Artificial Intelligence Demand Forecasting Techniques in Supply Chain Management: A Systematic Literature Review

Saad El Marjani
Department of management sciences
Université du Québec à Rimouski
Levis, QC, Canada
Saad.ElMarjani@uqar.ca

Safae Er-rbib
Department of management sciences
Université du Québec à Rimouski
Levis, QC, Canada
Safae.Er-rbib@uqar.ca

Loubna Benabbou
Department of management sciences
Université du Québec à Rimouski
Levis, QC, Canada
Loubna_Benabbou@uqar.ca

ABSTRACT

Demand forecasting is one of the vital elements of the supply chain management (SCM). It is in constant need of development and improvement given its critical impact on the supply chain. Forecasting the demand should be performed to answer the needs of the customers using efficiently the available resources.
We provide in this paper some overviews based on a systematic analysis of the related literature. The paper addresses different techniques and aeras of artificial intelligence (AI) adopted to determine and enhance the demand forecasting in SCM. The research aims at identifying AI techniques that can improve supply chain practices and fill the gaps in some interesting SCM fields, namely: Marketing, Production, Logistics and Supply Chain. We disclosed the most important aspects of the review such as: AI algorithms applied to different fields of the supply chain; potential AI techniques frequently used in demand forecasting and the different related subfields susceptible to be treated with these techniques.

Keywords
Demand forecasting, supply chain management, systematic literature review, artificial intelligence techniques, clusters.

1. Introduction

Companies are continuously required to manage efficiently and wisely their resources. They are in constant need to enhance the quality of their products and services by keeping up with new advances in technology and digitalization techniques (Woschank and al. 2020). Regardless of their activity sectors or their sizes, companies are faced to complex processes. As a matter of fact, they are in an imperative need to employ effective and optimized tools in their operations and processes (Mahraz and al. 2019).
The supply chain plays the most vital role in sourcing and procurement companies, it involves the planning of the demand and the supply management (Chopra 2019). The supply chain management is responsible of moving goods and services from suppliers through warehouses, processing locations and distribution locations to the consumer. According to the Association for Supply Chain Management APICS (2013), the control of physical information and financial flows is an important element in the supply chain process.
The last few decades have seen an increase in the volume of information processed in the supply chain (Ribeiro and Barbosa-Povoa 2018). This is due to several factors among which: globalization which has the effect of lengthening and internationalizing the physical flows, the increasing constraints of traceability of products, digitalization and automation of physical processes which generate a large amount of heterogeneous data etc. Moreover, with the fourth industrial revolution (Industry 4.0) and all the automation that supports it, artificial intelligence (AI) tools are the most suitable to analyze and process its related issues (Min 2008).
The artificial intelligence (AI) is defined as the ability of machines to interact with, and imitate, human capabilities. AI is not a new topic nor a new field of academic study Huin and al. (2003), it is applied in many fields and can be

adapted in areas such as the supply chain management. As mentioned before, AI arises strongly in the industries 4.0 technologies Woschank and al. (2020) and that is why it received a wide attention from the scientific community (Toorajipoor and al. 2021).
Among many elements in the supply chain management, the demand forecasting is an essential component in the SC strategy. Demand forecasting is the process of predicting customer demand to ensure that the right quantities of the right products are delivered. It is an essential element since it presents the process by which the operational and the strategic planning are devised. Any forecast error can occur in costly wastes or shortages of products.
The main purpose of the research is to present a systematic literature review and to answer the research question: What is the AI contribution to demand forecasting in SCM field?
Four keywords are drawn for the search purposes, namely supply chain, logistics, production, and marketing. The study is organized as follows: In section 2, we precisely state the research methodology, we present details on how we conducted the review and the important steps taken in account. In section 3, the analysis and synthesis present the components of individual studies and describe the relationships between them. We conclude the paper by summarizing the points discussed in the research and the main AI techniques discovered on some targeted articles.

2. Research methodology

This research study was conducted following the principles of a systematic literature review approach. This approach allows to ease the process of collecting data and analyzing it. With respect to the classical narrative review Tranfield and al. (2003), systematic approach overcomes the narrative review weaknesses. With the purpose of analyzing the methodologies and summarizing the findings, systematic review approach produces a new comprehension to the field, evaluates its quality and synthetizes the study using an adequate strategy.
Based on the five-step process introduced by Denyer and Tranfield (2009), we conducted the literature search to achieve a better understanding of the existing literature. We established parameters to select the literature and drew research questions and the following steps. Therefore, the systematic review deployed consists of 5 steps, as shown in (*Figure 1*)

2.1. Research strategy

In this section we introduce the initial steps of the research methodology. The research process aims at providing a more detailed understanding to the study, from which, we acquire the subsequent research questions.

- ***The research process***

As stated before, the research strategy is based on a five-step process. In the first step, we elaborated a research process for the field of study and the existing literature to better contain the subject.
Several electronic publishers' databases are investigated to find relevant literature sources by reviewing the results of a specific search string (see *Table* 2). Moreover, based on the idea of Denyer and Tranfield (2009), the research strategy is used to identify the requirements and criteria for the literature selection. This strategy is thoroughly detailed in the section 2.3.

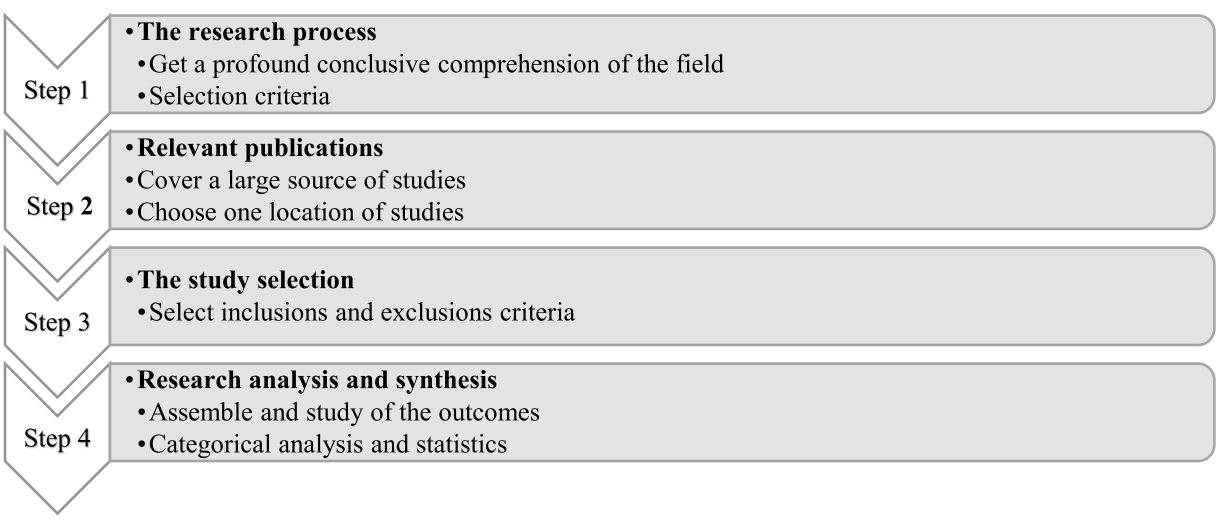

Figure 1 Research process of systematic literature review

- ***The research questions***

Defining a good research strategy is crucial to achieve a high-quality systematic literature review. As a first step, a well-structured relevant question to pilot the study Counsell (1997) is defined. This step is the most important and challenging phase of the research strategy as it leads to conceive the methods and strategies to conduct such a project (Bryman 2007). As mentioned in the introduction, the question evolving around this study is: how can AI contribute to demand forecasting in SCM?

