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Applications of Machine Learning Techniques in Supply Chain Management.

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Abstract: supply chains are network of facilities which consists of various entities in its network. These entities need to work together to reduce the total costing of supply chain. These paper consists of application of machine learning techniques in supply chain management. It consists of cases of supply chain management such as demand forecasting, supply forecasting, text analytics, price panning and more to enhance their processes, reduce costs and risk, and increase revenue. It gives us a précis about all the important aspects of economy and how to understand and use them wisely.

Keywords – supply, management, costs, revenue, techniques.

I. INTRODUCTION

Supply Chains are the network of facilities that not only includes retailers, distributors, transporters, manufacturers but also the customers. Therefore, it is vital to understand the important consumption and wishes of the purchasers as they are the prime nodal of each supply chain as they push various entities to supply and distribute. The availability chain facilities have now learned the importance of collaboration and coordination to fulfil the real demand. The entities also work cohesively to lower down the total cost of the supply chain. However, in the absence of such collaborations; a mismatch between the important and ideal world of supply chain networks occurs. The gap arises thanks to the varied known and unknown factors. Reasons for such gaps as: alignment of business interests, long term relationship management, reluctance to share information, complexity of large-scale supply chain management, competence of personnel supporting supply chain management, performance management and incentive systems to support supply chain management. With the advancement of e-business and therefore the existence of technology to become more agile and dynamic; the firms are restrictive to have long-term relationships. Another reason could be not knowing the real demand of the purchasers and producing more in anticipation of the demand. The normal way of knowing and forecasting the demand of their own entity is now overtaken by new techniques of Machine Learning Models. Supply chains are very complex and challenging in nature with various functions like purchasing, contracts, procurement, warehousing, production, packaging, transportation or distribution and hence consumption. Each function is complex and collaboration of all these functions therefore require much human effort along with time and cost. It is vital to include the techniques that give quick answers to complex situations. Earlier small decisions like, delivery of product to the customer used to take a long time but with the advent of Artificial Intelligence and machine learning techniques; this has now become easier and the product can be delivered within 24 hours. This study reviews various cases where Machine Learning Techniques are getting used currently and therefore the future directions of these techniques in Supply Chain Management.

II. Brief Sketch of Machine Learning Algorithms

Machine learning cares with empowering the PC programs to improve their performance at tasks through experience. Because of the complexity SC is challenging and hence its solutions can dwell machine learning techniques. However, little has been published about the utilization of machine-learning techniques within the SC domain. This section discusses several machine-learning techniques and examines applications during which they need been successfully deployed. Machine Learning Techniques are classified into three categories and every category is powerful which will be implemented as per the need of industry. These are stated as: Supervised Learning: Supervised Learning is that the technique where the pattern is recognized consistent with some past data and these patterns then support the future predictions. Past data is in pairs as input and output and predicts the longer-term value. The idea is to learn from the past trend provided by human operators and predict the future. These techniques are generally utilized in automated manufacturing like cars, trucks, chatbots, face recognition etc. Supervised learning

again various techniques like Naïve Bayes Classifier Algorithm, Support Vector Machine Algorithm, regression, Logistic Regression, Decision Trees, and random Forests. Reinforcement Learning: Reinforcement learning focuses on regimented learning processes, where a machine learning algorithm is given a group of actions, parameters and end values. By defining the principles, the machine learning algorithm then tries to explore different options and possibilities, monitoring and evaluating each result to determine which one is optimal. Reinforcement learning teaches the machine trial and error. It learns from experiences and begins to adapt its approach in response to things to realize the simplest possible result. Unsupervised Learning: Here there are no human operator to supply instructions. The learning algorithm itself recognizes patterns and groups them accordingly. Segmenting the info into groups and performing the analysis. Under the umbrella of unsupervised learning, fall. Clustering: Clustering involves grouping sets of comparable data (based on defined criteria). It's useful for segmenting data into several groups and performing analysis on each data set to seek out patterns.

