Artificial Intelligence: Pertinence in Supply Chain and Logistics Management

Dr. Uma Devi N.[a] & Maria Tresita Paul V.[b]*

[a]Assistant Professor & [b]UGC-Senior Research Fellow

BSMED, Bharathiar University, Tamil Nadu, India.

Abstract--Artificial Intelligence (AI) is the revolutionary invention of human intelligence. Artificial Intelligence is nothing but the duplication of human in which machines are programmed to rationally think and behave like humans developed for very many purposes including business decision making, problem-solving, business data analysis and interpretation and information management. The application of AI in business endeavours decides the competitive advantage, market leadership, robust operating efficiency of corporates and other business houses. Exploiting the application of AI in the manufacturing and distribution process enables the organisations to reach the pinnacle in their business graph. Businesses are operating in the international market which is highly multifaceted and challenging to serve the world as a sole market for their products, services and their products and without the integration of technology into their business processes, they cannot assure the sustainable growth. The management of the process of transforming the raw materials into the final product is called Supply Chain Management (SCM) and the effective movement and storage of goods, services and information are called Logistics Management (LM). This article analyses the applications of Artificial Intelligence in Supply Chain and Logistics Management (SC&LM)

Keywords--Artificial Intelligence, Supply Chain Management, Logistics Management, Supply Chain Profitability

I. INTRODUCTION

Artificial intelligence (AI) is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. AI is the term frequently applied to the project of developing systems embedded with the intellectual processes and characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience. (Copeland B.J. 2020). Companies must constantly reinvent and keep themselves updated through research and development on knowledge to ensure competitive advantage for achieving a sustainable future (Paul & Prithiviraj, 2012). One such latest knowhow is pertinence of AI in supply chain and logistics. The scope and benefits of AI has made the supply chain professionals to integrate AI applications and the supply chain and logistics management functions. The assimilation of AI in to SCM and Logistics improves the efficiency of the network of individuals, establishments, resources, activities, and technologies in the manufacturing and sales of the products and services significantly. Rapid development in technology, ever increasing demand uncertainty, greater market risks, cut throat competitions by rivals have made Supply Chain and Logistics management a highly complex and challenging process to all business organisations. Supply chain management refres to the management of the flow of services and goods, it also includes all progressions that convert raw materials into finished products. The flow should be made uninterrupted and efficient so as to gain supply chain profitability and to reap the benefits of competitive advantage. Logistics management is that component of supply chain management that is used to meet client demands by planning, control and implementation of the optimal movement and storage of goods, services and related information, from origin to destination.

II. ARTIFICIAL INTELLIGENCE – AN OVERVIEW

Since 1940 the year in which the digital computer was invented, the computer has been performing all complex tasks like arithmetic functions, processing of data, proving of mathematical theorems and also the computer is known for its processing speed and memory. But, the computer scientists felt that it is lame in some aspects which human can perform such as acquiring and analysing real-time knowledge, reasoning, problem-solving, perception and responding to language. As a result, AI research and invention was initiated. Human intelligence is characterised by many diverse abilities including rational thinking and responding to the language and situations. Hence, Research in AI has focused chiefly on the following components of intelligence: learning, reasoning, problem-solving, perception, and using language. Initially, the computer was programmed to learn by trial and error and to store the solution to a particular problem so that next time if the computer encountered with the same problem it would recall the solution stored. More challenging was the problem of implementing what is

* Corresponding author

called generalization. Generalization involves applying past experience to related new situations. Reasoning is drawing inferences appropriate to the situation. There are two types of reasoning namely deductive and inductive. The most imperative difference between the two forms of reasoning is in the inductive type the truth of the premise provides support to the conclusion without giving absolute assurance whereas in the deductive type the truth of the premises guarantees the truth of the conclusion. Inductive reasoning is widely applied in science, where data are collected and prototypes are developed to describe and predict future behaviour until any abnormalities shown in data requiring revision of the prototypes. Deductive reasoning is applied in mathematics in which theorems are built up from a set of basic rules and axioms. AI has been successfully implemented in programming computers for drawing inferences and particularly deductive inferences but drawing relevant inferences to the problems is the challenge faced by AI experts.

