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The Impact Of Using Artificial Intelligence (AI) In Supply Chain Management On Companies. Literature Review

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ABSTRACT

The survey found that SMEs face a number of difficulties when using IT to manage supply chains, including implementation and maintenance costs, a lack of technical knowledge and skills, etc. According to the study's findings, the impact of AI on supply chain management has been seen in a variety of areas, including greater supply transparency, efficiency, cost savings, and real-time information availability. tracking of items, coordination of efforts, and relationships between internal and external supply chain participants. Additionally, it has streamlined the procedures for transactions across the many services, and it is interconnected so that data travels through the various functions. Many savings have been made thanks to the numerous technologies employed to lower supply chain operation expenses. Additionally, the lead time for orders has decreased. Due to better service delivery quality and quicker supply chain responses, both internal and external customers are pleased with the improved customer services. The outcomes of the primary analysis showed some beneficial effects of the application of AI in supply chain planning, logistics tracking, and product delivery for SMEs. Based on the findings, it is suggested that businesses, particularly SMEs, adopt AI in their supply chain operations to increase productivity, effectiveness, and adaptability .functions that occur between planning and purchasing; logistics and storage.

I. INTRODUCTION

Supply chain management (SCM) has been identified as a growingly significant management discipline that can aid businesses in enhancing supply chain operations. The planning and management of all activities involved in supply, acquisition, conversion, management, and logistics, both within and between companies, are all included in supply chain management (SCM), according to the Council of Supply Chain Management Professionals, with the goal of integrating the key business functions and processes through a cohesive and high-performance business model. These logistics procedures cover tasks including purchasing, stock control, production, distribution, and sales order processing for a company. With a focus on efficiency and effectiveness, the entire commercial chain is integrated into the network .that performance evaluation is seen as a crucial managerial responsibility for achieving goals. asserts that supply chain performance should assess the degree to which the supply chain itself is now providing customer value and provide recommendations for improvement.

Nowadays, Supply Chain (SC) networks play a key role among suppliers [1], and end customers. Generally, SC networks involve variant agents such as suppliers, manufacturers, distributors, wholesalers, retailers, and customers [2], beside the interactions between them. SC is more complicated than traditional logistics as it is not limited to the transportation process among variant agents; rather, it has different phases and roles for different agents, such as what is supplied by suppliers [3-5], and what is ordered by customers. SC networks are sophisticated supplier-customer networks encompass agents, information, techniques, activities, [6], and resources. SC networks consist of: suppliers, manufacturing or production factories, stores, distribution centers [7], and customers. This network aims to achieve optimal resource choice to reduce cost and time [8]. SC networks are the main structure of the operations and the interactions among those agents, from the preliminary strategic level [9], to the final operational one. A good practiced SCM is a competitive advantage for organizations working in the field of investment and raising capital. Organizations have variant options in managing such interactions in SC (supplying with goods, assessing products, offering end products to customers) [10-13], according to time, cost, and profit. The problem is that SCM is responsible for a huge number of processes and operations such as production and procurement planning, choosing the optimal product, customer orientation, marketing, distributing products [14], and sales among others. SCM has to balance the SC and each organization's different objectives; some objectives may contradict other objectives in the same organization. So, there must be an appropriate method to coordinate between such objectives taking into consideration that the SC has variant agents in variant phases (i.e. the supplier, the distributor, the seller, and the customer). Suppliers and end customers may have different locations, a thing that may increase the cost of transporting goods in different paths [15-17], and among different nodes to reach the end customer. To achieve this balance among different objectives, companies must consider comparing and differentiating between different timings & time limits and between the added costs for the goods to determine the appropriate path, cost, [18], and timing. Generally, it is clearly noted from previous relevant works and Paper that SCM has many dimensions that need to be studied simultaneously to achieve the least cost and [19], the shortest time. In this Paper, however, we not only focus on the least cost and the shortest time, but we also try to determine the optimal and the best path alongside with the highest profit while preserving the quality, and improving it if possible. Moreover, this Paper focuses on reducing the cost while giving attention to possible risks that may occur in the transportation process. So, we must be precise and careful in improving SCM using the two new algorithms to reach the best possible results, then comparing them to those of other algorithms. Artificial intelligence techniques can help organization improve their objectives) [20].