Dimension Reduction: Dimension reduction reduces the number of variables being considered to seek out the precise information required. Some famous Machine Learning techniques utilized in Supply Chains are described as under.

III. Neural networks

As the name says Neural Networks, the technique is inspired by the way neurons work in our brain. Like the neurons are connected through links in the form of nodes in a brain, similarly the technique works, where the nodes (or neurons) pass signals through edges (or links) to other nodes during a highly complex network and hence draw a conclusion. There is a spread of neural network techniques, but most common is feed- forward error back-propagation, where each neuron receives an input because the weighted sum of the output of the neurons connected to it. The technique assumes that the network is described as layers of neurons called input layers, hidden layers and output layers. These layers are adjusted within the sense that output signals from the neurons are received by neurons of the subsequent the minimum number of layers are often two. One input and other output layer. And this is how the signals are passed in the whole network in forward direction. The complexity increases when the hidden layer between input and out layer takes part. The hidden layer increases the computational power though. Decision Trees & Random Forests Decision Trees are a bit like graphs within the sort of trees. The decision tree consists of nodes and branches. The nodes are again of two types' viz. chance node or decision nodes. The chance nodes show what alternatives are in hand of a decision maker while on decision nodes the decision makers must take some decision. The branches emanating from chance nodes show various states of nature and probabilities are related to the prospect branches while branches from decision nodes show various alternatives in hand. There are two main sorts of Decision Trees viz. classification trees and regression trees. In the classification tree, the variable is categorical in nature while in regression the variable is continuous in nature. Random forests are the forests of decision trees that are again used for both classification and regression tasks. It runs efficiently in large databases. Forrest is that the collection of decision trees and therefore the idea behind the techniques is that due to the continually sampling the data that is with replacement, some trees are replaced, and a few aren't. The sample will have training set with growing decision trees and provides the simplest option within the end i.e., the tree with the low error rate provides the simplest. Support Vector Machines Support Vector Machines (SVMs) are a more modern sort of universal function approximates that are supported the structural risk minimization principle from statistical learning theory as against the empirical risk minimization principle on which neural networks and rectilinear regression, to call a couple of, are based. The objective of structural risk minimization is to scale back truth error on an unseen and randomly selected test example as against NN and MLR, which minimize the error for the currently seen examples. Support vector machines project the data into a better dimensional space and maximize the margins between classes or minimize the error margin for regression. Margins are ''soft'', meaning that a solution are often found albeit there are contradicting examples within the training set. The problem is formulated as a convex optimization with no local minima, thus providing a singular solution as against back- propagation neural networks, which may have multiple local minima and thus cannot guarantee that the worldwide minimum error is going to be achieved. A complexity parameter permits the adjustment of the number of errors versus the model complexity, and different kernels, such as the Radial Basis Function (RBF) kernel, are often wont to permit non-linear mapping into the upper dimensional space.

IV. Machine learning Adoption and Cases

Machine Learning techniques are getting the necessity of the industry thanks to its smarter ways to grow revenue, and saving time in solving complex problems. One of the best uses of Machine learning in Supply Chain is predicting the longer-term demand of the customer. According to a study by McKinsey Global Institute, marketing and sales have a major impact of new technologies of Machine Learning and deep learning and these areas are benefitted the most. According to one among the reports by Forbes "61% of organizations picked machine learning as their company's most vital data initiative for next year." Few and vital areas of Supply Chain alongside applications where Machine learning algorithms are currently in use are following

- ML based demand and sales forecasting
- Personalized product recommendations
- Price and promotion recommendations to optimize markups and margins
- Inventory optimization with correct stock levels
- Logistics planning workbench and warehouse throughput optimization
- Build a 360° view of consumers
- Consumer insights (sentiment analysis/preferences/social listening) using cognitive services
- Shop-floor yield optimization
- Predictive equipment maintenance in factories
- Predictive lead scoring to enhance lead qualification, prioritization, and acquisition