AI is applied in problem solving also for both special purpose and general purpose methods. For example, in general purpose methods, one is means-end analysis which is a step by step reduction of the difference amongst the current state and the final goal. Robots are programmed in this method where the actions are selected from the list of means set inside. Computer is programmed for perception also in which the environment is scanned by the various artificial organs and the picture is decomposed into separate objects in various spatial relationships. The challenges in the process are an object may appear different from each angle and the direction and intensity of illumination and how much the object contrasts with the environment. Recently, AI is well advanced in perception which enables optical sensors to recognize individuals, and robots to roam in restaurants to serve people and autonomous vehicles to drive in different speed in traffic.

Thus, Artificial Intellignece provides computers, machines and robots the ability to comprehend new concepts, learn from experience, perform reasoning, make conclusions, assign meaning and interpret symbols in context. Because of all such abilities AI has been successfully applied in areas such as machine learning, robotics, data mining, Expert Systems, neural networks, genetic algorithms (Gas), Game Playing, Sematic Modeling and Human Performance Modeling. (Russell and Norvig 1995, Luger 2002).

III. Sub-Fields Of Artificial Intelligence

AI aims to create machines with ability to think like humans, act like humans and further to reason rationally and to act rationally (Russell and Norvig 1995). Thus, with the purpose of contributing these distinctive features, AI includes a number of sub-fields namely Artificial Neural Networks (ANN), Rough Set Theory (thinking humanly), Machine Learning, Expert Systems, Genetic Algorithms (acting humanly), Fuzzy Logic (thinking rationally) and Agent Based Systems (acting rationally).

3.1 Artificial Neural Networks

The theory behind the Artificial Neural Network is how neurons work in human brain. Neural Network is programmed to learn from experience, distinguish features, recognise patterns, cluster objects and process abstract information. Using the inter connected network of computer memories, NN can learn to elaborate. NN constitutes of a number of nodes which act like biological neurons. These nodes are connected to each other by links each of which are assigned with numeric weights. Their links and their weights are the primary means for storing the long-term memory. The neural network processes information such way that the one neuron's output is an input to another random neuron linked to it. The weights shall be responsible for the strengthening or weakening of the information transmitted through the connexion. Links are put and weight values are set in a process called learning. NN can be taught to respond to various data patterns according to one's wishes or to learn hidden interrelationships among the data. Once the network is started, NN can be modified to improve its performance using an inductive learning algorithm and can be trained in either unsupervised or supervised environments (McCulloch and Pitts 1943, Russell and Norvig1995). NN has been proved to be useful for semantic modelling for its ability to learn and pronounce English vocabularies. In the logistics field, NN can be useful for guiding autonomous vehicles using its image processing technique. NN was utilised to steer a land vehicle along a single lane on a highway by mimicking the performance of a human driver. (Pomerleau1993). Although the application of NN to auto-piloting land vegicles is still limited to a certain type of traffic environment and road condition, it showed promise in autonomous vehicle navigation.

3.2 Rough Set Theory

Rough Set Theory can be used to identify decision conditions and then to establish decision-making rules that are applicable to the decision-making situation. Rough set theory was first introduced by Pawlak (1982) as a way of synthesizing the approximation of concepts from the data acquired using a data table consists of one or more classification attributed. The attributes comprised equivalence classes, indiscernible or invisible relations, set approximation and rough membership. This classification characteristics are important for the application of processes similar to those used by humans for the classification and identification of objects. Furthermore, on the basis of a definition of common features of identical objects, they can be useful for the creation of decision-making guidelines (Pawlak 1984, 1989, 1997).

3.3 Machine Learning

Machine Learning inputs the computer to acquire knowledge automatically from data fed and to solve problems on its own based on the data. (Ratner 2000). The technique ML was coined by Samuel (1995), which was designed to provide computers with the ability to learn without being explicitly programmed. Based on the ML methods of learning tasks, Machine Learning can be sub-classified into the following categories namely concept learning that is designed to correctly identify or construct

concepts relevant to future decision-making processes applying an inductive learning process, decision tree learning which is designed to construct a decision tree by classifying all the objects by testing their values for certain properties, perception learning that aims to solve decision problems using a single layer of the network called “perceptron” through the acquired useful knowledge after reducing the error, Bayesian learning which is based on probabilistic technique that trains the computer to learn depictions of function and finally reinforcement learning which trains the computer to execute at high levels by giving constant feed back in the form of rewards. (Luger 2002).