II. METHODOLOGY

A collection of presumptions and convictions about how researchers come to know things is known as research philosophy. Any inquiry involves making assumptions about established philosophical ideas like ontology and epistemology. These assumptions will directly affect how well the study questions are understood, the a variety of research methodologies will be used, and obtained data will be analyzed. By The researcher can arrive at a consistent set of hypotheses by evaluating and selecting one.reliable research methodology. This concept will then direct and assist the Methodology, research plan, and data collecting and analysis choices made by the researcher throughout the research, techniques [28]The term epistemology refers to the theory of knowledge. It comprises conceptions about how information should be shared with others as well as assumptions about what knowledge is, what qualifies as suitable, true, and valid knowledge. Given the multidisciplinary nature of business and management, a wide range of information can be regarded as reliable knowledge. As a result, the choice of the researcher's tools and the research findings would be directly influenced by their epistemological expectations [28].research onion was used by researchers to select a method for this paper (see fig.1). When making choices on research philosophy, approach to theory development, methodological choice, research strategy, time horizon, tools, and procedures, a coherent methodology is produced [28].

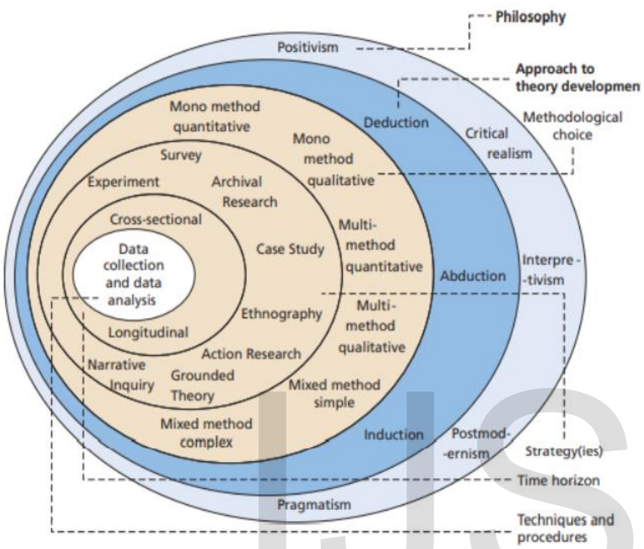

Fig. 1. The research onion (derived from Saunders et al., 2019

III.Related Work

This section presents the theoretical data that forms the basis of the paper. A foundational overview of SCM and AI theory is included. The chapter concludes with a presentation of related work that provided as inspiration for our investigation. also In order to emphasise the significance of the topic, this chapter provides a summary of prior research on supply chain management, stressing the important methods, findings, and limitations. We also provide a full study of certain crucial elements, such as replica location, choice, and cost reduction. After that, the suggested study factors are displayed. Thus, the research concerns discussed in chapters 4 and 5 are brought to light.

Literature Review

In the first section of our paper, we conduct a literature review (LR) to identify the machine learning (ML) applications and algorithms that have been utilised to address various supply chain-related issues. To be more precise, we concentrate on AI applications for least cost path forecasting. To show these advantages, we select a few algorithms, and we pick the best one depending on the performance measures, which we also pick based on our LR. Inclusion Standards:

•Articles published and released during 2006 - 2021.

•Articles published in Journals, books, conferences and magazines.

•Articles published in English.

•Articles fully available with or without institutional access.

•Articles not published in English.

•Articles without complete text.

•Articles prior to 2006

Our LR is conducted by using academic sources, which are Scopus, Emerald insight, Ieee Xplore,
Elsevier, Online Library, Research Gate etc. We search on these by using the keywords strings 'Artificial intelligence demand forecasting by using

Artificial intelligence

time series forecasting' Artificial intelligence applications in supply chain management' and as secondary we search under combinations of the followings:

- Artificial intelligence
- Supply chain management
- Big data
- Industry 4.0
- Time series
- Forecasting
- Forecasting metrics

The benefit of this kind of evaluation is that if the method is repeated, identical results should be produced. To keep the number of publications we assess to a minimum, we choose this precise FoR; otherwise, our method would not be repeatable and impartial. Our screening procedure follows the procedures listed below:

- The initial stage involved conducting a search online using the previously listed sources and keywords. The next stage was to choose which papers, in accordance with our FoR and paper theme, we would preserve. \s
- The third stage involved downloading the articles, noting who wrote them, and recording the publication date in an.xlsx file in order to classify them according to the year and content for simpler perusal. Additionally, we create the Figure 2 graph, which shows the annual amount of articles. As you can see, our LR consists primarily of fresh items.
- The last stage is to evaluate and compare each article to create our LR. We conducted research and

discovered 110 articles that are related, which we ultimately used.

