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**ARTIFICIAL INTELLIGENCE ENABLED SUPPLY CHAIN SERVICES - AN  
EMPIRICAL STUDY**

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**ABSTRACT**

Artificial intelligence (AI) was introduced to develop and create “thinking machines” that are capable of imitating, learning, and replacing human intelligence. AI has shown great promise in enlightening human decision-making processes and the subsequent productivity in various business endeavors due to its ability to identify business patterns, study business phenomena, seek information, and analyze data intelligently. Despite its widespread acceptance as a decision-aid tool, AI has seen limited application in supply chain management (SCM). To fully exploit the potential benefits of AI for SCM, this paper explores various sub-fields of AI that are most suitable for solving practical problems relevant to SCM. In so doing, this paper reviews the awareness level as well as the reasons that make AI preferable to SCM and identifies the most fruitful areas of SCM in which to apply AI and the major challenges that stood in way of AI implementation.

Key Words: Artificial Intelligence, Supply chain Management.

**I.INTRODUCTION**

In an era of greater demand uncertainty, higher supply risk, and increasing competitive intensity, supply chain (SC) excellence often hinges on the organization’s ability to integrate and orchestrate the entire spectrum of end-to-end processes of acquiring materials or components, converting them into finished goods, and delivering them to customers. Since such ability can be enhanced by increased visibility across the end-to-end

SC processes, many leading-edge organizations have attempted to enrich their information sources and share real-time information with SC partners. Thus, SC management (SCM) is becoming more information intensive and its focus has been directed toward the substitution of assets (e.g., inventory, warehouses, transportation equipment) with information.

Acknowledging the growing importance of information to SC success, SC professionals have explored various ways to better manage information and leverage it to make better business decisions. One of those ways may include artificial intelligence (AI) that has been in existence for decades, but has not been fully utilized in the area of SCM.

One area of AI's potential application that has not yet been fully explored is the emerging management philosophy of SCM, which requires the comprehension of complex, interrelated decision-making processes and the creation of intelligent knowledge bases crucial for joint problem-solving. For example, Eastman Kodak once structured the thinking processes of experienced order pickers and then developed a rule-based expert system to select the optimal order-picking path in a warehouse. Also, in an effort to synchronize a series of interrelated but different stages of joint demand planning and forecasting processes in the SC proposed an agent-based forecasting system that has the capability to predict end customer demand through information exchange among multiple SC partners and learn from the past forecasting experience. As illustrated by these examples, some sub-fields of AI such as expert systems and agent-based systems can be useful for dealing with various aspects (e.g., warehousing, joint demand planning, inventory control) of the SCM.

## **II. OBJECTIVES OF THE STUDY**

- To study the benefits of replacing manual system with Artificial Intelligence.
- To analyze the current status of Artificial Intelligence adoption in supply chain management.
- To ascertain the major drivers for the implementation of Artificial intelligence in organization.
- To find out the areas where Artificial intelligence can be applied in supply chain management.
- To identify the challenges for acquiring Artificial Intelligence in supply chain management.

### ***III. SCOPE OF THE STUDY***

The study provides a clear understanding about the awareness level about this technology and the view about the beneficiary in adopting artificial intelligence. The primary reason that strongly recommends AI implementation as well as the key areas where artificial intelligence adoption can be adopted were identified. The major challenges in acquiring of this technology revealed, that opens a huge area of exploitation of this technology in supply chain management

The problem scope is categorised with respect to the three-level decision-making hierarchy: (1) strategic decisions that deal with long-term, executive-level issues such as strategic alliances, facility location, and capital investment; (2) tactical decisions that deal with intermediate term, mid-manager-level issues such as joint demand planning, supplier selection, and inventory planning and (3) operational decisions that deal with short term, routine issues such as vehicle routing, order picking, and cycle counting.

### ***IV. LIMITATIONS OF THE STUDY***

The main limitations of the study are,

- It is limited to the field of supply chain alone.
- The accuracy level of the secondary data is not known.
- Little knowledge and awareness about this emerging technology
- The sample size is limited and area of sample is confined to Coimbatore city.