To define and to develop further the study, we dissected the main question into four sub-research questions (RQs) (see *Table 1*). The purpose of the question RQ1 is to know the most used methods in AI that predict supply demand. For RQ2 the goal is to identify existing AI approaches in supply chain management. RQ3 aims at identifying all the business sectors and fields of application related to SCM that have promoted the use of forecasting using AI techniques. RQ4's purpose is to answer and discuss the fields and areas of activities that can promote the demand forecasting related to AI techniques.

Table 1 Research questions

RQ	Issue
RQ 1	What are AI's most often used methods and techniques for demand forecasting?
RQ 2	What are the possible/existent SCM research AI approaches?
RQ 3	What are the fields and missions that have been enhanced in demand forecasting/SCM using AI?
RQ 4	What are the fields and missions that can be enhanced in demand forecasting/SCM using AI?

2.2. Relevant publications

To be able to locate our study and to identify the relevant publications, we conducted a selection of search engines and search terms. Considering that we needed literature sources and databases covering large choices of peer reviewed literature, five databases are selected: Scopus, Emerald insight, JSTOR, the Wiley Online library, and Taylor & Francis (see *Table 2)*. We examined These databases based on the search strings related to our specific need to cover the topic.

Table 2 The search protocol for selected literature sources

Database	Article parts searched	Fields searched	Search string	Time span
Scopus	Title, Abstract, Keyword	All fields	"Artificial intelligence" AND "Demand forecasting" AND "Supply chain" OR " Logistics" OR "Production" OR "Marketing"	2008 - 2020
Emerald insight	Title, Abstract, Keyword	All fields	"Artificial intelligence" AND "Demand forecasting" AND "Supply chain" OR " Logistics" OR "Production" OR "Marketing"	2008 - 2020
JSTOR	Title, Abstract, caption	Business, Public Policy & Administration, Management & Organizational Behavior, Marketing & Advertising, Finance	"Artificial intelligence" AND "Demand forecasting" AND "Supply chain" OR " Logistics" OR "Production" OR "Marketing"	2008 - 2020

Wiley online library	Title, Abstract, Keyword	All fields	"Artificial intelligence" AND "keyword 1" NOT "keyword 2" NOT "keyword 3" NOT "keyword 4"	2008 - 2020
Taylor & Francis	Title, Keyword	All fields	"Artificial intelligence" AND "keyword 1" NOT "keyword 2" NOT "keyword 3" NOT "keyword 4"	2008 - 2020

It is important that the search strings be judicious as described by Rowley and Slack (2004). The research focused on including 'artificial intelligence', 'demand forecasting' and 'keyword' in the search strings. We used the terms 'supply chain', 'logistics', 'production' and 'marketing' as keywords. The search protocol is basically the same for all the databases, only minor changes were applied on every search engine to adapt the search to the database engine. Moreover, for the Scopus and Emerald insight engines the searches were undertaken by searching all the business sectors using the titles, abstracts, and keywords. The search, then, focused on the keywords discussed rather than using the 'AND' conductor for the two important keywords of the search and then 'OR' for the keywords: logistics, production, supply chain and marketing. For the JSTOR search engine, the same procedure was done on the keyword search except for the activity search which was specified in advance. Finally, for the Wiley and Taylor & Francis search engines, the same procedure was done as for Scopus, using all sectors of activity except for the keyword search. The main keywords were added using the 'AND' by adding the third keyword searched, then using 'NOT' for the other keywords to avoid a discord in the search.
In the basis of the chart analysis provided in *(Figure 2)* and *(Figure 3)*, we have decided to focus the study on the databases with a significant coverage of peer reviewed literature related to our research, namely Scopus.
The number of relevant publications is significant compared to other databases.

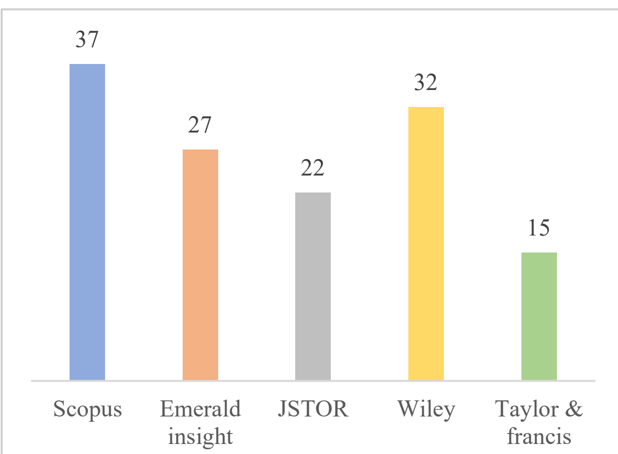

Figure 2 Number of papers found per search engine

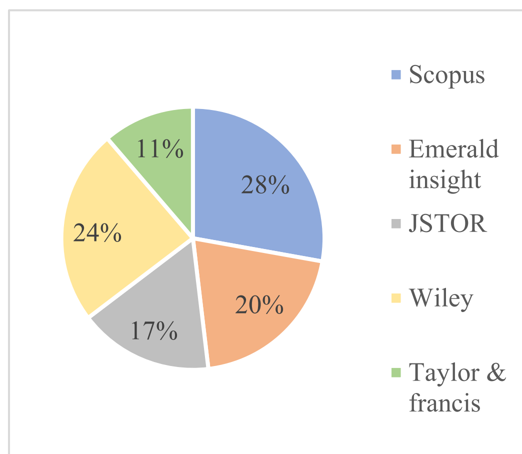

Figure 3 Percentage of paper found per search engine

3. Research analysis and synthesis

The purpose of this section of the review is to unravel the relevant papers found, analyze, and describe their related studies. This first step will allow, thereafter, to synthesize the findings into a complete interrelation between different components of the reviewed studies.

3.1. Distribution and statistics

Before starting the data analysis and synthesis, we collected all the relevant papers from Scopus search engine. 37 articles were selected for analysis and their distribution by field is as follow: 3 papers belong to marketing, 8 to logistics, 12 to production, and 14 to supply chain sector. We derived the

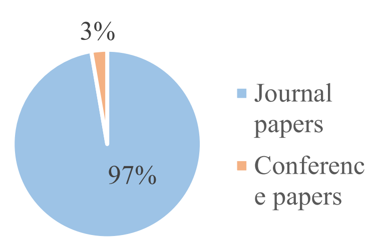

Figure 4 Papers type distribution

literature from conference proceedings and peer-reviewed journals using a data base search spanning from 2008 to 2021 (see Figure 5). Thus, 97% of the literature came from conference papers and only 3% was journal papers publications.