During our research, we found 120 related articles of which we finally use in our LR 64 of them

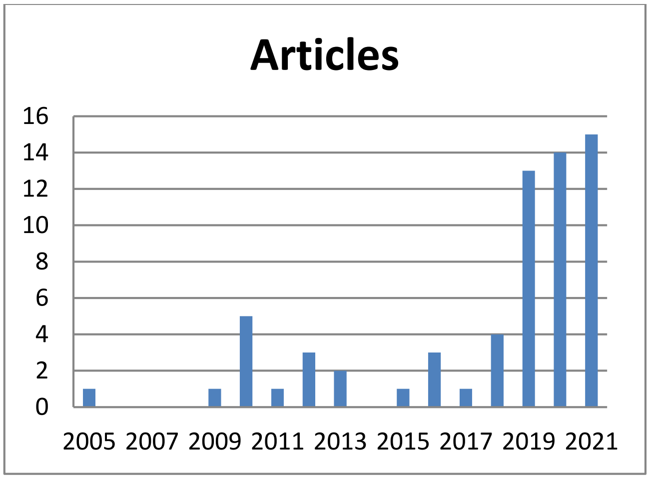

Figure :2 Articles per year graph

Supply chain strategic

Researchers and practitioners have tried a few different approaches to supply chain issues. We divided the supply chain strategic problems that were addressed by multi-objective techniques into many categories in this review, including risk/disruption mitigation, facility location selection, supplier selection, and so on.

Supplier selection

In the context of supply chain management, supplier selection is a crucial concern. "Which supplier(s) will be picked and how much order quantity will be assigned to each provider selected," according to [29] is the definition of the supplier selection problem. An organisation must choose the finest provider from a pool of alternatives that can satisfy all of its requirements. We discovered a number of publications on the topic of multi-objective supplier selection. For example, a multi-objective model for supplier selection under stochastic demand conditions was created by [30]. They took into account supplier requirements based on the overall cost, the product rejection rate, the late delivery rate, and the flexibility rate. [31] used a multi-objective genetic algorithm strategy that took into account four criteria, i.e. cost, time, quality of the goods, and green appraisal grade. Two multi-objective mixed integer non-linear models were created by [32] for multi-period lot-sizing issues involving numerous products and suppliers. The model was created to satisfy three target tasks for lot sizing and supplier selection involving cost, quality, and service level. [33] used multi-objective optimization for domestic or international supplier selection to meet the requirements of the supply chain's minimal cost and maximum reliability of delivery. For a closed-loop supply chain network, [34] conducted research on supplier selection and combined it with the choice of the best refurbishing locations. In a reverse logistics network setup, ranked, and determined the ideal quantity of new and reconditioned components and finished goods. He created a model taking into account the inherent volatility in customer demand, supplier capacity, and the percentage of products that were returned.

Facility location selection

Problems with facility location relate to how to choose the location of a facility, such as a plant, warehouse, distribution centre, etc., based on the established criteria [35]. NSGA II was utilised in earlier facility location selection studies by [35] to address the issues. In order to reduce the expenses associated with facility placement and [36] built a supply chain to determine decisions on the number and location of plants, the flow of raw materials from suppliers to plants, and the quantity of goods to be exported. A multi-objective facility location model was developed [37] for a closed-loop supply chain network with uncertain demand and return[38]. Supply chain was planned to choose the best plant location for China's three production phases, namely component manufacturing, subassembly manufacturing, and end-product manufacturing. [34] conducted research to determine the ideal refinishing locations for closed loop supply chains. In order to create a generic closed-loop supply chain network, they created a facility location model. Multiple manufacturing and remanufacturing facilities, demand markets, collection points, and products make up the established model. The objective is to determine how many and which plants, collecting centres, and products, in what amounts, should be kept there[39] used a multi-objective strategy to address the issue of facility location. used a multi-objective approach to choose the best plans for increasing plant capacity [40].