1. Predictive Analytics for Demand Forecasting

Retail Chain Forecast the case is a few chains (RC) of a furniture company whose forecasts are based on buying behavior and weather conditions. The company predicted the everyday demand for various models showcased in one of their brick-and-mortar stores. The models include various parameters to work out the sales pattern like, date and time of purchase, number of things purchased. By using different ML models, the firm is now ready to learn the pattern of the buying behavior and seasonality in the data. The firm observed that there is a rise in sales during the vacation season. The sales also increase or decrease according to the weather of the day and news events i.e., there is a correlation between the two. Due to the curated weather (such as temperature, rainfall levels for a city, data of mergers and acquisitions) and economic time-series data set the firm has now begun to recognize the cause- and-effect relationship for predicting future demand.

2. Best Routing Option

A company that deals in energy management, automation solutions, spanning hardware, software, and services wanted to scale back the prices involved in their existing supply chain flows for 240 manufacturing facilities round the world and 110 distribution centers and analyze potential opportunities to assimilate new business units that they had just acquired. The firm built a supply chain predictive model that could automatically create the best routing options for an enormous raw materials supply chain which incorporates circuit breakers that are sufficiently small to fit on a store shelf to transformers that are the dimensions of an outsized room. They used Machine Learning models to feed data of enterprise supply chain data like transportation rates and policies, data regarding product shipping routes etc. from several business units. Data engineers initially built a knowledge extraction tool that could collect the enterprise data from all the ERP systems, verify and 'clean' the data. The customized model analyzed 200,000 transportation policy data points, 130,000 flow and routing constraints, and quite 150 initial scenarios and could identify $9.32 million (8 million Euros) in annual savings which could potentially be obtained by altering product flow within the supply chain.

3. AI for Warehouse Management

Automated guided vehicles (AGVs) are operating in industrial environments since the 1950s, and until recently were largely incapable of autonomous navigation without physical path guiding mechanisms like wires, tracks, or magnetic tapes. With incremental improvements in AI and navigation technologies like simultaneous localization and mapping, and machine vision, AGVs can enable automated material handling across traditional manufacturing boundaries by moving between buildings. Today's AGVs have the potential of being made relatively more autonomous by integrating them with data from existing warehouse management and control systems through a connecting software layer called warehouse execution systems (WES). WES uses AI to make existing logistical systems more efficient over time, and many of the top AGV players have made clear strategic decisions towards acquiring WES capabilities. We discuss some use-cases of a number of the highest AGV manufacturers using AI to offer WES services. A reputed firm created its own WES supported Distribution Science Its platform can aid warehouse management operations in identifying the most-efficient picking density for warehouse robots or in optimizing the order-release workflow. The case is studied by apparel retail manufacturers to support their retail store fulfilment (replacing items in stores) by using WES. WES was used to develop a distribution canter to replenish products in 3,900 retail stores. The apparel retailer needed to vary their store fulfilment operations for eight individual store brands into one distribution center which meant that the distribution canter needed to possess a high density of storage and simultaneously ensure speedy product replenishment. WES was wont to optimize operational processes for the entire distribution center right from order receiving (from data within the client's ERP systems) to shipping and scheduling (with data from the WMS). The company claims that the retail store replenishment system helped the retailer to accommodate up to 600,000 pieces per day replenished in their stores which was about the required demand for replenishment of all eight brands (including peak conditions). Also, their system reduced processing costs and expanded storage capacity.

4. Procurement with Artificial Intelligence

The most convenient way of seeing how revolutionized procurement has become is through application like Amazon's Alexa, where after the order has been placed, the processes thereafter are in automation — from the instant procurement buyers delegating the supplier communications to virtual assistants or chatbots, to the system responding to any requests thats associated with transactions, procurement, spend, payment, etc., and stretching to the choice to purchase and/or making a re-order. When invoices are submitted late, the AI system may trigger an online look for red flags which will indicate internal problems on the supplier- end. In spend analytics, the system will be able to cross-check every single invoice that's entered, rapidly flag-up any errors or inconsistencies, and immediately alert the appropriate persons on both sides of the order, where it might usually take days if processed manually.