3.4 Expert Systems

Expert Systems programme computer to become capable of imitating human cognitive skills such as language, understanding, visual perception and problem-solving and are capable of performing reasoning about problem domain which is complex enough for a large amount of human intelligence (Jackson 1999). Expert Systems include four sub components namely knowledge base, inference engine, justifier/scheduler and user interface. The knowledge base is the store house of the rules, facts and knowledge acquired from the human expertise. The inference engine the “brain” of the expert system is a cluster of problem-solving programs that coordinates the searching, reasoning and inference based on the rules of the knowledge base. The justifier explains why and how the expert arrives at a particular solution, the scheduler is set up to coordinate and control the scheduling and sequencing rules. The user interface facilitates the interaction between the system and its user through a series of user queries. (Award 1996).

3.5 Genetic Algorithms

A subset of evolution systems, Genetic Algorithms (GA), emulates the concepts of natural evolution and extracts a series of rules from processes of natural selection that produce creatures that suit the environment best. GA has also been used to solve problems of combat optimization for which a function can be built which can estimate the fitness of a given representative (solution) to a given environment (problem). The GA encodes possible alternate solutions to the problem in chromosomes (which are numerical strings). The GA produces solutions that are not essentially optimal, but quite satisfactory interms of the fitness to the optimization problem by iterative application of genetic operators (cross over mutation and selection) to a whole population of such chromosomes. GA is referred to, in general, as a stochastic AI technique that utilize a solution search process that imitates natural evolutionary phenomena, genetic interitance and Darwinian struggle for survival (Holland 1975, Michalewicz 1999). The GA comprises of five components (Michalewicz 1999, Gen and Cheng 2000)

- A genetic expression of the problem's possible solutions.
- A way to create a populace (an initial set of potential solutions).
- An appraisal function that tests the efficiency of solutions to see if they can survive.
- Genetic operators that modify the genetic composition of descendants. These operators include reproduction, cross over and mutation. Reproduction is a process in which individuals are copied through the selection of individuals that are the most fit. Cross over combines the features of two parent chromosomes (potential solutions) to form two similar descendants by exchanging corresponding attributes of the parents. Mutation randomly modifies one or more features of a selected solution to introduce extra variability.
- Parameter values that determine size of population (how many people should be in the population); crossover rate (the likelihood of crossover by the individual); and mutation rate (the likelihood of transmutation by a certain gene).

3.6 Fuzzy Logic

Fuzzy logic is created as a powerful tool for building knowledge bases for particular domains and acquiring knowledge from the experts. In detail, fuzzy logic uses expert opinions as an input to define "positive" and "bad" regions of each variable, and then calculates the probability of "positive" and "badness" levels by contrasting the actual variable with the professional opinion. (Tanaka 1997). The fuzzy logic is an extension of Boolean logic formulated to presume partial truth – somewhere between definitely true and definitely false. Typically, fuzzy logic comprises of five basic components namely a. linguistic variables, b. linguistic values, c. fuzzy sets, d. membership functions and e. fuzzy IF-THEN rules. Thus, fuzzy logic is unlike crisp logic that is predicated on clear distinction between objects. In other words, fuzzy logic can handle uncertainty, ambiguity and imprecision of objects. For example, fuzzy logic may help us answer questions of how expensive the product price is how hot the temperature is, how intelligent a person is, without setting a clear-cut boundary.

3.7 Agent-Based System

Agent Based method is one of the useful problem-solving techniques which divides the problem of decision into sub-problems and resolves those sub-problems using independent entities called ages. Each agent can use different methodology, resourses and knowledge to process given tasks. An agent is characterized by its capability to exploit significant amounts of domain knowledge over come mistaken input, use symbols and concept learn from the decision environment, operating in real time and communicating with others in natural language (Newell 1989). Reis (1999), stated that an agent refers to an autonomous entity while pursuing its individual goals that can take certain activities to accomplish a set of goals and can compete and co operate with other agents.

IV. SUPPLY CHAIN AND LOGISTICS MANAGEMENT

Supply chain management is the procedure of transforming and delivering a product from raw material to the final consumer. It includes supply planning, product planning, demand planning, sales and operations planning, and supply management. At present, the competition among the companies is how economically the process of transfer of products and services is planned and executed with maximum customer value. The impact of supply chain whether positive or negative greatly affect the entire business. The companies have to plan the activities to maximise both the ROI and the customer value. Any effective supply chain will meet or exceed the expectations of customer if the efficiencies are ensured throughout the chain both forward and backward. Supply-chain management is defined as the "design, planning, execution, control, and monitoring of supply-chain activities to generate net profit, build a sustainable infrastructure, optimise global logistics, synchronise supply with demand and measure performance globally. (www.orie.cornell.edu.). The Global Supply Chain Forum explains SCM as the convergence from end-user to original vendors of key market processes that offer goods, resources and information that bring value to consumers and other stakeholders (Lambert, Douglas M., Martha C. Cooper and Janus D. Pagh, 1998). SCM involves the active strengthening of supply-side endeavours of business to maximize customer value and in turn to get higher profit margin.