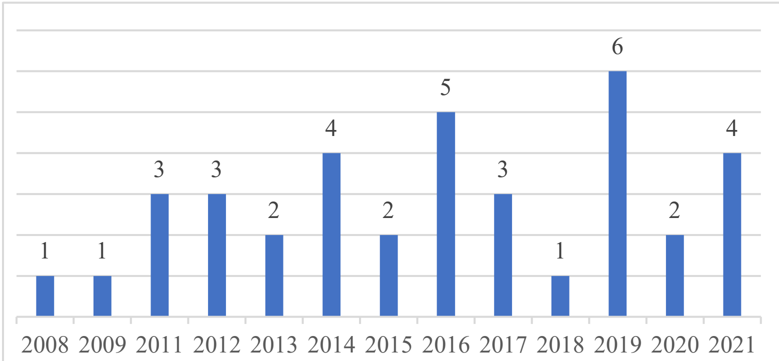

Figure 5. Distribution and tendency of publications by years

Figure 5 defines the tendency and frequencies of publication by years on the 37 articles found at scopus. we can see that publication start to increase at 2011 to reach the top at 2019. Those papers were well selected as defined at 2.2 relevant publications. We have to mention that publication below 2008 were not relevant.

3.2. Results analysis Vos Viewer

As a first phase to identify the classification, a mapping and clustering are created using the software tool VOSviewer. This tool allows to create and visualize bibliometric networks consisting of researchers, publications, co-authorship relations, co-citation network, etc. Based on text mining functionality, this software also allows to build and visualize co-occurrence network of terms or keywords sourced out of a large amount of scientific literature.

At First, we created a file with the crucial map information: authors, terms and citation and we used the Scopus database for this purpose. This initial analysis helped in detecting the connections and clusters between words with a text mining algorithm. Filters are also implemented to avoid the repetition of synonymous words on the maps. Thereafter, we developed the relationship map (*Figure 4)* and the VOSviewer heat map (Figure 5) to identify the various words that are linked in a structured manner to the demand forecasting, supply chain and artificial intelligence.

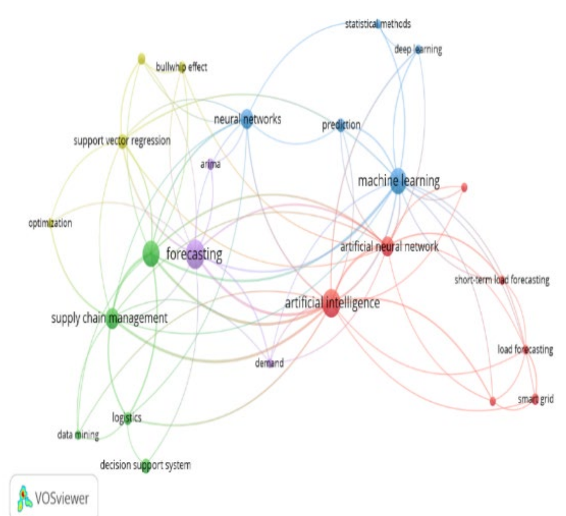

Figure 6 Keywords Co-occurrences in both AI and SCM research

Figure 7 Keywords density

5 clusters are disclosed: 1- artificial intelligence, 2- supply chain management, 3- Forecasting, 4- Support vector regression, 5- machine learning. These clusters are well represented in the heat map which allow us to emphasize the main keywords with a high weight.

3.3. Categorical analysis of the literature and discussions

The following table (*Table 3*) presents the different fields related the SCM and the number of publications found in the literature. The total numbers in every first row of the subfields represent the publications found based on including, as keywords, 'Artificial intelligence' and 'Demand forecasting' in the 5 search engines. As for the second rows numbers, some exclusions were applied to extract relevant articles to the study:

- Only articles in English language,
- Only publications from 2008 to 2021 and
- Only papers that contributes to the SCM and employ AI and DF as the main tool.
- Only papers who used AI techniques.

Table 3 Distribution of results on search engines

Search engine	Scopus	Emerald insight	JSTOR	Wiley	Taylor & francis	Total
Subfields	"Artificial intelligence" And "Demand forecasting"					
Marketing	16	50	5	20	50	**141**
Selected papers	*3*	*5*	*5*	*4*	*2*	***24***
Production	110	50	15	20	50	**245**
Selected papers	*12*	*4*	*15*	*11*	*7*	***57***
Logistics	43	50	2	20	34	**149**
Selected papers	*8*	*10*	*2*	*6*	*3*	***30***
Supply chain	51	50	0	20	44	**165**
Selected papers	*14*	*8*	*0*	*11*	*3*	***43***
Total	**220**	**200**	**22**	**80**	**178**	**700**
Total selected papers	***37***	***27***	***22***	***32***	***15***	***133***

In this section we analyze some of the relevant articles in each business area: Marketing, Production, Logistics and Supply Chain.

In the marketing field, 3 articles (from the Scopus database) discuss mainly the topics: market trends, cellular predictions, and meteorological predictions.

In the market trends domain, Chiu and Chiou (2016) discuss the possibility of developing a technical service planning and a prediction platform to have a unique competitive advantage. Future trends have become a solid strategy to secure a leading position in the production of technologies in the global market. A multi-step approach is proposed to organize the framework of technology services while integrating the advantages that the company holds, and the technology forecast during the development of the platform. Several techniques are implemented by the two authors such as fuzzy algorithms integrating Neural networks. By using these techniques and using market forces and trends the company can meet the needs of existing and potential customers, develop more innovative services that cater to different market segments and achieve economies of scale.

In the cellular network domain, Bogomolov and al. (2016) seek to reduce the energy consumption of cellular data. The authors have proposed a new approach that differs from the past literature that predicts energy consumption based on big data. The approach consists in analyzing the regularities of the source data which then give an overview of the data extraction method, and which helps to set up a regression model applicable to the problems of human consumption of energy and big data. The techniques used by the authors are those of clustering and statistical regression models.

In the production field, 12 papers primarily address the following topics: energy, construction, aviation, food, and gas and oil.

In the energy topic, Boza and al. (2021) examine what AI can offer in managing the “Variable Renewable Energy” (VRE) integration costs. They discussed how AI techniques can create value and what are their benefits in the energy sector. The authors used a VRE integration cost economic model to prepare a systematic review on how substantial integration cost can be decreased using AI techniques. By linking known and existing artificial intelligence solutions such as smart grid, micro grid, artificial neural networks (ANN) or hybrid-based models to integration cost components, the authors were able to improve the economic and commercial viability.

In Aktepe and al. (2021), several techniques were used in a production facility manufacturing spare parts for construction machinery. These methods are: support vector regression linear and nonlinear multiple regression analysis and artificial neural networks. The objective of the study was to predict as closely as possible the number of spare parts required by the customer in the future period.