5. AI using Chatbots

A firm that has launched a chatbot, which can open conversational interfaces between human operators and sales/marketing automation services like SAP's Salesforce. Was utilized in the beverages industry for procurement management. Beverages manufacturers used to require employees to call help-desk operators to get information about their procurement needs. In most cases, that meant a forced waiting time to retrieve the knowledge. The chatbot solution, unrolled to employees and therefore the suppliers, reportedly was then ready to provide answers to queries regarding order and shipment status, stock availability, stock prices, supplier status and contract details.

6. Optimization of a Truck-drone in Tandem Delivery Network

Herein, the minimal time of delivery utilizing K-means clustering to seek out launch locations, also as a genetic algorithm are used to solve the truck route as a traveling salesman problem (TSP). The optimal solution is set by finding the minimum cost related to the parabolic convex cost function. To evaluate the launch locations and finding the optimal min-cost K-means algorithms are used while a genetic algorithm is used to determine truck route. It is concluded that standalone systems don't provide satisfactory results as against in-tandem delivery efforts.

7. 10 cases for Machine Learning in Supply Chain

Supply chains across the planet are adopting Machine Learning to enhance their processes, reduce costs and risk, and increase revenue. Here are 10 ways that you can leverage the facility of ML in your supply chain.

1. Demand Forecasting — Let AI remove the guesswork in forecasting and avoid supply chain surprises. Leverage AI to manage complex and unpredictable fluctuations in demand volumes.

2. Supply forecasting — based on supplier commitments and lead times, the bills of fabric and PO's data are often structured, and accurate predictions can be made for supply forecasts. Balance your demand and transform your business must span the whole value chain.

3. Text Analytics — Data are often cleansed with text analytics to drive better decisions. Text analytics are often implemented with supply data, partner data, or shipment data to derive better insights from the availability chain.

4. Price Planning — Leverage ML to optimize the increase or decrease in product prices supported demand trends, product lifecycles, also as stacking products with the competition.

5. Inventory Planning — Automatically raise POs with suppliers based on shortages or future demand shortages by predicting both demand and supply to form sure you have got the proper products at the proper time but are not overspending for excess inventory.

6. Inventory Price Balancing — ML can recommend products that are in excess and automatically reduce prices to clear inventory accordingly. ML uses historical data like past buying patterns to recommend products supported inventory positions.

7. Stock Analytics – supported multiple structured and unstructured datasets, machines can now predict the reason for out-of-stock items or when those items will run out of stock more accurately than ever before so as that you simply can plan shipments and delivery accordingly.

8. Exception Analytics – Stock-outs at every level within the supply chain are often predicted. Understanding the idea explanation for stock outs and predicting accurate demand trends with better lead times from suppliers to scale back stock-outs.

9. Component Level Analytics – Plan your supply on a component level with dynamic replenishment supported staple planning.

10. Production Planning – Leverage IoT sensors and production automation mechanics to increase/decrease products and increase quality supported real-time customer feedback.

CHALLENGES IN SUPPLY CHAIN MANAGEMENT

The supply chain frequently changes. Hence, there evolves a requirement for meeting the new demands within maintaining a smooth sailing flow. Overall, supply chain management can potentially face several challenges such as:

- Fluctuation in demand
- Inadequate inventory planning
- Backlogs of orders
- Uncertainties in logistics
- Communication gaps within the availability chain
- Shortages in supply

At times, it is often difficult to affect the supply chain challenges and ensure the business goals are realized consistent with schedule. Advanced technologies like machine learning as a branch of AI are the optimal solution in addressing these business issues across various industries. However, it is vital to know that though Machine Learning is flexible, it is not a general purpose solution which can be utilized altogether data. Instead, machine learning can only successfully add cooperation with skilled data scientists and business leaders for accurate data selection and validation.

