus increasing the overall income of the country. However, the apparel manufacturing supply chain has faced numerous disruptions in recent years, including the COVID-19 pandemic and fluctuating energy prices. These challenges have not only affected production, but have also necessitated more meticulous management of chain flows. During this period, there has been a substantial increase in raw material costs and significant delays in delivery. In light of these obstacles, Iranian garment manufacturing companies must adopt an intelligent approach that offers superior cost control, short-term and mid-term vision, and enhanced flexibility in risk management. It is believed that new technologies such as artificial intelligence and application models utilizing optimization algorithms can enhance the efficiency of clothing production, enabling companies to simulate different scenarios and improve the chain through automatic responses. These technologies can also strengthen distribution planning, inventory management, and chain slack. The application of such technologies in the value chain of clothing production aligns with the Iranian government's digital transformation efforts, supported by the Ministry of Industry, Commerce, Investment, and Industrial Digital Economy. Presently, the country is witnessing various digital advancements, including satellite imaging, Internet of Things networks, e-commerce platforms, and Internet-based technologies such as databases for product recommendations and price information for clothing products. In the system that analyzes the prices of products based on regions and types of markets and e-commerce platforms that are starting to focus on industries. It examines the supply and production of clothing products in the context of Iran's emerging economy.

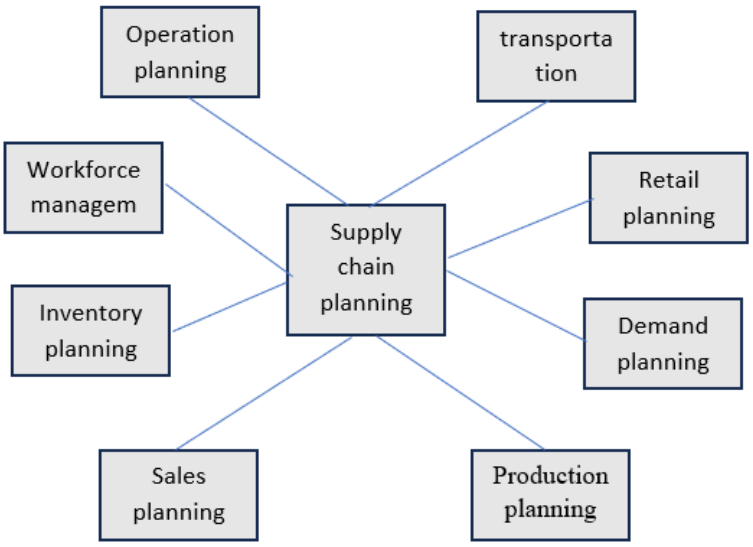


Fig 2-Significant improvements in various areas of supply chain and logistics

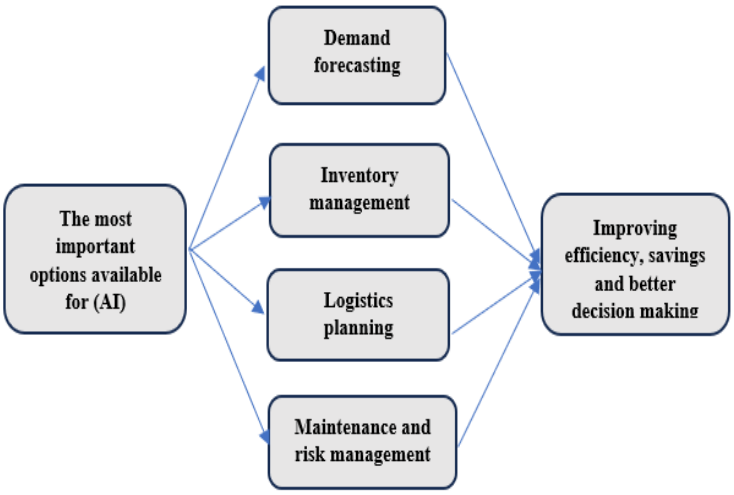


Fig-3 The most important options available for artificial intelligence in the supply chain and product manufacturing market