The concept of SCM

The two concepts of logistics and SCM are distinct. The goal of logistics is to maximise each link in the supply chain, including the company itself. Management consultants originally used the more contemporary term SCM in the early 1980s. SCM places more emphasis on processes than on functions, and these processes should be controlled to maximise customer satisfaction [41]. This indicates that the entire supply chain should be optimised as a whole rather than just the individual enterprises. The potential benefits of SCM are well acknowledged, yet there is a significant discrepancy between what theory predicts and how commercial enterprises actually operate [42]. Both the criteria and the demands change throughout time. However, a highly competitive global market makes it more challenging for businesses to obtain a competitive advantage. The customer wants the things delivered on time, without any damage, and quickly. Given another source with equivalent quality, a consumer could opt for a product that is produced more slowly. Today's businesses mostly compete on the basis of time and quality. Information sharing is necessary for supply chain improvement. Improved production planning, resource utilisation, and customer service can be achieved, as well as lower inventory costs and shorter lead times, by sharing information and adopting an SCM approach, or optimising the entire supply chain as opposed to just one entity [43]. However, a number of challenges make this information exchange challenging. Structures and culture may affect a company's readiness to share information (ibid.), information can be incomplete or misconstrued, and some businesses worry that sharing information will make them less competitive [44]. According to earlier research [43] the supply chain partners' IT systems are incompatible, which makes information sharing challenging and expensive. Working in an advanced business system with a partner who utilises a spreadsheet can make it challenging to convey information. These challenges could contribute to the fact that many businesses do not implement SCM in accordance with theory. Companies should communicate demand information in the order handling sector to enhance production and planning. Information that is delayed for any reason has almost no value for the company, as the study [44] . demonstrates. Therefore, timely information interchange is crucial in order to use it for decision-making and to boost the company's competitiveness in a market where demand shifts quickly.

Supply chain network design

Designing a supply chain network (SCN) is a strategic aspect of supply chain management that determines how many, where, how many at a time, and what kind of plants, warehouses, and distribution centres will be used. Additionally, SCN determines distribution methods and the quantity of goods to be purchased, produced, and shipped from suppliers to customers [92]. Researchers have undertaken a number of studies on the use of many objectives for SCN design problems. [92] devised a two-stage SCN design for plastic items in Turkey. They take into account how to balance the SCN's capacity usage, customer service, and overall cost. Design of supply chain networks was established by [93] and included network configuration as well as operational choices such as order splitting, transportation scheduling, and inventory management. The objectives are to provide the best customer service at the lowest possible cost. [45] built a network for the integrated supply chain taking volume flexibility into account. Minimizing the overall cost of the supply chain and increasing flexibility are the two main goals. In their study, combined stochastic demand with sustainable order allocation and sustainable supply chain network strategic design. The goal of the proposed study is to create a supply chain network with five tiers that includes suppliers, plants, and distribution centres that send goods via direct shipment and cross-docks in order to meet stochastic demand from a group of retailers [64].

The order process

The three purchasing levels are strategic, tactical, and operative. Long-term decision-making is what the strategic level is all about. [47]. Standardizing purchasing procedures, negotiating contracts with suppliers, and working to improve suppliers are all aspects of tactical purchasing. This is based on the first-level supplier strategies that were successful. The final level focuses on routine decisions, procedures, and planning. The operational purchasers' job is to acquire supplies at the best possible price, with the proper amount and quality at the right time [47]. shows the procedure for operational purchasing in PipeChain when placing standard orders. When establishing long-term agreements, estimates for client demand are created and can be shared with suppliers. After then, the supplier can get ready for upcoming demand. An order can be placed exactly as predicted, but it can also vary greatly because the actual demand might be different from the predicted one. An order often consists of a few order lines that each provide the quantity and price for a different component, i.e., each order line denotes the ordering of a distinct component. The relevant supplier must approve the order, which is done by an order confirmation.

Before the order confirmation has been sent, it is occasionally feasible to modify or cancel the order without suffering any ramifications. Once the invoice has been paid, the order is considered to be complete.

Artificial Intelligence

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One seeks to comprehend and create intelligent entities in the science and engineering field of artificial intelligence (AI). There are various AI definitions. One has a tendency to allow the various definitions focus on the logic or behaviour of the entity and whether it is comparable to either a human performance or an ideal performance. There are several other sub-fields of AI, such as learning, communicating, and planning [47]. There are various approaches of handling uncertainty in AI. Uncertainty may result from partial observability or no determinism. In the instance of this endeavour, the uncertainty is brought on by the non-deterministic goal of trying to anticipate future events. To deal with uncertainty, one may use logical agents or problem-solving agents. These agents maintain a belief state, which entails that they keep track of all potential states in which they might find themselves and produce a plan for each one. However, these approaches are not thought to be appropriate for the project's current task. This is due in part to the nature of the task and in part to the limitations of these approaches, such as the fact that the agent must take into account every explanation and prepare for every scenario, regardless of how unlikely it may be, which can result in very extensive calculations and data storage. Predicting future events and their likelihood is the nature of the current assignment. To put it another way, the goal is to raise the level of belief necessary for a particular occurrence to occur. Probability theory is a method that can be used to address these levels of belief. In probability theory, an agent's level of belief for any state or sentence ranges from zero to one; in contrast, a logical agent merely believes that a given assertion is either true or untrue. Instead of being made with reference to the actual world, the probability assertion is made with respect to the knowledge state, or what the agent knows about the world (ibid., p. 480-482). This is also referred to as probabilistic reasoning occasionally. In the subfield of AI known as probabilistic reasoning, network models are constructed under uncertainty in accordance with the principles of probability theory (ibid., p. 510).