In the aviation sector, Mobarakeh and al. (2017), explore forecasting methods and estimating strategies, their variations, and AI strategies created for irregular demands. The insight behind is to propose the best strategy variant capable of accurately determining a request that is not only doubtful but also unpredictable. They considered the Boot Strapping (BS) strategy as the most appropriate fundamental strategy for determining questionable and eccentric demands. This strategy has the fundamental capacity to reduce errors due to resampling with substitution. The demand forecasting results are compared to forecasts generated by existing comparative forecasting methods such as: moving average and simple exponential smoothing.

Anifowose and al. (2011) introduced a paper in the field of oil and gas context. They demonstrate that the hybrid model of computational intelligence tool can predict the porosity and permeability. These reservoir properties are very important in the domain of gas and oil. The authors presented a successful hybridization application of three AI techniques which are: Support Vector Machines (SVM), Functional Networks and Type-2 Fuzzy Logic System. These techniques helped in sending high-quality information and producing accurate predictions. The hybrid model helped in better predicting resource assessment and management.

Matsuo and al. (2020), presented a paper on the field of smart automation with a study focusing especially on the process of garlic production. They introduced a robot system using a deep learning model capable of automatically grading and sorting root-trimmed garlics with the help of image analysis. This robot system is armed with a deep convolutional neural network (CNN) predicting the garlic class.

In the supply chain context, we have 14 articles discussing mainly medical health equipment, inventory, systems, and service chain.

In the medical health equipment topic and using a multilayer long-short memory (LSTM) network, Koç and Türkoğlu (2021), introduced a deep model approach. This approach aims to forecast the medical equipment demand and the outbreak spreading during the coronavirus outbreak (COVID-19). The proposed model consists of 3 stages: normalization, deep LSTM networks and dropout-dense-regression layers. First, the authors normalize the process of the daily input data then, they introduce the deep model into a dropout layer and fully connected layer. Finally, to forecast the medical equipment demand and the outbreak spreading of the virus, they used the weight of the trained model.

In the inventory case studies, Jaipuria and al. (2019), proposed a forecasting model to predict and control the demand under uncertainties caused by the Bullwhip effect. The study focused on the analysis of the behavior of the bullwhip effect through the inventory policies. The contribution of the authors is the development of a hybrid forecasting models using and combining intelligent techniques such as the multi-gene genetic programming (MGGP) and the discrete wavelet transformation (DWT)

Amirkolaii and al. (2017) are interested in forecasting demand for irregular demand in business jet spare parts supply chains. They find that the techniques used so far are not very precise such as the smooth and linear pattern in this forecasting activity. Also, many factors have been added to the business jet spare part supply chain, not to mention that mass storage has its limits. The authors therefore focused on the fields of AI to increase forecasting accuracy in the supply chain. They first put all the classical existing techniques into forecasting and then AI techniques. The result of the study is the use of a forecasting model that focuses on the mean square error (MSE) and the neural network (NN) in the spare parts supply chain of planes.

Finally, in the logistic field, 8 articles discuss mainly Distribution and inventory. Bottani and al. (2019), in the distribution context, proposed a framework based on AI to support prediction and decision making in wholesale distribution. They use the artificial neural network (ANN) technique in their study, which aims to anticipate and

forecast retailer demand and derive the selling price of the products offered by the wholesaler. The proposed framework results in reducing the economic losses due to the occurrence of out of stock by more than 56%.
Also, in the inventory topic, Boru and al. (2019) are interested into solving the inventory routing problem (IRP). They created a new hybrid method integrating an artificial intelligence-based and simulation optimization. The goals first, are to minimize the total supply chain cost and to maximize the average service level. Second, with the use of ANN, the authors help refine the order-up-to-level and the reorder point by better forecasting customer demand at each resupply time.

3.4. AI techniques on demand forecasting

In this section, we analyze the AI techniques raised form the literature. 'AI techniques' represents a selection of methodologies, algorithms and models that are used and applied to perform data analysis. A full list of AI approaches drawn from scientific sources is investigated and presented *(Figure 8).*
Finally, we examined the categorization of AI techniques based on the fields: marketing, logistics, production, supply chain management according to the 37 articles analyzed on section above and summarized on *(Figure 9).*

The production and supply chain fields present the biggest variety in terms of AI techniques compared to other domains. This can be explained by the practical nature of these fields due to the real-life case studies, the experimental nature of the problems as well as the significant number of publications in this area. According to the articles selected from the 37 SCOPUS articles, 38% of these articles use an AI technique, 32% use two AI techniques, whether complementary or to compare between techniques, 27% of the articles use several AI techniques and only 3% of articles that discuss AI techniques but use statistical techniques.

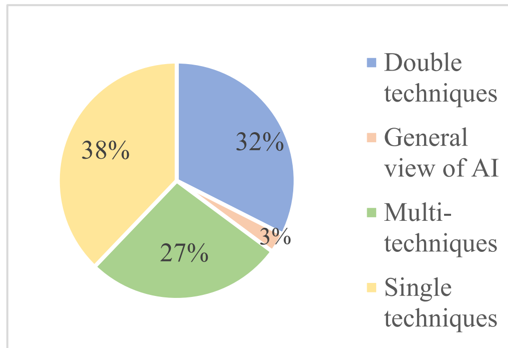

Figure 8 Varieties in terms of AI techniques

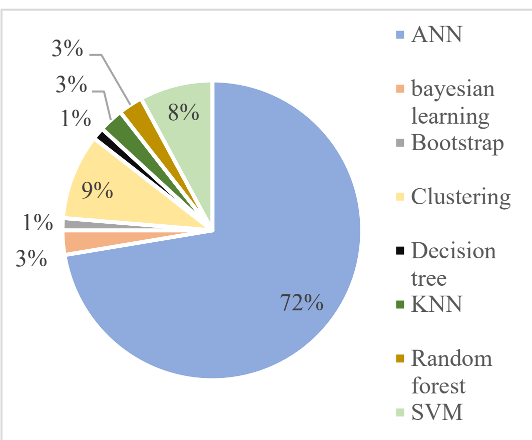

Figure 9 Different AI approaches found in the literature

Figure 9 presents the main AI techniques applied on demand forecasting used in 37 articles in Scopus reseach. It is noted that 72% of techniques used are ANN (Artificial neural networks), followed by 9% of clustering techniques and finally 8% of SVM (support vector machines). The other techniques like bayesian learning, bootstrap, decision tree, KNN (K-nearest neighbors) and random forest are less used on the studies.
To give more details, we have grouped the techniques used in the articles according to the nature of these techniques. The artificial neural network (ANN) is the most frequently used techniques in all areas, mostly in production, supply chain and logistics. We regrouped those techniques on the ANN such as MLP (multiple layer perceptron), Deep LSTM network (multilayer long short-term memory) and RNN (recurrent neural networks). Clustering techniques are more used in logistics and production fields. Finally, support vector machines are less used in all areas but mostly in marketing fields.