3.2 Sampling and data collection

The research employed a quantitative approach in order to ensure the objectivity of the study. Additionally, this approach was chosen for its cost and time efficiency, as well as its ability to yield a higher response rate compared to the qualitative approach. Primary data for this study was obtained through a survey of experts in the field of supply chain management and artificial intelligence. The survey respondents consisted of senior managers, managers, and specialists from various sectors of the supply chain and production process, including apparel manufacturers, wholesalers, retailers, logistics service providers, quality improvement heads, and technology suppliers, among others. These individuals operate in Tehran. To ensure the validity of the questionnaire, a pre-test was conducted by sending the initial version to a large number of experts and professors in SCM-related universities. Their feedback was used to refine the questionnaire and identify any necessary additions. After distributing the final questionnaire with the assistance of an available database, the researchers received a total of 300 usable responses out of the 600 submitted, resulting in an acceptable response rate of approximately 50%.

The improvement of supply chain monitoring and management through enhanced transparency, agility, traceability, and product efficiency is a critical concern that must be addressed. The integration of artificial intelligence into logistics, distribution, and production processes will bring about significant changes, revolutionizing traditional practices and leading to increased customization, information accuracy, and task output. The current business landscape, which is characterized by a chaotic environment, underscores the need for AI technology due to its ability to dynamically adjust delivery schedules in order to avoid delays and unexpected increases in demand. With regards to transportation and delivery, AI can offer solutions for load balancing, vehicle maintenance, and product quality monitoring through the use of sensors and devices. In the event of any damage, quick corrective action can be taken. Furthermore, AI can optimize last mile delivery by selecting the most efficient routes and modes of transportation, taking into consideration factors such as traffic conditions and road closures. This optimization results in reduced energy consumption, time, and costs. Consequently, artificial intelligence is playing a transformative role in the clothing production sector, contributing to improved economic, environmental, and energy efficiency. This research draws upon existing literature to identify constructs and research items, which are detailed in Appendix A. The questionnaire used in this study is divided into six sections, covering demographic information, organizational sector, age and size of the organization, and respondents' experience in the fields of supply chain management and artificial intelligence. As control variables, larger organizations with more resources are expected to adopt a strategic perspective in supply chain design, while managers' expertise in this field can influence supply chain performance. The reflective and formative models are measured using a five-point Likert scale, which is employed to assess the impact of AI technology on decision making and supply chain execution (SCE) development. The third section of the questionnaire focuses on the development of an 8-item scale that examines distribution network efficiency (DNE), encompassing aspects such as distribution strategy, delivery speed flexibility, warehousing, transportation planning, and inventory management. The final sections deal with ECPSC and PCMC and compare the organization's performance with other apparel manufacturing companies. Finally, the authors explore respondents' insights into barriers to AI adoption in DNE and ECPSC.

Table 2

Sample composition.

		Frequency	Percentage
Business activity	cloths manufacturing	140	40 %
	Distribution	109	32.9 %
	Retail trade	57	17.9 %
	Transportation and warehousing	37	11.4 %
	Computing infrastructure providers	35	10.5 %
Firm age	<10	67	19.9 %
	[11 20]	172	49.8 %
	[21–40]	92	27.1 %
	≥40	39	11.2 %
Years of experience in SC/AI fields	<1	5	0.8 %
	[1–5]	37	10.8 %
	[6–10]	38	9.5 %
	[11–15]	94	27.4 %
	[16–20]	120	35.7 %
	>20	82	24.2 %
Firm size	<10	19	6.4 %
	[10–50]	144	41.8 %
	[51–150]	82	24.5 %
	[151–200]	34	10.4 %
	>200	92	27.1 %

4-1A common method in research

A prevalent approach employed in research involves the utilization of existing literature to ascertain constructs and research items outlined in Appendix A. The questionnaire is partitioned into six sections, encompassing demographic particulars, organizational sector, age and size of the organization, as well as respondents' experience in the domains of supply chain management and artificial intelligence. As control variables, larger organizations endowed with ample resources may exemplify a strategic outlook in the realm of supply chain design, while the expertise of managers in this field can exert an influence on supply chain performance.