AI techniques can be summarized as shown in Table 1.

Category	Supply chain	Marketing	Logistics	Production
Technique	Artificial neural networks Agent-based/multi-agent-based systems Bayesian networks Swarm intelligence Stochastic simulation	Artificial neural networks Genetic algorithms Agent-based/multi-agent-based systems Hill climbing Tree-based model	Agent-based/multi-agent-based systems Robot programming Heuristics Artificial neural networks Fuzzy logic	Artificial neural networks Genetic algorithms Decision trees Expert systems Swarm intelligence Rule-based reasoning

Table1. AI techniques in SCM Areas

Supply Chain Management Areas

To improve the long-term performance of the individual companies and the supply chain as a whole, supply chain management may be viewed as the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a specific company and across businesses within the supply chain [98]. Management of the supply chain is continually changing. Changing paradigms are happening in the business sector. Supply chain 4.0 is the newest trend in the corporate world. [48] knowledgeable about how SCM affects an organization's success. ICTs, especially artificial intelligence, have been heavily incorporated into SCM procedures today. Marketing Decision Support Systems, pricing, customer segmentation, production forecasting, supplier selection, demand management, and consumption forecasting are just a few of the SCM applications where AI integration is used. As a result, AI makes automated compliance possible, which lowers costs and improves the efficiency of a value chain network [49].

The business world is experiencing a paradigm shift. The most recent corporate trend is supply chain 4.0. [48] aware of how the success of an organisation is impacted by SCM. Artificial intelligence in particular has been significantly implemented into SCM practises nowadays. A few SCM applications that make advantage of AI integration include pricing, customer segmentation, production forecasting, supplier selection, demand management, and consumption forecasting. Automated compliance is thus made possible by AI, which reduces costs and boosts the effectiveness of a value chain network [50].

AI integration in Supply Chain Management

The systemic, strategic coordination of the conventional business operations and their methods within a specific corporation may be seen as supply chain management. The predictive abilities necessary for demand forecasting in today's dynamic business environment are also considerably improved by AI. As interactions may be customised by AI-driven bots, which can help in tracking the delivery status of an item and are further backed by echo users with assistance from a customer care team, AI can be quite effective at engaging customers [51]. AI may be used to track a warehouse's performance in terms of demand and shelf life. It could be accomplished by thoroughly analysing stock levels and coordinating related actions in line with those findings [52]. Artificial intelligence (AI)-based innovations can encourage real-time coordination and collaboration to increase supply chains' visibility [53]. Based on dynamic capacities, margins, and the location from where a company is operating, demand patterns can be identified [53]. AI can advance because the idea of network planning and mapping in the supply chain is so crucial. The supply chain can benefit from the use of AI technology in terms of production, routes, and other linking nodes [54]. In order to better shape the supply chain in these exceptional times, collaboration between contractors and suppliers can be increased [104]. AI may have an impact on real-time pricing (RTP), a key element of SCM. RTP is a crucial component of demand-side management that controls the load curve and enables peak load shifting. It has the potential to be covered on a higher level using AI, as indicated in the literature [55]. Numerous studies have been conducted, for instance, on RTP in China [55].

With the two-dimensional view shown , AI facilitates supply chains in environmental scanning, demand, supply, process, and control [55]. By identifying, testing, and assessing novel solutions, AI-based innovation has the potential to expedite the decision-making process[56]. Based on the aforementioned literature analysis, we may also see AI as a critical enabler to support quick and informed decision-making in the supply chain to foresee issues, cut costs, and foster a value chain network [57]. Deliveries that are on time and undamaged help to improve service quality and please consumers [58].

E. Mastrocinque et al. this work propose a technique of improving SC using the Bees algorithm with MO to reduce the cost and the time consumed. It also uses the Pareto system to determine the optimal solutions to the problem of cost and time to improve the SC. It proposes new weights in applying the algorithm and compares the proposed system with other algorithms. The results show that the proposed algorithm exceeds other algorithms in reducing the cost and time. This work recommends complicating the problem and improving the Bees algorithm by integrating other objectives in further work [59].

R. Ehtesham et al. this work improves the SC by integrating other environmental and economic dimensions to the MO. The main goal of this work is to achieve the highest margin of profit by transporting the largest amount of goods, while reducing environmental pollution. This problem has been solved using two algorithms with Multi-Objective Optimization to select the suppliers and to improve the SC. These proposed algorithms have been applied to Mega Motor Company to reduce the cost and time. The results show that the proposed algorithm exceeds other algorithms in reducing environment pollution. This work recommends improving the algorithm using Meta-heuristic and addressing cost and time simultaneously [60].