### ***V. THEORETICAL BACKGROUND OF THE STUDY***

The main objectives of AI are to understand the phenomenon of human intelligence and to design computer systems that can mimic human behavioral patterns and create knowledge relevant to problem-solving. Thus, AI should have the ability to learn and comprehend new concepts, learn from experience, perform reasoning, draw conclusions, impute meaning, and interpret symbols in context. Due to such ability, AI has been successfully applied in areas such as game playing, semantic modeling, human performance modeling, robotics, machine learning, data mining, neural networks, genetic algorithms (GAs), and expert systems.

## ***IMPLEMENTATION STATUS***

Since SC managers may be interested in determining the applicability of the proposed AI technique, we included the third dimension of the taxonomy indicating whether the proposed AI technique has been applied to the real-world decision environment using actual data, and whether the AI technique was successfully implemented in the SC setting.

## ***THE KEY AREAS OF AI APPLICATIONS IN SCM***

Despite the long history of AI, the potential of AI as a means of solving complex problems and searching for information in the SCM area has not been fully exploited in the past. However, some pioneering efforts have been made to initiate AI applications in the SCM area. In particular, certain sub-disciplines of AI such as expert systems and GAs have been increasingly utilised to address SCM issues involving inventory management, purchasing, location planning, freight consolidation, and routing/scheduling problems.

## ***INVENTORY CONTROL AND PLANNING***

Inventory represents idle resources that are required to maintain high levels of customer service but which incur substantial costs. Thus, the firm's success in a competitive market often hinges on its ability to control and plan inventory at minimum cost, while making inventory constantly available for customers when needed. Such ability can be enhanced by the presence of accurate, real-time information about expected customer demands, the size and type of inventory at hand and the amount of order cycle time to fulfill the customer order. However, since this kind of information is often difficult to estimate, predict and obtain, traditional decision rules based on mathematical models such as economic order quantity cannot reflect the very essence of inventory management. That is to say, a tool such as an expert system, which can replace the sound judgment and intellect of experienced inventory managers and deal with the unexpected, is better suited to handling inventory control and planning decisions.

## ***TRANSPORTATION NETWORK DESIGN***

So far one of the most popular applications of AI techniques to a particular SC area has been to a class of the transportation network design problems that are intrinsically combinatorial and for which global optimal solutions are thus difficult to find. This class of problems include: the TSP, the vehicle routing and scheduling problem, the minimum

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spanning tree problem, the freight consolidation problem, and the intermodal connection problem. Other related problems include: road network design, gas distribution pipeline network design, parking space utilization, traffic assignment, and ramp metering in freeway networks. In particular, due to the combinatorial nature of these problems, GA turns out to be one of the most popular forms of AI techniques employed to handle these various aspects of transportation network design problems

### ***PURCHASING AND SUPPLY MANAGEMENT***

A make-or-buy decision is primarily concerned with weighing the options of producing goods or services internally or purchasing those from the external sources of supply to better utilise the firm's given resources (e.g., capacity and personnel) and focus on its core competency. Due to the complexity and dynamics of the above scenarios, the make-or-buy decision calls for systematic decision-aid tools. Such tools include an expert system. To handle a broader spectrum of purchasing decisions, an agent-based purchasing system to automate the on-line ordering process involved can aid the purchasing manager in a series of strategic and tactical purchasing decisions, while traditional OR techniques such as analytic hierarchy process and multiple attribute theory can handle only one aspect of purchasing decisions (e.g., supplier selection).

### ***DEMAND PLANNING AND FORECASTING***

Information about future demand is a basis for the firm's capacity planning, workforce scheduling, inventory control, new product development, and promotional campaigns. However, its usefulness often depends on its accuracy that, in turn, rests with the firm's ability to reduce the uncertainty and variability inherent in future demand. AI techniques have recently been introduced as viable alternatives for demand forecasting and planning. AI techniques such as agent-based systems and GAs can be useful for predicting future demand for new products or innovative products/services that have not yet been introduced in the market and thus have no historical demand data.