For example, in the fields of logistics, Bottani, and al. (2019) use two techniques in the field of distribution which are ANN and multilayer neural networks (MNN) in their study. Bala (2012) uses in the field of distribution two techniques in his study which are neural networks and k-means clustering. Finally, Zambang and al. (2021) use three techniques in their study on the transportation planning process which are SVM and KNN.
In the fields of supply chain, Lima and al. (2020) use multiple techniques in their study related to solar forecasting, which are deep learning, MNN, Support vector regression (SVR) and Multilayer Perceptron. In the field of inventory control, Jaipuria and Mahapatra (2019) use one technique in their study which is multi-gene genetic programming. In the field of electronics, Fu and Chien (2019) use multiple techniques such as Backpropagation algorithms, extreme

learning machines, SVM, recurrent neural networks and KNN. Laosiritaworn (2011) use one technique in his study which is ANN in the field of systems.
In the fields of production, Matsuo and al. (2020) use multiple deep learning techniques such as convolutional neural network (CNN) in the field of Smart automation system. Brahimi (2019) uses two techniques which are ANN and Backpropagation algorithms on his study. Cheng and al. (2016) use one technique in their study which is K-means Chaotic Genetic Algorithm on the field of Biodiesel. Šimunovic and al. (2011) use one technique which is adaptive neuro-fuzzy inference in their study on technology. Anifowose and Abdulraheem (2011) use multiple techniques on their study which are type-2 Fuzzy logic, hybrid computational intelligence and clustering algorithms on the field of oil and gas.
Finally, in the marketing fields, Sudha and Balasubramanian (2016) use multiple techniques such as Naïve Bayes (NB), Bayesian Logistic Regression (BLR), Multi-Layer Perceptron (MLP), Classification and Regression Tree (CART and Random Forest (RF)). Chiu and Chiou (2016) use as well multiple techniques on the field of market trends which are Technology Road Mapping (TRM), radial bias function (RBF), fuzzy algorithms and Neural networks. Finally, Bogomolov et al. (2016) use one technique which is clustering algorithms in the field of cellular network.

Conclusion

This research study presents a systematic literature review that shed the light on AI contributions to demand forecasting in supply chain management.
Based on the five phases research strategy presented in section 2.1., we identified 133 articles among which 37 were selected for analysis. We conducted a distribution by field, type, and year of publication. In fact, we have drawn several AI techniques on 4 targeted sectors of activities: logistics, supply chain, production, and marketing. To classify the papers, we performed a mapping and clustering. It allowed to identify and weight various keywords related to demand forecasting, supply chain, artificial intelligence, and machine learning.
We disclosed 80 AI techniques, some of which are homogeneous and others heterogeneous (see Appendix 1). The top 3 AI techniques raised are ANN, clustering and SVM. These techniques help to better forecast the needs in supply demands across multiple business lines. They contribute to improve efficiency and increase targeting of supply needs. Future research should review relevant publications with the purpose of elaborating the tools and the frameworks that are profitable and advantageous to demand forecasting in supply chain management.

Appendixes

Appendix 1. AI techniques on the four fields studied at 37 articles of scopus

Fields	Areas	AI techniques	study	Articles	years
Logistics	Transportation planning process	Support vector machine	Zambang, M. A. M. ; Jiang, H. ; Wahab, L.	Modeling vehicle ownership with machine learning techniques in the Greater Tamale Area, Ghana	2021
		Linear support vector clasification - Linear SVC			
		K nearest neighbors KNN - ML			
	Ditribution	Artificial neural networks (ANN)	Bottani, E. Centobelli, P. Gallo, M. Kaviani, M. A. Jain, V. Murino, T.	Modelling wholesale distribution operations: an artificial intelligence framework	2019
		Multiple neural networks (MNN)			

	Inventory	Artificial neural networks (ANN)	Boru, A. Dosdoğru, A. T. Göçken, M. Erol, R.	A novel hybrid artificial intelligence based methodology for the inventory routing problem	2019
	Using supermarket data	Artificial neural networks (ANN) Muliple layer perceptron - MLP	Slimani, I. El Farissi, I. Achchab, S.	Configuration and implementation of a daily artificial neural network-based forecasting system using real supermarket data	2017
	Food	General Regression Neural Network (GRNN) Multiple regression Cluster analysis	Pan, W. T.	Mixed modified fruit fly optimization algorithm with general regression neural network to build oil and gold prices forecasting model	2014
	Distribution	Multi-layer perceptron Artificial neural networks (ANN)	Hernández, L. Baladrón, C. Aguiar, J. M. Calavia, L. Carro, B. Belén Sánchez-Esguevillas, A. Pérez, F. Fernández, A. Lloret, J.	Artificial neural network for short-term load forecasting in distribution systems	2014
	Inventory	Neural tree Artificial neural networks (ANN)	Chien, C. F. Hsu, C. Y. Lin, S. C.	Manufacturing Intelligence to Forecast the Customer Order Behavior for Vendor Managed Inventory	2012
	Inventory	Neural networks K- means clustering - clustering custumors	Bala, P. K.	Improving inventory performance with clustering based demand forecasts	2012
Supply chain	Medical (health) equipement	Deep LSTM network - multilayer long short-term memory Dense regression layers - ANN	Koç, E. ; Türkoğlu, M.	Forecasting of medical equipment demand and outbreak spreading based on deep long short-term memory network: the COVID-19 pandemic in Turkey	2021
	Solar forecasting	Deep learning Multilayer neural networks Support vector regression	Lima, M. A. F. B. Carvalho, P. C. M. Fernández-	Improving solar forecasting using Deep Learning and Portfolio Theory integration	2020

		Multilayer Perceptron	Ramírez, L. M. Braga, A. P. S.		
	Sugar cosumption	Neural networks Long Short-Term Memory (LSTM)	Kantasaard, A. ; Bekrar, A. ; Aitelcadi, A. ; Saliez, Y.	Artificial intelligence for forecasting in supply chain management: A case study o White Sugar consumption rate in Thailand	2019
	Inventory control	multi-gene genetic programming (MGGP)	Jaipuria, S. Mahapatra, S. S.	A study on behaviour of bullwhip effect in (R, S) inventory control system considering DWT-MGGP demand forecasting model	2019
	Elecronics	Backpropagation algorithms Extreme Learning machines - RNN Support vector machine Recurent Neural networks K nearest neighbors KNN - ML	Fu, W. Chien, C. F.	UNISON data-driven intermittent demand forecast framework to empower supply chain resilience and an empirical study in electronics distribution	2019
	Heavy Oil reservoirs	Artificial and computational intelligence Clustering algorithms Backpropagation neural networks - BPN Single Layer Perceptron (SLP) - ANN Multilayer Perceptron (MLP) - ANN	Amirian, E. Dejam, M. Chen, Z.	Performance forecasting for polymer flooding in heavy oil reservoirs	2018
	Aircraft manufacture	Neural networks - ANN	Amirkolaii, K. N. Baboli, A. Shahzad, M. K. Tonadre, R.	Demand Forecasting for Irregular Demands in Business Aircraft Spare Parts Supply Chains by using Artificial Intelligence (AI)	2017