SUPPLY CHAIN APPLICATIONS IMPACTED BY MACHINE LEARNING

In keeping a business successful and profitable, it's necessary to form sure that challenges and problems within the availability chain are addressed and solved during a quick manner, mistakes are avoided, future opportunities are predicted as accurately as possible. Implementing AI and machine learning algorithms within the availability chain for your business proves to be successful within the subsequent cases. Transportation Management - Companies actively acquire Transportation Management Systems to plug freight savings and provide a more competitive service while determining the impact on performance. Machine learning gives companies the prospect to access the doubtless insightful data and spot the solution to the questions concerning the company's performance:

- Do service level standards meet in terms of delivery and schedule?
- That lanes square measure associated with a lot of delays among the service?
- What square measure the stops that cause delays to shipments?

Having all this info, the company will realize solutions to conflicts among the future as machine learning promotes high service levels and the way higher understanding for shippers on the thanks to deliver results expeditiously.

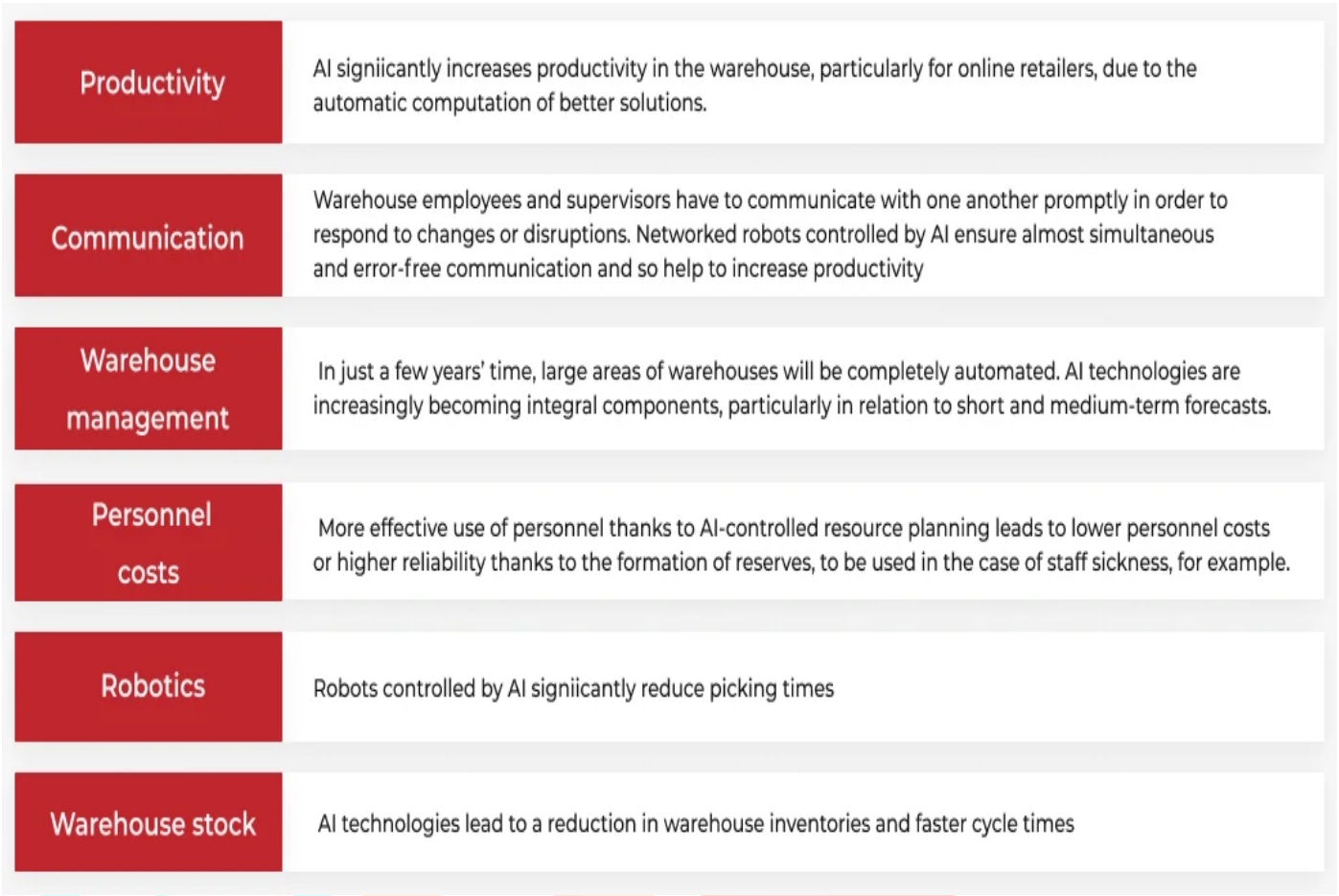
Warehouse Management – Machine learning provides a lot of correct inventory management that helps predict the demand for growth and its drops. Machine learning is used in warehouse optimization aiding among the detection of excesses and shortages of stocks in your store on time. This can be essential in preventing sales losses due to the ability to pinpoint acquainted patterns, inspect storage, and check the inventory each currently then throughout a lot of correct approach. Supply Chain coming up with – victimization machine learning in offer chain coming up with makes decision-making processes optimized through the appliance of AI algorithms from analyzing huge knowledge sets. It results in making certain wider planning practicality, manufacturing correct results, and creating it a powerfully reliable tool in your business.