Supply Chain covers all such activities from procurement of raw materials and other inputs, conversion of the inputs into products and services and distribution of final products to the end-users and the chain includes the flow of money and information and also the reverse flow of such goods, services, money and information which is known as ‘reverse logistics’. Reverse logistics is the process of managing the order returns and exchange of products. Logistics is part and parcel of supply chain management. It involves planning, production and distribution management of goods, services, and information from the point of origin to the point of consumption. Logistics takes care of the complex pattern of production planning, purchasing, warehousing, inventory management, transportation, shipping and receiving, import and export operations, and customer service. Companies perceive logistics as a significant part of the supply chain. Logistics is the process to manage, coordinate and monitor resources needed to move products in a smooth, cost-effective and efficient manner. Value is the price that buyers are prepared to pay for what a business sells which is determined by gross sales. The definition of 'value-added operation' derives from the 'value chain' paradigm of Porter and characterises the value provided by an action in relation to the expense of implementing it (Porter, 1985).

4.1 Supply Chain and Logistics Management Process

SCM process is the smooth functioning of the supply chain involving all the supply chain partners for the efficient flow of product and service which includes the flow of money and information also among the partners. Figure 1 shows the SCM process and the various functions involved in the flow of products and services. In weighing the success of the supply chain, the links between the manufacturer and the retailer have to function at a preferred level. Though the performance at earlier stages of the supply chain is outstanding, this is not important if the product is not available to support retail sales. This is because the end customer is the only source of revenue for the supply chain and the efficient linkage is the ultimate check to the success of the supply chain.

The basic objective of Supply Chain Management is to maximize the supply chain profitability. A more successful supply chain will, therefore, have higher profitability. The profitability of a supply chain is the difference between what the customer pays for the final product and the costs the supply chain expends in filling the customer’s request. Hindustan Lever the FMCG major company has reduced its inventory from about 45 days to less than 5 days by strengthening its supply chain. Mahindra & Mahindra has been successful in reducing its inventory by 20 - 50 days, Whereas in the case of LG, the decrease was about 30 days. These businesses owe a large part of their performance to the manner in which they handle their supply chain activities.

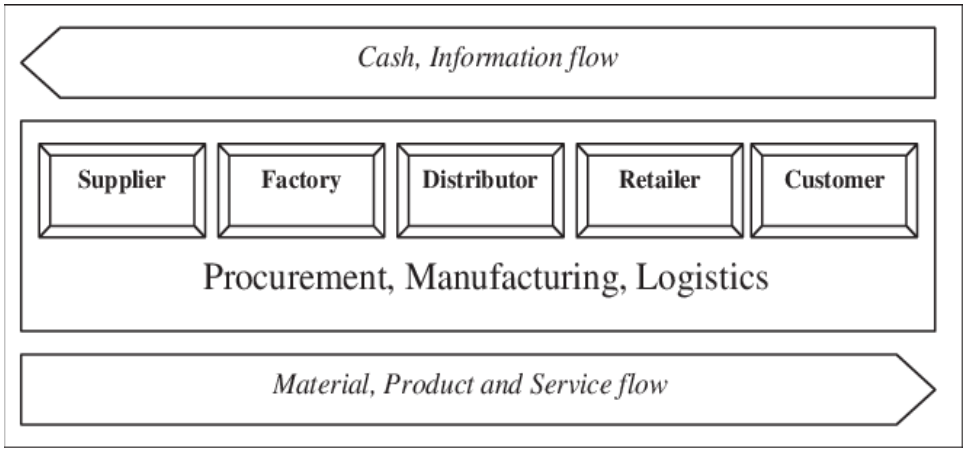

Fig. 1. Supply Chain Management process

Supply chain profitability, is also known as supply chain surplus, it represents value addition made in the profit by supply chain function of an organization. Jonathan Birkin2 defines supply chain surplus as "the discrepancy between the revenue