	Business environement	Artificial neural networks (ANN) Adaptive network-based fuzzy inference system - ANN Fuzzy inference system - ANN	Singh, L. P. Challa, R. T.	Integrated Forecasting Using the Discrete Wavelet Theory and Artificial Intelligence Techniques to Reduce the Bullwhip Effect in a Supply Chain	2016
	Water demand	Artificial neural networks multi-layer perceptron (MLP) - ANN	Ponte, B. Ruano, L. Pino, R. De Fuentela, D.	The Bullwhip effect in water demand management: Taming it through an artificial neural networks-based system	2015
	Biogas	Artificial neural networks Backpropagation algorithms	Yetilmezsoy, K. Turkdogan, F. I. Temizel, I. Gunay, A.	Development of ann-based models to predict biogas and methane productions in anaerobic treatment of molasses wastewater	2013
	Rice production	Adaptive Neuro Fuzzy Inference System (ANFIS) Modified Regularized Least Squares Fuzzy Support Vector Regression (MRLSFSVR)	Chaudhuri, A.	Forecasting rice production in west Bengal state in India: Statistical vs. computational intelligence techniques	2013
	Systems	Artificial neural networks	Turrado García, F. García Villalba, L. J. Portela, J.	Intelligent system for time series classification using support vector machines applied to supply-chain	2012
	Systems	Artificial neural networks	Laosiritaworn, W. S.	Supply chain forecasting model using computational intelligence techniques	2011
	Methods	Artificial neural networks	Shahrabi, J. Mousavi, S. S. Heydar, M.	Supply chain demand forecasting: A comparison of machine learning techniques and traditional methods	2009

Production	Energy	Artificial neural networks	Boza, P. ; Evgeniou, T.	Artificial intelligence to support the integration of variable renewable energy sources to the power system	2021
	Construction machines	Multiple linear regression Multiple non linear regression Artificial Neural networks Support vector regression	Aktepe, A. ; Yanık, E. ; Ersöz, S.	Demand forecasting application with regression and artificial intelligence methods in a construction machinery company	2021
	Smart automation system	deep convolutional neural network (CNN) Deep neural networks Artificial Neural networks	Matsuo, M. ; Thuyet, D. Q. ; Kobayashi, Y.	A robot system equipped with deep convolutional neural network for autonomous grading and sorting of root-trimmed garlics	2020
	Wind energy	Artificial Neural networks Backpropagation algorithms	Brahimi, T.	Using artificial intelligence to predict wind speed for energy application in Saudi Arabia	2019
	Aviation	Boot Strapping (BS) - mEthode ensemble	Mobarakeh, N. A. Shahzad, M. K. Baboli, A. Tonadre, R.	Improved Forecasts for uncertain and unpredictable Spare Parts Demand in Business Aircraft's with Bootstrap Method	2017
	Biodiesel	K-means Chaotic Genetic Algorithm (KCGA) - clustering	Cheng, M. Y. Prayogo, D. Ju, Y. H. Wu, Y. W. Sutanto, S.	Optimizing mixture properties of biodiesel production using genetic algorithm-based evolutionary support vector machine	2016
	Energy	Random Forest Neural Networks	Jurado, S. Nebot, À Mugica, F. Avellana, N.	Hybrid methodologies for electricity load forecasting: Entropy-based feature selection with machine learning and soft computing techniques	2015

	Electricity	Neural Networks	Lee, S. H. Moon, K. I.	Forecasting and modeling of electricity demand using NARX neural network in smart grid environment	2014
	Energy	neural networks	Donohoo, B. K. Ohlsen, C. Pasricha, S. Xiang, Y. Anderson, C.	Context-aware energy enhancements for smart mobile devices	2014
	Technology	Adaptive neuro-fuzzy inference - ANN	Šimunovic, G. Šaric, T. Svalina, I.	Adaptive neuro-fuzzy inference system model for technological parameters prediction	2011
	Oil and gas	Type-2 Fuzzy logic	Anifowose, F. Abdulraheem, A.	Fuzzy logic-driven and SVM-driven hybrid computational intelligence models applied to oil and gas reservoir characterization	2011
		Hybrid computational intelligence			
		Clustering algorithms			
	Plants	Neural networks	Clara, N.	Neural networks complemented with genetic algorithms and fuzzy systems for predicting nitrogenous effluent variables in wastewater treatment plants	2008
Marketing	meteorogical predictions	Naïve Bayes (NB)	Sudha, M. Balasubramanian, V.	Identifying effective features and classifiers for short term rainfall forecast using rough sets maximum frequency weighted feature reduction technique	2016
		Bayesian Logistic Regression (BLR)			
		Multi-Layer Perceptron (MLP)			
		Classification and Regression Tree (CART)			
		Random Forest (RF)			
	Market trends	Technology Road Mapping (TRM)	Chiu, M. C. Chiou, J. Y.	Technical service platform planning based on a company's	2016

		radial bias function (RBF)		competitive advantage and future market trends: A case study of an IC foundry	
		fuzzy algorithms			
		Neural networks			
	Cellullar network	Clustering algorithms	Bogomolov, A. Lepri, B. Larcher, R. Antonelli, F. Pianesi, F. Pentland, A	Energy consumption prediction using people dynamics derived from cellular network data	2016

Acknowledgements

This research was funded by The Natural Sciences and Engineering Research Council of Canada (NSERC).

References

Aktepe, A., E. Yanık, and S. Ersöz., Demand Forecasting Application with Regression and Artificial Intelligence Methods in a Construction Machinery Company, Article, *Journal of Intelligent Manufacturing*, 2021.

Amirian, E., M. Dejam, and Z. Chen., Performance Forecasting for Polymer Flooding in Heavy Oil Reservoirs, Article, *Fuel,* vol. 216, 2018.

Amirkolaii, K. N., A. Baboli, M. K. Shahzad, and R. Tonadre, Demand Forecasting for Irregular Demands in Business Aircraft Spare Parts Supply Chains by Using Artificial Intelligence (Ai), Article, *IFAC-PapersOnLine* vol. 50, no. 1 2017.

Anifowose, F., and A. Abdulraheem, Fuzzy Logic-Driven and Svm-Driven Hybrid Computational Intelligence Models Applied to Oil and Gas Reservoir Characterization, Article, *Journal of Natural Gas Science and Engineering,* vol. 3, no. 3, 2011.

APICS. (2013). APICS Dictionary - The essentiel supply chain reference (14th ed.).

Arco, M. D., L. L. Presti, V. Marino, and R. Resciniti, Embracing Ai and Big Data in Customer Journey Mapping: From Literature Review to a Theoretical Framework, Article, *Innovative Marketing,*vol. 15, no. 4, 2019.

Bala, P. K., Improving Inventory Performance with Clustering Based Demand Forecasts, Article, *Journal of Modelling in Management* , vol. 7, no. 1, 2012.