The reflective and formative models are gauged via implementation of a five-point Likert scale, which is employed to construct artificial intelligence technology and take into account the four items related to resource utilization and the integration of artificial intelligence outcomes into decision-making processes and supply chain evolution. The third section concentrates on the development of an eight-item scale that addresses distribution network efficiency, encompassing aspects such as distribution strategy, delivery speed flexibility, warehousing, transportation planning, and inventory management. The final sections delve into the evaluation of environmental corporate performance and production cost management and compare the organization's performance against other companies engaged in apparel manufacturing. Lastly, the authors delve into the exploration of respondents' perspectives concerning obstacles to the adoption of artificial intelligence in distribution network efficiency and environmental corporate performance.

4-2data analysis

For a model of considerable complexity, such as ours, it is often susceptible to subjective model fit indices. Consequently, the research employs Partial Least Squares Structural Equation Modeling (PLS-SEM) with CBSEM cost to evaluate and scrutinize the reflective-constituent constructs inherent to our model, as the latter exhibits limitations in analogous studies. Incidentally, the adoption of PLS-SEM arises from the fact that our sample size (n = 300) is deemed small relative to the intricacy of the relationship among the model constructs (30 in our particular case), which accounts for 10% (Wright et al., 2012). In order to assess the fit of the proposed model and the interconnectedness of the developed hypotheses, a two-step method is

implemented. Initially, confirmatory factor analysis (CFA) is employed to gauge the reliability and validity of the model, followed by an examination of the structural paths to assess the hypotheses.

Results Assessment Before building the structural model, it is necessary to evaluate the overall fit of the model using fit indices. Specifically, the authors conducted a confirmatory factor analysis (CFA) to evaluate the measurement scale indices for each latent variable in terms of construct reliability, convergent validity, and discriminant validity. This analysis included measures such as Cronbach's alpha, factor loadings, composite reliability and average variance extracted. The results of the measurement model show satisfactory reliability with factor loadings greater than 0.7 for all items. Furthermore, both the composite reliability and the mean variance extracted exceed the recommended threshold of 0.7. In addition, the validity of the measurement model was evaluated through the discriminant validity test using the Fornell-Larker criterion and the Heterotrait-Monotrait ratio. The correlation values between the constructs and the root mean square variance extracted were examined and found to exceed the construct correlations, thus meeting the standards of the Fornell-Larker criterion. Heterotrait-Monotrait ratio was also used and the results show that the highest value in the matrix is 0.89, which is below the threshold of 0.90. Overall, the findings of both the Fornell-Larker measure and the Heterotrait-Monotrait ratio support the discriminant validity of the measurement model.

Table 3
Reliability and validity test results.

Constructs	Items	Loading/ weights	Cronbach's Alpha	CR	AVE	VIF
AI	AI1	0.896	0.933	0.947	0.818	2.363
	AI2	0.978				1.975
	AI3	0.816				1.994
	AI4	0.948				2.848
DNE	DNE1	0.932	0.879	0.915	0.712	2.176
	DNE2	0.932				2.885
	DNE3	0.723				1.721
	DNE4	0.834				2.108
	DNE5	0.956				1.206
	DNE6	0.865				1.798
	DNE7	0.955				1.632
	DNE8	0.882				1.705
ECPSC	ECPSC1	0.862	0.950	0.960	0.777	3.060
	ECPSC2	0.938				2.102
	ECPSC3	0.855				3.201
	ECPSC4	0.839				1.592
	ECPSC5	0.866				2.598
	ECPSC6	0.892				1.552
PCMC	PCMC1	0.974	0.945	0.959	0.79.3	1.297
	PCMC2	0.966				1.680
	PCMC3	0.984				2.514
	PCMC4	0.949				3.056
AIAI	AIAI1	0.822	0.931	0.946	0.717	3.047
	AIAI2	0.753				1.369
	AIAI3	0.86.1				1.371
	AIAI4	0.875				1.875
	AIAI5	0.811				2.455

Table 4
Fornell-Larcker test.