### ***ORDER-PICKING PROBLEMS***

Put simply, order picking involves selecting the items that have been placed on order. Due to its labor-intensive operations, order picking typically accounts for the largest portion of warehousing operating expenditure. Thus, it affects warehousing productivity significantly. Considering its significant role in warehousing operations, warehousing managers have attempted to devise ways to improve order-picking efficiency. Such ways include the computerization and subsequent automation of sequencing and filling the

orders. As part of the automation process, the use of AI techniques such as an intelligent agent-based system may better handle the added complexity caused by the increasing adoption of value-added services and e-fulfillments due to their inherent learning capability.

### ***CUSTOMER RELATIONSHIP MANAGEMENT***

To retain customers, the firm should make its customers trust its manufacturing and service capabilities and make customers believe it can deliver exactly what they want. Such trust cannot be instilled without constantly communicating and building a long-term relationship with customers. Thus, CRM is an important prerequisite to demand creation that drives SC activities. It would be necessary for the firm to assess the costs of sustaining CRM and weigh its benefits against costs, an agent-based model that simulated interaction between members of customer populations and business environments in which they were contained. Their agent-based model considered the communication of customer experiences between members of a social network and then incorporated the powerful influence of word-of-mouth reputation on the purchase of products and services. By doing so, it aided the firm in assessing the extent of its return on investment in CRM and enhancing its customer acquisition efforts.

## **VI. RESEARCH METHODOLOGY**

Both primary and secondary data were used for the present study. Convenient random sampling method has been used for this study. Secondary data have been collected from Websites, Records and Journals. SCM Professionals from Coimbatore city are involved in this study. The data required for the study have been collected through the structured questionnaire. 50 respondents were deliberated for the study purpose.

**TOOLS FOR ANALYSIS:** Percentage Analysis, Chi-square analysis, Weighted Average, Mean and Standard deviation and Pearson's Correlation.

**VII. ANALYSIS AND DISCUSSION:  
PERCENTAGE ANALYSIS & WEIGHTED AVERAGE**

*Table 1: Percentage Analysis*

<b>Factors</b>	<b>Response</b>	<b>Percentage</b>
<b>Awareness status</b>	Well acquainted	<b>79</b>
	Un acquainted	21
<b>Beneficial level</b>	Excellent	22
	Good	<b>63</b>
	Moderate	09
	Low	06
<b>Primary reason of adoption</b>	Automated decision making	<b>34</b>
	Eliminating manual costs	16
	Eliminating manual errors	30
	Automated data reporting	17
	Others	03
<b>Major drivers Challenges in adoption</b>	Performance or transparency	13
	Automation	<b>60</b>
	Processing power	10
	Technology war	17
	Shifting of roles	21
	Lack of emotional intelligence	<b>45</b>
	Lack of skilled man power	22
<b>Barriers in adoption</b>	Access of data	12
	High implementation cost	<b>59</b>
	No improvement with experience	07
	Unemployment	08
	No Creativity	07
<b>Best Strategy</b>	Lack of technology power	19
	AI adoption	83
	AI reduction	17

**Interpretation:-** Out of total respondents, about 79 percent have been technologically knowledgeable and 63 percent opined good with regard to the beneficial level of AI adoption. It is found out to be automated decision making (34%) and elimination of manual errors (30%) with reference to the primary reason for AI adoption. Majority of respondents (60%) have been selected automation as the major driver for AI adoption. Among the challenging factors, lack of emotional intelligence has been recognized as the main challenge (45%). 59% of respondents have been of the view that high implementation

cost could be the main barrier in adoption of AI. Most of the respondents (83%) have been of the opinion that adoption of AI could be the best strategy for organizational success.

**Table 2: Weighted Average for the Key benefits in AI adoption**

Key benefits	Mean	Rank
Predictive analysis	3.32	4
Reduction of time and cost	2.70	1
Improved quality	2.91	3
Ease of operation	2.85	2
Accuracy	3.48	5

**Interpretation:-** Among the key benefits of artificial intelligence, reduction of time and cost ranked first, whereas easiness of operation ranks second, improvement of quality turned to be in third position. Predictive analysis stood in fourth rank and accuracy was the least with fifth rank.

### CHI SQUARE ANALYSIS

This test has been employed to find the relationship between level of awareness and best strategy for organizational success.