generated by the consumers and the total expense of the supply chain." The operational definition of the supply chain profitability is 'sharing the amount that exists following subtraction of expenses generated in the manufacture and distribution of goods or services. Ideally, value is spread to supply chain partners at a sale price.. For example, a consumer buys a laptop from Samsung at Rs. 30,000, which is the revenue earned by the company's supply chain. The entire chain involves costs to ensure the efficient transfer of the product, funds, information including storage of the product and transport to the final consumer. If the supply chain cost is Rs. 22000 then the supply chain profit is Rs. 8000 which is The discrepancy between income from Computer purchases and the expense of the supply chain is the surplus of the supply chain or the viability of the supply chain. Supply chain surplus is the overall benefit shared by both processes and intermediaries. The bigger the supply chain shortfall, the more efficient the supply chain. Success of the supply chain, measured on the basis of the total surplus, not on the basis of the benefit of each part of states.

Logistics, as already discussed, is the aspect of the supply chain mechanism that schedules, executes and monitors the productive forward and backward movement and storing of goods, resources and related information between the point of production and the point of use, in order to satisfy the needs of the consumer. Council of Logistics Management defines that "Logistics is the method of designing, executing and monitoring the reliable , accurate flow and storage of goods, resources and related information from the point of production to the point of usage in order to meet with the requirements of the consumer". Logistics is involved at various stages of a supply chain; from supplier to plants, from plants to distribution centres, from distributions centres to stores, from stores to customers, or any of these combinations. Logistics activities include customer service, demand forecasting, distribution communication, inventory control, materia l handling, order processing, part and service support, procurement, packaging, return goods handling, scrap disposal, transportation, warehousing and storage. The figure 2 explains the general logistics cycle of any products produced and supplied to the final customer.

Fig. 2. Logistics Management

V. Artificial Intelligence: In Supply Chain And Logistics Management

Application of AI in SCM is still in preliminary stage only. The capabilities of AI in solving complex problems and manipulating information in the SCM and Logistics have not been fully utilized. But some sub-disciplines of AI such as expert systems and GAs (Genetic Algorithms) have been increasingly utilised to address SCM issues involving location planning, purchasing, inventory management, freight consolidation, and routing/scheduling problems. This section discusses about the application of AI techniques in Supply Chain and Logistics functions.

5.1 AI in Inventory Management

Inventory plays a significant role in the SCM and Logistics. Though, Inventory is considered to be idle resource if it is managed efficiently major proportion of cost will be saved and the smooth functioning of supply chain lies on the availability of inventory throughout the operating cycle of any business. In fact, the annual cost of holding an individual unit of inventory ranges from 15% to 35% of its product price (Timme and Williams-Timme 2003). Thus, inventory planning and control determines the firm's success in this competitive era. There are many factors involved in inventory management such as expected demand in the market, the volume of inventory to be made available and the order cycle time for different types of inventory which are highly uncertain. One of the tools of AI, expert system helps in handling inventory control and planning functions more efficiently. For example, Allen(1986) developed an expert system called the Inventory Management Assistant (IMA) that was intended to aid the US Air Force Logistics Command in replenishing various types of spare aircraft parts and reducing safety stocks. The company has reported that it has been successful in improving the effectiveness of inventory management by 8–18% by reducing the inventory errors through the Inventory Management Assistant. Another expert system is implemented for material requirement planning which stores databases regarding bills of materials, master production schedules, and order patterns and then develops systematic EOQ principles for calculating the optimum amount of potential orders and the optimum duration of inventory refilling. The application of AI technique to inventory control and planning includes the recent study of

Teodorovicet al. (2002) on Fuzzy logic rules for making an online, smart, airline seat inventory distribution decision as to if to approve or deny any passenger request for seating arrangements.

Aera Technology was founded in 1999 in San Francisco and functioning with approximately 153 employees. The company offers predictive analytics software which uses machine learning (aided by domain experts) for applications in supply chain management. The company claims that its applications can allow companies to simplify their planning and optimise current supply chain flows. For example, in many countries, an car manufacturer in the US might have parts being produced that then need to be shipped to distribution centres and dealers. The supply chain management platform of Aera will allow the manufacturer to easily keep track of the entire supply chain with goods ranging from small screws to massive engines and to gain actionable insights from the platform aimed at cost reduction and quality improvement. The company believes that its technology uses machine learning to identify trends in supply chain knowledge (such as historical delivery data or stock tracking data at fulfilment centres) that could theoretically help provide insights that enable the vendor to produce products quicker and reduce the amount of inventory storage.