	AI	AIAI	DNE	PCMC	ECPSC
AI	0.991				
AIAI	0.463	0.821			
DNE	0.789	0.592	0.963		
PCMC	0.807	0.534	0.865	0.966	
ECPSC	0.794	0.490	0.855	0.751	0.965

Table 5

Heterotrait-monotrait ratio (HTMT) criterion.

	AI	AIAI	DNE	PCMC	ECPSC
AI					
AIAI	0.402				
DNE	0.798	0.584			
PCMC	0.823	0.497	0.882		
ECPSC	0.839	0.494	0.891	0.782	

5-Structural model evaluation

The previous section has shown the reliability and validity of the measurement model, the current step includes testing the developed hypothesis and direct and indirect effects using PLS-SEM and bootstrapping methods. As the structural model presented in Fig. 1 shows that the results of path analysis show that 72% of the total variance in PCMC is explained by ECPSC, which in turn 95% of its variance is attributed to AI, DNE and AIAI. In addition, the results show that AI and AIAI explain 85% of the variance in DNE

table 6

Hypothesis testing outcomes.

	β	Standard deviation (STDEV)	T statistics	P values	Decision
AI - > DNE H1	0.872	0.044	2.631	0.000	Supported
AI - > ECPSC H2	*0.482*	*0.043*	*2.382*	*0.000*	*Supported*
DNE - > ECPSC H3	0.591	0.038	2.021	0.000	Supported
ECPSC - > PCMC H4	*0.845*	*0.017*	*8.524*	*0.000*	*Supported*

جدول 7
قابلیت پیش بینی و ارتباط.

	آر ²	س²
DNE	0.854	0.603
PCMC	0.691	0.675
ECPSC	0.945	0.716

The efficiency of the distribution network and the supply chain of clothing production is directly and positively correlated (β = 0.872, P < 0.01 / β = 0.482, P < 0.05). Similarly, the mediating constructs demonstrate that DNE is positively associated with ECPSC (β = 0.591, P < 0.05), which in turn has a direct impact on the organizational performance of apparel manufacturing (β = 0.845, P < 0.05).

5-2Theoretical concepts

The development of theories can manifest in various ways that align with our theoretical contributions. Through this research, the authors shed light on novel constructs that have not been extensively explored in previous literature, such as outbound logistics or distribution and supply chain efficiency. This study confirms the existing knowledge regarding the adoption of artificial intelligence and its influence on the supply chain efficiency of companies, thus highlighting the significance of downstream logistics in the field of operations management. Instead of relying solely on one theory, this study incorporates the dynamic capability perspective (DCV) and the organizational information processing theory (OIPT). Consequently, this research presents a comprehensive theoretical framework that posits the potential enhancement of entire supply chains in manufacturing companies through the implementation of smart transportation, smart warehousing, and sustainable packaging, facilitated by AI-based technology. Ultimately, artificial intelligence's ability to enhance management practices, reduce production costs, and promote sustainable and economic efficiency is paramount.

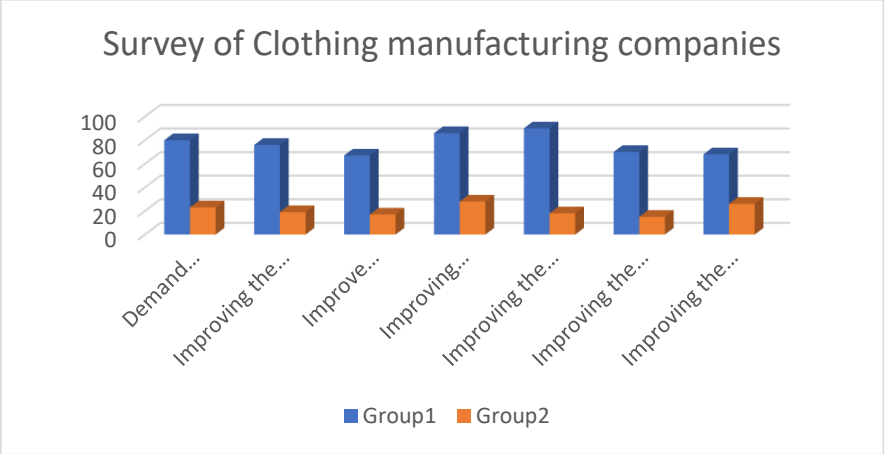
5-3Practical concept

Reducing costs, optimizing resource utilization, and improving quality are among the pivotal concerns for supply chain managers. This is particularly relevant within the manufacturing industry, where the supply