H. Banerjee et al. this work propose a new technique that is using Pareto Optimization in the cases of the uncertainty of the preliminary assumptions. It uses Pareto Optimization with a Genetic algorithm and Mixed-Integer Linear Programming (MILP). It shows some scenarios of avoiding risks in SC systems that are affected directly by the customer's requirements. The work also improves the process of selecting the nearest suppliers to the customers to reduce the total cost and to avoid risks. This methodology proves that the experimental results are better than those of other algorithms in cases of uncertainty. The work recommends using different algorithms to improve the methodology used in the cases of uncertainty [61] .

L. Martínez et al. this work proposes the technique of Meta-heuristic using Water Drop with MO to reduce the cost and the time. It depends on Pareto optimization to determine the number of optimal solutions simultaneously. The results show that the proposed algorithm exceeds other algorithms in reducing the cost and time. This work recommends improving the algorithm using the distances between nodes to determine the optimal and the shortest path [62] .

S. Gupta et al .this work proposes a method of an optimal allocation of suppliers and resources with specific products with the help of decision makers. The work divides the decision makers into two groups: the first group is responsible for the goods transported to distributors, and the second group determines the amounts reasonably. The first group is concerned with transporting goods with least cost, while the second group is concerned with reducing delivery time also with least cost. This Paper uses Fuzzy with MO to address Conflicting objectives, reaching a compromise in the process of transportation. The results show that the proposed algorithm exceeds other algorithms in achieving the optimal amounts of products in the process of making a decision. This work recommends using Meta-heuristic with Pareto optimization [63] .

R. Sun et al .this work describe the application of Ant Colony with MO in SCM. It addresses a number of objectives such as cost, time, customer service, and flexibility with the goal of improving the SC. The work also introduces MO system to solve some problem to improve the SC. It recommends improving the algorithm and using other algorithms [64].

P. Phuc et al. this work focuses on the problem of directing the vehicles for logistic services. While delivering a product to the customer, the vehicle has to pass over all the nodes inherent in the network to reach every customer in their lists. The main objective of this work is to reduce the cost of traveling from one customer to another, considering that not all vehicles are similar. ACO has been used to direct vehicles and detect each vehicle's arrival time. The work recommends analyzing more optimal results by integrating MO and using AI to reach the shortest path, considering time and traffic [65]

Y. Wenfang et al. this work design a new strategy to manage the inventory of the SC, manage the marketing process, and improve companies' response speed. It also improves more than one methodology of ACO algorithm with Fuzzy. This work positively influences the efficiency of the organizations' ability to manage inventory in SC. The work recommends using AI to manage inventory to improve SC [66].

X. Zhang et al. this work develops ACO algorithm with MO using two different colonies to reduce the cost of the goods in the SC. The work also develops a method to determine priorities and weights, detecting the path of transporting goods and the optimal cost. The results show that the proposed system exceeds other algorithms on a large scale in smart cities. Therefore, this work recommends reducing resource consumption to the minimum, and improving the system with other algorithms that can be applied on a larger scale with addressing objectives such as cost, time, and optimal path to transport goods [67] .

VI. Discussion and related works

It is clearly noted from previous studies and articles that is relevant to this field that SCM has many dimensions that has been largely studied to achieve the least cost and the shortest time. This Paper does not only focus on reducing the cost and time, but it also tries to determine the optimal and the best path taking into consideration the highest margin of profit and preserving the quality of the product and improving it without negatively affecting the customer or environment. The Paper focuses on reducing the cost while giving attention to possible risks that may occur in the transportation process among nodes is presented in table 1. So, we have to be precise and careful in improving SCM using the two proposed algorithms (PSO & ACO) to reach optimal results.

Table 2 .A comparison between the reviewed AI techniques in the Supply chain management