5.2 AI in Purchasing Management

Make-or-buy is primarily an important decision which deals with weighing the options of producing goods or services internally or purchasing them from outside sources of supply to better utilise the firms resources and the firm can focus on its core competency. Although the make-or-buy decision sounds simple and straight forward, it should consider various"what- if"s as illustrated below(Bailyetal.2005).

1. What is the quantity of goods the company is expected to produce
2. How much risk is involved in developing the new product or innovating particular technology to stay competitive in the market?
3. How much capital investment is needed additionally to produce goods or render services to the new market?
4. Has the company product reached its peak demand or the maturity stage of its lifecycle?
5. What is the crucial strength of the company?
6. What business is the company in?

All these questions are now easily answered by many expert systems developed by the software people. Humphreys et al.(2002) developed an expert system that assists the purchase manager in appraising production of prospective vendors, facilitate the sharing of information between purchasing officials and reduce the time required to make or procure decisions. To cope with a wider question field of purchasing decisions, Kimetal (2002), proposed an agent-based purchasing system in which the on-line ordering process for acquisition of shoe materials from the global supply base is automated. Similarly, Cheung et al (2004), has developed a hybrid agent-and knowledge-based method that can analyse on-line bids and the performance of bid-winning suppliers in order-fulfilling. Chatbots, the conversational interfaces provide a range of incentives to companies, including lower processing costs and time-cycle deliveries. This figure indicates the various modules that need to be placed together to make chatbots operate.

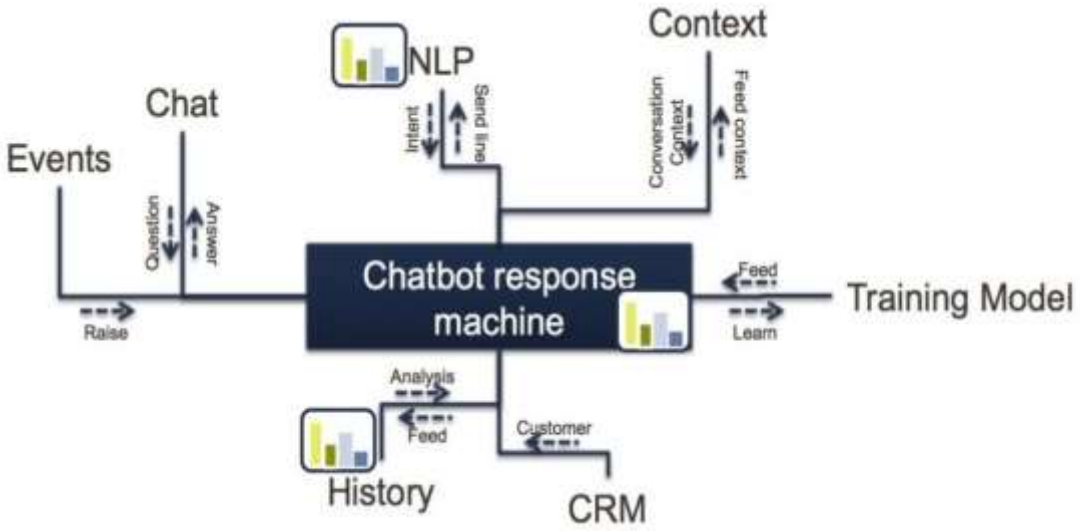

Fig. 3. The different component requirement for chatbot

Texas-based startup Univired, launched a chatbot, Chyme, in which one conversational interfaces between human operators and sales / marketing automation resources such as the Sales Force of SAP can be opened. Unified, Its chatbot was used for the administration of sourcing in the liquor industry. The maker of drinks used to force workers to contact the support desk operators to collect details about their procurement needs. In most instances, this meant a forced waiting period to obtain the

results. The Chymebot solution has been rolled out to staff and vendors and has reportedly been able to provide answers to concerns about order and shipping status, product supply, stock costs, supplier status and contract information.