Bayrak, M., and Ö Esen., Forecasting Turkey's Energy Demand Using Artificial Neural Networks: Future Projection Based on an Energy Deficit, Article, *Journal of Applied Economic Sciences*, vol. 9, no. 2, 2014.

Bogomolov, A., B. Lepri, R. Larcher, F. Antonelli, F. Pianesi, and A. Pentland., Energy Consumption Prediction Using People Dynamics Derived from Cellular Network Data, Article, *EPJ Data Science,* vol. 5, no. 1, 2016.

Boru, A., A. T. Dosdoğru, M. Göçken, and R. Erol., A Novel Hybrid Artificial Intelligence Based Methodology for the Inventory Routing Problem, Article, *Symmetry* ,vol. 11, no. 5, 2019.

Bottani, E., P. Centobelli, M. Gallo, M. A. Kaviani, V. Jain, and T. Murino., Modelling Wholesale Distribution Operations: An Artificial Intelligence Framework, Article, *Industrial Management and Data Systems*, vol. 19, no. 4 , 2019.

Boza, P., and T. Evgeniou., Artificial Intelligence to Support the Integration of Variable Renewable Energy Sources to the Power System, Article, *Applied Energy* Vol. 290, 2021.

Brahimi, T., Using Artificial Intelligence to Predict Wind Speed for Energy Application in Saudi Arabia, Article, *Energies,* vol. 12, no. 24, 2019.

Cheng, M. Y., D. Prayogo, Y. H. Ju, Y. W. Wu, and S. Sutanto, Optimizing Mixture Properties of Biodiesel Production Using Genetic Algorithm-Based Evolutionary Support Vector Machine, Article, *International Journal of Green Energy*, vol. 13, no. 15, 2016.

Chien, C. F., C. Y. Hsu, and S. C. Lin., Manufacturing Intelligence to Forecast the Customer Order Behavior for Vendor Managed Inventory. Vol. 16. *Smart Innovation, Systems and Technologies*, 2012.

Chiu, M. C., and J. Y. Chiou., Technical Service Platform Planning Based on a Company's Competitive Advantage and Future Market Trends: A Case Study of an Ic Foundry, Article, *Computers and Industrial Engineering*, vol. 99, 2016.

Chopra, Ashok., AI in supply & procurement, *2019 Amity International Conference on Artificial Intelligence (AICAI)*. IEEE, 2019.

Clara, N., Neural Networks Complemented with Genetic Algorithms and Fuzzy Systems for Predicting Nitrogenous Effluent Variables in Wastewater Treatment Plants, Article, *WSEAS Transactions on Systems*, vol. 7, no. 6, 2008.

Dellino, G., T. Laudadio, R. Mari, N. Mastronardi, and C. Meloni., A Reliable Decision Support System for Fresh Food Supply Chain Management, Article, *International Journal of Production Research*, vol. 56, no. 4, 2018.

Ding, J., M. Wang, Z. Ping, D. Fu, and V. S. Vassiliadis, An Integrated Method Based on Relevance Vector Machine for Short-Term Load Forecasting, Article, *European Journal of Operational Research* vol. 287, no. 2, 2020.

Donohoo, B. K., C. Ohlsen, S. Pasricha, Y. Xiang, and C. Anderson, Context-Aware Energy Enhancements for Smart Mobile Devices, Article, *IEEE Transactions on Mobile Computing*, vol.13, no. 8, 2014.

Fu, W., and C. F. Chien., Unison Data-Driven Intermittent Demand Forecast Framework to Empower Supply Chain Resilience and an Empirical Study in Electronics Distribution, Article, *Computers and Industrial Engineering*, vol. 135, 2019.

Hernández, L., C. Baladrón, J. M. Aguiar, L. Calavia, B. Belén Carro, A. Sánchez-Esguevillas, F. Pérez, A. Fernández, and J. Lloret., Artificial Neural Network for Short-Term Load Forecasting in Distribution Systems, Article, *Energies,* vol. 7, no. 3, 2014.

Huang, H. C., A Study on Artificial Intelligence Forecasting of Resort Demand, Article, *Journal of Theoretical and Applied Information Technology*, vol. 70, no. 2, 2014.

Jaipuria, S., and S. S. Mahapatra., A Study on Behaviour of Bullwhip Effect in (R, S) Inventory Control System Considering Dwt-Mggp Demand Forecasting Model, Article, *Journal of Modelling in Management*, vol. 14, no. 2, 2019.

Jindal, R., R. Malhotra, and A. Jain., Prediction of Defect Severity by Mining Software Project Reports, Article, *International Journal of Systems Assurance Engineering and Management*, vol. 8, no. 2, 2017.

Jurado, S., À Nebot, F. Mugica, and N. Avellana., Hybrid Methodologies for Electricity Load Forecasting: Entropy-Based Feature Selection with Machine Learning and Soft Computing Techniques, Article, *Energy*, vol. 86, 2015.

Kalieva, O. M, and N. V. Karelin., Marketing Management in Urban Passenger Transportation Innovations, Article, *International Journal of Economics and Business Administration*, vol. 7, 2019.

Kantasaard, A., A. Bekrar, A. Aitelcadi, and Y. Saliez., Artificial Intelligence for Forecasting in Supply Chain Management: A Case Study O White Sugar Consumption Rate in Thailand, Article, vol. 52, no. 13, 2019.

Koç, E., and M. Türkoğlu., Forecasting of Medical Equipment Demand and Outbreak Spreading Based on Deep Long Short-Term Memory Network: The Covid-19 Pandemic in Turkey, Article, 2021.

Laosiritaworn, W. S., Supply Chain Forecasting Model Using Computational Intelligence Techniques, Article, *Chiang Mai University Journal of Natural Sciences*, vol. 10, no.1, 2011.

Lavoie, M., A Decision Support System to Deal with the Medical Isotopes Crisis, Article, *Technology in Society*, vol. 32, no. 3, 2010.

Lee, S. H., and K. I. Moon., Forecasting and Modeling of Electricity Demand Using Narx Neural Network in Smart Grid Environment, Article, *Information (Japan)*, vol. 17, no. 12B, 2014.

Lima, M. A. F. B., P. C. M. Carvalho, L. M. Fernández-Ramírez, and A. P. S. Braga., Improving Solar Forecasting Using Deep Learning and Portfolio Theory Integration, Article, *Energy*, vol. 95, 2020.

López Lázaro, J., Á Barbero Jiménez, and A. Takeda., Improving Cash Logistics in Bank Branches by Coupling Machine Learning and Robust Optimization, Article, *Expert Systems with Applications*, vol. 92, 2018.

Martín, A., and J. R. Trapero., Recursive Estimation Methods to Forecast Short-Term Solar Irradiation, Vol. 34. *Handbook of Environmental Chemistry*, 2016.

Mobarakeh, N. A., M. K. Shahzad, A. Baboli, and R. Tonadre., Improved Forecasts for Uncertain and Unpredictable Spare Parts Demand in Business Aircraft's with Bootstrap Method, Article, *IFAC-PapersOnLine* vol. 50, no. 1, 2017.