Authors	Multi-objective model
Liang (2008), Xu et al. (2008), Cardona-Valdés et al. (2011), Pourrousta et al. (2012), Latha Shankar et al. (2013), Mastrocinque et al. (2013), Moncayo-Martínez & Zhang (2014), , Rad et al. (2014), , Nikabadi & Farahmand, (2014), MoncayoMartínez & Zhang (2013), Nekooghadirli et al. (2014);	• Min. total cost • Mindelivery lead time
Xu et al. (2008), Farahani & Elahipanah (2008), Benyoucef & Xie (2011), CardonaValdés et al. (2011), Li & Chen (2013), Latha Shankar et al. (2015)	• Min. total cost • Max service level
Wang et al. (2011), Jamshidi et al. (2012), Validi et al. (2014), Nurjanni et al. (2014), Saffar et al. (2015)	• Min. total cost • Min gas emission
Prasannavenkatesan & Kumanan (2012), Atoeia et al. (2013)	• Min. total cost • Max. delivery reliability
Pishvaee & Razmi (2012), Amin & Zhang (2013)	• Min. total cost • High availability • Min. environment impact
Pishvaee & Torabi (2010), Dzupire & Nkansah-gyekye (2014)	• Min. total cost • Min. delivery tardiness
Zhang & Xu (2014))	• Min. total cost • Max. average safe inventory

	levels
Sadeghi, et al (2014)	• Min. inventory cost • Min. storage space
Wang et al. (2013)	• Min. total cost • Min. shortage
Shahparvari et al. (2013)	• Min. total cost • Max. flexibility level
Cheshmehgaz et al. (2013)	• Min. total cost • Min. response time
Liu & Papageorgiou (2013)	• Min. total cost • Min. Process time • Min. sale losses
Al-e-hashem et al. (2011)	• Min. total cost • Min. variance of cost • Max. productivity
You et al. (2012)	• Min. total cost • Min. gas emission • Min. local labor cost
Yeh & Chuang (2011), Zhang et al. (2013)	• Min. total cost • Min. delivery lead time • Max. product quality • Max. green appraisal score
Liu et al. (2014)	• Max. profit • Min. gas emission • Min. fossil use
Ruiz-Femenia et al. (2013)	• Max. NPV • Min. global warning potential
Pasandideh et al. (2015)	• Min. total cost • Max. the average number of products
	dispatched to customers
Bandyopadhyay & Bhattacharya (2013)	• Min. total cost • Min. Bullwhip effect
Özkir & Basligil (2013)	• Max. satisfaction level of trade • Max. satisfaction degrees of customers • Max. profit

Table 3 The other metaheuristic techniques in multi-objective for supply chain problems

Optimization techniques	**Description**	**Application for SC problem**
Memetic algorithm	A memetic algorithm combines an evolutionary algorithm and a local search to achieve two goals: flexibility and efficiency in the amount of time spent looking for a solution (Donoso and Fabregat, 2007).	Pishvaee et al. (2010) Jamshidi et al. (2012)
Multi-objective label correcting (MLC) algorithm	A forward search is used by the MLC method from a chosen output point to all reachable points. The last-infirst-out (LIFO) rule is used to process the nodes in the stack. For the serial approach, each iteration involves pulling out a node from the stack for investigation and pushing its succeeding node(s) back into the stack. The MLC then decides on and modifies the pathways. The algorithm ends when every node in the stack has been removed (Liang et al., 2013).	Liang et al. (2013)
Modified Fruit Fly optimization algorithm	MFOA stands for the creation of the fruit fly optimization algorithm, which was motivated by the fruit fly's approach to locating food. The fruit fly has superior sensory and perceptual abilities to other species, particularly in osphresis and eyesight. Fruit fly may utilise its sensitive vision to locate food and the company's flocking location	(Mousavi et al., 2015)

	once it is close to the food source, and then fly in that direction. (Pan, 2012)	
Tuned hybrid bat algorithm (HBA)	Particle swarm optimization (PSO), which is utilised to hybridise the bat method, is a local searcher that is employed in HBA . To tackle permutation issues, the HBA, which consists of the swap, inversion, and reversion operators, can be utilised (Sadeghi et al., 2014)	Sadeghi et al. (2014)
Multi-objective hybrid approach (MOHEV)	The modified multiobjective electro-magnetism mechanism algorithm (AMOEMA) and the modified multiobjective variable neighbourhood search (AMOVNS) are combined to form MOHEV (Govindan et al., 2015)	Govindan et al. (2015)
Intelligent Water Drop (IWD)	The IWD algorithm is built on a new swarm-based metaheuristic that draws inspiration from nature and mimics some of the natural phenomena of a swarm of water drops with the dirt into the river bed (Moncayo-Martnez and Zhang, 2014).	Moncayo-Martínez and Zhang (2014)

VII. CONCLUSION AND FUTURE WORK

The purpose of the paper was to propose an AI maturity model in order to be able to assess the extent to which medium-sized companies use AI in supply chain management. As well as to reveal the challenges related to the implementation of artificial intelligence. The major conclusions of this paper demonstrate that a relatively small number of the organisations we contacted do not use artificial intelligence in supply chain management. Companies must stay up to date with technology if they want to obtain a competitive advantage. This investigation focused on the use of artificial intelligence (AI) by mid-sized businesses (AI). The analysis revealed that the company's lack of resources,Knowledge and money turned become roadblocks to the technology's adoption. Not Implementing the technology might prevent general growth and stagnation of the processes.
company. not advancing when other, perhaps larger companies are advancing potentially widen the gap between competitors.