5.3 AI For Demand Forecasting And Production Planning

Information about expected demand is a basis for the firm's production planning, work force scheduling, inventory control, new product planning and development, and product promotional campaigns. However, such information about future demand, customer preferences for new products, competitors market strategies are highly uncertain and volatile in nature. The firms are constantly engaged in reducing the uncertainty inherent in such future demand and other market conditions. Given the unpredictable nature of potential demand and the differing degree of volatility and heterogeneity associated with it, future demand, it has been a risky task to develop accurate forecasting techniques and select a forecasting technique that is more suitable for particular business environments. For example, some forecasting techniques are successful for short-term projections whereas others work well for long-term projections. However, the basic denominator of the more conventional forecasting strategies, such as exponential smoothing, rolling average, time series, and Box – Jenkins processes, is their fundamental concept that future demand will follow the trend of past demand. Under this assumption, these conventional forecasting methods relied heavily on the precision of historical records. The traditional forecasting techniques are not suitable for the prediction of the future demand of new products and innovative services that were not existent in the past. AI techniques have recently been introduced as feasible alternatives for demand forecasting and planning.

For instance, Yuetal.(2002) proposed an agent-based System architecture incorporating human experience with data processing tools to forecast the need for new goods. Their studies have demonstrated that the hierarchical pattern matching method is superior to exponential smoothing techniques in terms of forecast precision. In comparison to exponential smoothing, which relies entirely on historical evidence, the dynamic pattern matching technique utilized multiple agents to capture past, current, and future customer behaviors that helped improve its forecasting accuracy. Similarly, Jeongetal.(2002) improved forecasting accuracy without relying heavily on historical data by introducing a genetic algorithm-based causal forecasting technique that replaces the traditional regression analysis. Hence, AI techniques such as agent-based systems and GA scan be adopted for predicting future demand for new products or innovative products and services that have not yet been introduced in the market and which do not have any historical data on demand.

LLamasoft was a software company founded in 2003 in Ann Arbor, Michigan, provides supply chain strategy and design tools for the design, preparation and monitoring of supply chain applications. The organisation says that its Market Guru predictive market prediction programme uses machine learning to detect hidden trends (those in seasonal demand or correlations between demand,external weather and other influences) in historical market data to help companies find ways of doing business to increase operational efficiency and cut costs For example , a company that sells furniture (like IKEA) might be able to use the Demand Guru platform to forecast the regular demand for various models in one of its brick and mortar stores.

Using past market data for all models including date and time of purchase, number of products bought, etc., machine learning models in Demand Guru might theoretically 'learn' a particular pattern in terms of seasonality (such as a rise in purchases over a given holiday season). In addition, the app will be able to take into account weather details and news storeys in order to identify associations with market trends, such as the detection of days that made for more weekday market. An additional function that comes with access to Demand Guru is the LLamasoft Data Cube, in which the array of curated weather and economic time-series datasets that will allow the learning capabilities of the application to begin to identify cause and effect relationships for forecasting potential demand. This can provide access to statistics such as temperatures and precipitation levels for a specific city in the US or statistics on mergers and acquisitions in a particular sector.

5.4 AI in Order-Management System

Order picking requires the collection of products that have been put on request. Due to its labour-intensive operations, order picking typically accounts for the largest portion of warehousing operating expenditure (Frazelle 2002). Thus, it affects warehouse planning and management significantly. Considering its significant role in warehousing operations, warehousing managers have endeavored to devise ways to improve order-picking and managing efficiency. Such ways include the computerisation and other automation of sequencing and filling the orders. As part of the automation process, Kim et al. (2002) developed an intelligent agent-based system that optimally assign workers to a specified zone from which orders are picked It was also designed to dynamically change the conveyor speed to reduce queuing time for order pick intervals and optimise order pick output. While the issue of order-picking has always been solved by simulation models and statistical simulations in the past, the use of AI strategies such as an intelligent agent-based method will help solve the additional difficulty created by which adoption of value-added services and e-commerce trading.

5.5 AI for Customer Relationship Management

Customer Relationship Management is an important prerequisite for profitable functioning of any organization. In general, CRM is referred to as a market strategy designed to enhance service quality, create social ties with consumers and maintain customer satisfaction by cultivating a long-term , mutually beneficial partnership with trusted customers chosen from a pool of more than a few customers (Min2006). In order to attract customers, the company should make its customers value its manufacturing capabilities and service quality and make customers believe it can deliver products and services to their expected quality. Suchtrustcanbe instilled only with constantly building a long-term association with customers. CRM is therefore an essential prerequisite for the market for development that drives SC operations.

In order to be truly successful in today's competitive climate, companies must maintain an interconnected partnership with supply chain partners, such as producers, distributors and suppliers, to react effectively to the needs of the end-customer. Customer Relationship Management (CRM) has given today's businesses better tools for managing and integrating customers' demands across a company's entire value chain. Baxteretal.(2003) proposed an agent-based model that simulates interaction between customers and the corporate conditions in which they were based. Their agent-based model considered the exchange of consumer experiences between members of the social network and therefore integrated the influential effect of word-of - mouth credibility on the buying of goods and services. By doing so, it helped the company determine the level of its return on investment in CRM and improve its efforts to attract and retain customers.