chain is heavily invested in maintaining goods' quality throughout the value chain, especially during the production and delivery stages. Accordingly, guided by the manufacturing sector, the adoption of emerging technologies and digitization has already been implemented with the vision of ensuring industry efficiency and sustainability. In this regard, the managerial contributions of this study are in line with providing guidance to clothing manufacturing business managers and policy makers.

6-Conclusions and limitations

Based on surveys conducted in clothing and apparel manufacturing companies, which were divided into two groups - group 1 utilizing artificial intelligence and group 2 without artificial intelligence in medium and small companies - the following results were obtained.i n the study conducted among the first group of companies, encompassing managers and executives from manufacturing industries, regarding the influence of artificial intelligence on product production quality, it was discovered that artificial intelligence has had a remarkably significant impact on enhancing product quality compared to the second group. The improvement achieved by the first group was five times more substantial than that of the second group. In terms of enhancing the stability and performance of the supply network, the utilization of artificial intelligence algorithms can assist managers in optimizing these aspects. Through meticulous analysis of available data, it becomes viable to identify patterns related to customers, suppliers, and various processes. By implementing intelligent solutions, substantial enhancements in the supply network's performance can be realized. Moreover, the adoption of artificial intelligence in improving the quality of goods and products can also contribute to reducing failure rates and product returns. The implementation of intelligent solutions can facilitate the enhancement of quality control and inspection processes, leading to a decrease in failure rates and returns. Consequently, costs incurred due to return payments and after-sales services can be diminished.



- In the survey, it was found that the companies that use artificial intelligence and SCM automation in different capacities to help simplify processes and operations in production, storage, inventory and transportation have a significant increase in improving their system compared to the companies of the 2nd group of companies. A maker that has no artificial intelligence. AI engineers at SCM provide support to operationalize and execute AI initiatives using critical capabilities such as analytics, model development, and forecasting.

AI engineers help build AI applications and systems to increase SCM efficiency, productivity and performance.

- The surveys conducted in the survey and the available data from the garment manufacturing companies in group 1 show that using artificial intelligence, it digitizes manual processes such as collecting inventory data and stores that data in your software environment such as a database or It integrates an enterprise resource planning (ERP) system. This type of mechanized warehouse runs on a barcode ecosystem and wireless barcode scanners for data entry and tracking, which are connected via software to a centralized repository where information is stored for future retrieval, improving warehouse processes. to a level not possible by mere human agency. They "mechanize the warehouse" by performing repetitive, time-consuming or difficult tasks, freeing up your warehouse personnel to focus on more meaningful activities that require human intervention, resulting in a 3.95x improvement in warehouse management in companies. Production group 1 lacked artificial intelligence compared to production companies.

7-Suggested future work

Further research can be focused on developing more valid models and in-depth analysis of each link in the supply chain of apparel manufacturing products in conjunction with specific AI-based technologies.

Future studies can explore the understanding of AI-based logistics in other industries, regions, and countries, especially in developing industries.
The existing research shows that there is still much to explore and discover about the possibilities of using artificial intelligence model in supply chain management.
Certainly, the Internet has played a fundamental role in promoting and accelerating the process of expanding the possibilities of using the artificial intelligence model. Combining management with technological advances, such as artificial intelligence, is seen as an important path for the future of the supply chain.
More research is needed to understand how to better integrate AI into various supply chain processes and identify the best options available in the market. Overall, future work on AI in supply chain management involves exploring the unique and neglected potential of AI. Using the Internet for further developments and conducting more research work is needed to understand the integration and implementation of artificial intelligence in various supply chain processes.

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