While some organisations are still in the planning stages for the next five years on how to grow and improve their AI capabilities, other businesses are depending heavily on AI to master supply chain management. Furthermore, the findings show that even though some businesses are using AI, this technology has advanced considerably.

New challenges have been found, in addition to the numerous that have already been mentioned in this paper and by the prior theory. This implies that in order to develop policies that might aid and support better organisations in addressing these difficulties, both old and new challenges need to be given closer and deeper attention, both in theory and in practise.

We have provided a thorough analysis of the multi-objective solution to the supply chain problem. The issue statement, supply chain type, MOICA , representative, and optimization strategies were all covered in this review. We have talked about different supply chain arrangements that were resolved using many objectives. Minimizing overall cost was the first goal in the authors' multi-objective strategy, which was then followed by a variety of other goals and models. There are numerous algorithms available to formulate supply chain problems, which depend on formulations of objective, intrinsic, and constraint constraints as well as variable decision forms. Optimization techniques for multi-objective problem were divided into two approaches i.e. traditional and metaheuristic techniques. Multi-objective optimization techniques can be used to solve numerous supply chain issues. For further studies, we identify a few crucial and vital subjects in supply chain issues resolved by many objectives.

- Strategic supply chain. There aren't many articles discussing strategic risk/disruption mitigation in the context of multi-objective supply chain solutions. A multi-objective optimization framework can be used by researchers to build stochastic or probabilistic mathematical formulations of supply chain risk/disruption mitigation strategic models.
- Supply chain sustainability. We haven't come across any publications that explore how multi-objective techniques might improve sustainability in the supply chain. If a supply chain satisfies the three key criteria of economic, social, and environmental sustainability, it is considered sustainable. Future research can explore sustainable supply chains using multi-objective optimization techniques to satisfy three primary sustainability factors.

In upcoming study, scientists can create multi-objective optimization techniques for more time-, memory-, stage-, and user-friendly solutions. traceability of the supply chain. Future research may take into account using several objectives to address supply chain traceability issues.

Recommendations

1- According to the paper, businesses, especially SMEs, should integrate AI in their supply chain operations to increase efficiency , which will encourage them to boost sales and improve customer service.

2- In order to increase overall effectiveness and gain a competitive edge over rivals through the improved pricing and goods that result, organisations must integrate the supply chain function with the other functions involved in its operation.

3- The paper also advises the adoption of AI that help to improve the supply chain's efficiency for both customers and suppliers. These ought to be mechanisms that increase transparency, as doing so will raise the organization's reputation.

4- The paper also suggested working with technical corporations to educate manufacturing and production companies about the costs, advantages, and training needs of new AI technologies.

5- Last but not least, it is advised that proper planning be done for SMEs firms when planning to adopt new AI technologies for their supply chain practices in accordance with business requirements.

Future work

There are many optimization methods for multi-objective problems developed by researcheres. The supply chain is a complicated system, making it difficult to formulate in NP-hard models. The difficulties are typically solved using metaheuristic methods.

Being integrated with Multi-Objective Optimization in the field of transportation and tested by AI techniques, the simulation results show the efficiency of the proposed algorithms. Many other objectives can be addressed in further works, such as improving means of transportation and reducing resource consumption using the least-cost paths. We also propose addressing other objectives, such as improving the cost, reducing the time consumed between the supplier and the end customer, speeding up the transportation process, and reducing risks. The two proposed algorithms are applicable with other objectives in the field of goods transportation
uture research on the implementation of Artificial Intelligence as part of the daily business process needs to investigate where exactly the technology is benefitting companies and
how they are benefitting. The narrow scope of this study, looking at small to mid-sized companies in the local area, can expand both in region and to include larger companies. This would give a broader scope to be able to better generalize the research. Larger companies may have the resources, both money and personnel knowledge, to implement the technology. Looking at larger companies could shed more light on the implementation reasons and whether they looked at internal or external resources to solve the problem. It may also show that there is a different problem set between mid-sized and larger companies. Future work should also look at
internal resources versus external resources. Larger companies may spend more money to keep the resource in house, through training of their employees in the technology, thus giving them an advantage over those that outsource the technology. A financial study to look at the ROI between training and process improvement is warranted.

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