5.6 AI in Warehouse Management

The Automated guided vehicles (AGVs) have been operating in industrial environments since the 1950s. With improvements in AI and navigation technologies such as simultaneous localization and mapping and machine vision, AGVs can enable automated material handling across manufacturing boundaries by moving between buildings. Recently, AGVs have the ability to become relatively more independent by combining them with data from current warehouse management and control systems via a software layer called warehouse execution systems (WES). WES uses AI to make existing logistical structures more effective over time, and many of the top AGV players have taken clear strategic decisions on the procurement of WES capabilities. Without discussing robots, one can not speak about artificial intelligence. While robotics is considered a new phenomenon of technology, it is now being used by the supply chain. They are used to log, locate and transfer product inside the warehouse These robotics come with deep learning algorithms that help robots make autonomous decisions about the various processes that take place in the warehouse. Dematic IQ (Former Reddwerks)founded in Grand Rapids, Michigan, In 1891, with more than 4400 staff globally, the American company offers engineering services for supply chain management applications. According to DematicReddwerks, Its platform can assist warehouse management operations in determining the most effective pick-up density for storage robots or in optimising the order-release workflow. Dematic partnered with the American apparel company to facilitate the delivery of their department store (replacing merchandise in stores) by using the Dematic IQ WES. According to Dematic, their WES were used to build a logistics system centre to replenish products in 3,900 retail stores. Dematicretail store replenishment system helped the retailer to accommodate up to 600,000 pieces per day replenished in their stores which were needed demand for all eight labels (including peak conditions) to be replenished. Dematic also believes that their device decreased computing costs and improved storage space, but more detailed observable findings were not disclosed by Dematic at the time of writing. Swisslog is a 118-year-old company based in Buchs, Switzerland. The corporation is owned by the German robot manufacturer Kuka, part of the Chinese electronics industry of the Midea Group. The new application area for AI tends to be in warehouse management systems (WMS) typically used by companies to track and enhance resilience in the warehouse. AI-enhanced WMS has the ability to improve activities by identifying anomalies. Swisslog uses intralogistics systems which can help improve efficiencies autonomously by learning the most-optimized workflows from data such as customer ordering behaviour, a company's machine use and its use of resources.

5.7 AI in Transportation Management

AI techniques are applied in the supply chain to transportation network analysis which is highly complicated to do manually or through normal methods of analysis. For vehicle routing and scheduling, freight consolidation, road network, pipeline network design, traffic analysis, parking space utilization analysis and similar other applications are done at local, national and international level with the help of AI. When companies Cargo flies around the world, it's always nice to have a pair of eyes to track, and it can be useful when it comes to state-of-the-art technologies. Now you can see it in a different light by using a machine vision centred on artificial logistics intelligence. Genetic Algorithms has been one of the most popular forms of AI techniques employed to handle various transportation network design problems (Chambers2001). Meta-heuristic is the ant colony optimisation algorithm is another AI technique that has emerged as a popular tool in network design. This algorithm has been implemented successfully to handle well-known network design problems such as vehicle routing problem, and the minimum spanning tree problem (Dorigoand Gambardella 1997, Bullnheimer et al.1999, Shyu et al.2003).

VI. CONCLUSION

With recent revolutions in technology such as big data and deep learning algorithms, AI is expected to come up with uncommon innovations in the supply chain, manufacturing and transport industries in the future. AI has been integrated as a useful decision-aid tool that helps firms to connect their customers, vendors and SC associates by promoting the sharing of knowledge between separate business organisations. Despite the presence of AI for the last half-century and its recent emergence in the SCM area, AI has not been fully exploited to improve the efficiency of SC and to solve SC problems whose keys are either too expensive or difficulty due to their inherent complexity and ill-structured nature. SCM and Logistics Management continues to draw more attention from both practitioners and academicians a like and begins to mature as an academic field, AI is having a promising future in the SCM and logistics area. Altogether, the future competitiveness of supply chain and logistics systems will largely depend on the collaboration of human intelligence and artificial intelligence. Therefore, a high level of interest in both research and business practice is necessary and legitimate for this field, including interdisciplinary approaches from several science and application disciplines.

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