**H0 :** There is no significant association between level of awareness and best strategy for organization success.

**H1:** There is a significant association between level of awareness and best strategy for organization success.

**Table 3: Chi Square Analysis**

	Value	Df	Sig.
Pearson Chi-Square	14.091	3	.003
Likelihood Ratio	15.604	3	.001
Linear-by-Linear Association	2.250	1	.134
N of Valid Cases	50		



**Interpretation:**

Since, the significance value is less than 0.05 we reject the null hypothesis and accept the alternate hypothesis at 95 percent confidence level. Hence, it is proved that there is a significant association between level of awareness and best strategy for organization success.

**Table :4 Mean and Standard deviation**

	<b>Mean</b>	<b>SD</b>
Awareness	1.23	.430
Level of Awareness	2.17	.913
Best strategy	1.20	.407
Challenges in adoption	3.33	.959
Major drivers	2.77	.716
Preference reason	3.53	.907

**Interpretation:** - Among the key factors, preference reasons has been found out to be the first with a mean value of 3.53 and with standard deviation of .907.

**PEARSON’S CORRELATION**

The correlation expresses the degree of relationship or interdependence of two sets of variables. This analysis is used to ascertain the relationship of factors identified for the AI enabled SCM.

**Table 5 – Summary Results of Correlation Analysis between the factors of AI enabled SCM**

		<b>Awareness</b>	<b>Beneficial Level</b>	<b>Best strategy</b>	<b>Challenges in adoption</b>	<b>Major drivers</b>
<b>Awareness</b>	Pearson Correlation	1	.688**	.118	.307	.497**
	Sig. (2-tailed)		.000	.534	.099	.005
<b>Beneficial Level</b>	Pearson Correlation	.688**	1	.279	.171	.444*
	Sig. (2-tailed)	.000		.136	.367	.014
<b>Best strategy</b>	Pearson Correlation	.118	.279	1	.177	.563**
	Sig. (2-tailed)	.534	.136		.350	.001
<b>Challenges in adoption</b>	Pearson Correlation	.307	.171	.177	1	.426*
	Sig. (2-tailed)	.099	.367	.350		.019
<b>Major drivers</b>	Pearson Correlation	.497**	.444*	.563**	.426*	1
	Sig. (2-tailed)	.005	.014	.001	.019	

**Interpretation:** -From Table 5, it is clear that the significance values of awareness and beneficial level, awareness and major drivers, beneficial level and major drivers, best strategy and major drivers, challenges in adoption and major drivers have been less than 0.05. Hence, there exists correlation between these variables.

## VIII. FINDINGS

- Most of the respondents have awareness about AI.
- Majority of the respondents believes the beneficial status as good.
- Automated decision making and elimination of manual errors are the primary reason of adoption.
- Automation is the major driver for AI implementation.
- Lack of Emotional Intelligence is the major issue in AI adoption.
- High implementation cost was found out to be the major barrier in AI implementation in Supply Chain Management
- Adoption of AI in SCM is the best strategy for organizational success
- Among the key benefits of Artificial Intelligence, reduction of time and cost ranked first
- There is significant relationship between awareness and best strategy for organization.
- Awareness, Beneficial Level and Major drivers are highly correlated to each other

## IX. DISCUSSIONS AND CONCLUSION

In the Recent scenario SCM is a booming area of business where advanced technology is required to cope up with its massive developments. AI with its wide acceptance and efficiency can be adopted in key areas of SCM. This study analyzes the awareness level towards the technology and its impact on various aspects of supply chain management. The study explored the key areas where AI can be adopted. The major drivers and challenges in implementation of AI is analyzed and pointed out with an aim of supply chain effectiveness. AI can be fully utilised to solve SC problems where solutions are either too expensive or difficult to be derived. Allocating AI in the key areas of SCM will result in an efficient and effective SCM network. By adopting proper measures to overcome the limitations of AI implementation, AI will be the best key for success of SCM in the growing future. The study decides the best strategy for organizational success is in the adoption of Artificial Intelligence. Thus it is concluded that Artificial Intelligence is going to conquer the future of supply chain with its efficiency and effectiveness.

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