Nikolopoulos, K. I., M. Z. Babai, and K. Bozos., Forecasting Supply Chain Sporadic Demand with Nearest Neighbor Approaches, Article, *International Journal of Production Economics*, vol. 177, 2016.

Nita, S., Application of Big Data Technology in Support of Food Manufacturers' Commodity Demand Forecasting, Article, *NEC Technical Journal*, vol. 10, no. 1, 2015.

O'Donnell, T., P. Humphreys, R. McIvor, and L. Maguire., Reducing the Negative Effects of Sales Promotions in Supply Chains Using Genetic Algorithms, Article, *Expert Systems with Applications*, vol. 36, no. 4, 2009.

Pan, W. T., Mixed Modified Fruit Fly Optimization Algorithm with General Regression Neural Network to Build Oil and Gold Prices Forecasting Model, Article, vol. 43, no. 7, 2014.

Ponte, B., L. Ruano, R. Pino, and D. De Fuentela., The Bullwhip Effect in Water Demand Management: Taming It through an Artificial Neural Networks-Based System, Article, *Journal of Water Supply: Research and Technology - AQUA* ,vol. 64, no. 3, 2015.

Ribeiro, João Pires, and Ana Barbosa-Povoa., Supply Chain Resilience: Definitions and quantitative modelling approaches–A literature review., *Computers & Industrial Engineering,* vol. 115, 2018.

Shahrabi, J., S. S. Mousavi, and M. Heydar., Supply Chain Demand Forecasting: A Comparison of Machine Learning Techniques and Traditional Methods, Article, *Journal of Applied Sciences*, vol. 9, no. 3, 2009.

Simchi-Levi, D., and M. X. Wu., Powering Retailers' Digitization through Analytics and Automation, Article, *International Journal of Production Research,* vol. 56, no. 1-2, 2018.

Šimunovic, G., T. Šaric, and I. Svalina., Adaptive Neuro-Fuzzy Inference System Model for Technological Parameters Prediction, vol. 53, no. 4, 2011.

Singh, L. P., and R. T. Challa., Integrated Forecasting Using the Discrete Wavelet Theory and Artificial Intelligence Techniques to Reduce the Bullwhip Effect in a Supply Chain, Article, *Global Journal of Flexible Systems Management*, vol. 17, no. 2, 2016.

Slimani, I., I. El Farissi, and S. Achchab., Application of Game Theory and Neural Network to Study the Behavioral Probabilities in Supply Chain, Article, *Journal of Theoretical and Applied Information Technology*, vol. 82, no. 3, 2015.

Slimani, I., I. El Farissi, and S. Achchab., Configuration and Implementation of a Daily Artificial Neural Network-Based Forecasting System Using Real Supermarket Data, Article, *International Journal of Logistics Systems and Management*, vol. 28, no. 2, 2017.

Stubbings, P., B. Virginas, G. Owusu, and C. Voudouris., Modular Neural Networks for Recursive Collaborative Forecasting in the Service Chain, Article, *Knowledge-Based Systems*, vol. 21, no. 6, 2008.

Sudha, M., and V. Balasubramanian., Identifying Effective Features and Classifiers for Short Term Rainfall Forecast Using Rough Sets Maximum Frequency Weighted Feature Reduction Technique, Article, *Journal of Computing and Information Technology*, vol. 24, no. 2, 2016.

Tanaka, K., H. Akimoto, and M. Inoue, Production Risk Management System with Demand Probability Distribution, Article, *Advanced Engineering Informatics*, vol. 26, no. 1, 2012.

Thuyet, D. Q., Y. Kobayashi, and M. Matsuo., A Robot System Equipped with Deep Convolutional Neural Network for Autonomous Grading and Sorting of Root-Trimmed Garlics, Article, *Computers and Electronics in Agriculture*, vol. 178, 2020.

Turrado García, F., L. J. García Villalba, and J. Portela., Intelligent System for Time Series Classification Using Support Vector Machines Applied to Supply-Chain, Article, *Expert Systems with Applications*, vol. 39, no. 12, 2012.

Warren Liao, T., and P. C. Chang., Impacts of Forecast, Inventory Policy, and Lead Time on Supply Chain Inventorya Numerical Study, Article, *International Journal of Production Economics*, vol. 128, no. 2, 2010.

Yetilmezsoy, K., F. I. Turkdogan, I. Temizel, and A. Gunay, Development of Ann-Based Models to Predict Biogas and Methane Productions in Anaerobic Treatment of Molasses Wastewater, Article, *International Journal of Green Energy*, vol. 10, no. 9, 2013.

Yosif Abidalreda, N., and B. Z. Hasan Al-Sammarraie, Using the Techniques of Scheduling the Production Processes and Supply Chain Management in the Foggy Environment; Applied Research of the Electronic Production Plant at Al - Zawra General Company - Iraq, Article, *International Journal of Supply Chain Management*, vol. 8, no. 1, 2019.

Zambang, M. A. M., H. Jiang, and L. Wahab, Modeling Vehicle Ownership with Machine Learning Techniques in the Greater Tamale Area, Ghana, Article, *PLoS ONE*, vol. 16, no. 2, 2021.

Zhu, X., G. Zhang, and B. Sun, A Comprehensive Literature Review of the Demand Forecasting Methods of Emergency Resources from the Perspective of Artificial Intelligence, Article, *Natural Hazards*, vol. 97, no. 1, 2019.

Biography

Saad El Marjani holds a MSC degree in audit and management control, from ENCG (Ecole Nationale de Commerce et de Gestion - Fèz Morocco). He is completing an MSC in Project Management at Université du Québec à Rimouski (UQAR) - Lévis campus. He is carrying out an end of program research that will focus on the digitization of planning processes for resources and supplies in project management by introducing artificial intelligence techniques.

Safae Er-Rbib holds a Ph.D. in operations research from Polytechnique de Montréal. She is currently a postdoctoral researcher at Université du Québec à Rimouski (UQAR) at Lévis campus. She is interested in optimization problems, AI and machine learning techniques, and supply chain risk management which presents her last research project. Dr. Er-Rbib has been co-supervising graduate students in academic research projects. Dr. Er-Rbib earned as well a M.Sc.A in applied mathematics from Polytechnique de Montréal and an industrial engineering degree from AIAC (Académie international de l'Aviation Civile - Casablanca Morocco)

Dr. Loubna BENABBOU is a Professor of Management Sciences at Université du Québec à Rimouski (UQAR) at Lévis campus. Her research work lies in the application of decision/ management sciences and machine learning techniques to transform data for making better decisions and improving operational processes. Dr. Benabbou has been supervising several undergraduate and graduate students in projects for different Industries related to the areas of Decision Sciences, Machine Learning and Operations Management. Her research related to these fields has been published in international scientific journals and conferences' proceedings. Dr. Benabbou is an industrial engineer from EMI School of Engineering; she earned an MBA and Ph.D. in Management and Decision Sciences from Laval University.