Demand Prediction – Machine learning-powered demand prediction algorithm provides a lot of improved demand prognostication operate. By analyzing client behavior tendencies, businesses will simply match potential shopping for habits and form the client portfolio with preciseness. With predictive analytics among the provision chain, businesses square measure able to management manufacturing and provision among the bar of offer shortages and excesses.

Logistics Route optimization – it is vital to incorporate machine learning for route optimization that analyses existing routes for quicker delivery of products. Facultative this operate conjointly prevents delays in delivery and helps enhance client satisfaction. Workforce coming up with – By victimization existing production knowledge, machine learning is capable of creating a lot of acceptable surroundings which can naturally regulate to various condition changes within the future. It's applicable in enlisting, retention, worker development, and performance management. Automation of the processes in gathering knowledge, creating inferences, and generating ready-to-use insights square measure usually done once machine Learning is used in workforce management. Thus, managers get reliable tools for increasing the overall men performance.

End-to-End Visibility – Machine learning algorithms play a key role in providing end-to-end visibility from suppliers and manufacturers to stores and customers and eliminating the chance of conflicts as a result of the technology will accurately determine inefficiencies that require a direct response. There is a huge quantity of data concerned an honest network of IoT sensors in combination with advanced analytics. With the use of machine learning to analyze this knowledge, hidden interconnections between numerous processes in supply chain management square measure usually discovered while not fail.

Security of supply Chain – it is vital to possess sensible and complex Security for your company to avoid outlawed infiltrations which can hurt knowledge within the provision chain. Machine learning algorithms square measure capable of evaluating risk factors by merely victimization knowledge of those UN agency attempt to access info, what quite info they are attempting to access, and from what quite environment the request is returning from. If your offer chain is secured with this technology, an information privacy breach is prevented.



AI and Machine learning will have impacts on the following areas in particular

V. A Gist of Future Use-Cases

Machine Learning and its core constructs area unit ideally fitted to providing insights into up provide chain management performance not accessible from previous technologies. Combining the strengths of unsupervised learning, supervised learning and reinforcement learning, machine learning is proving to be a really effective technology that regularly seeks to search out key factors most affecting provide chain performance. Compiled area unit the key functions of artificial intelligence applications that area unit presently commencing to be commercialized or under analysis trials.

Non-linear prediction ways area unit won't to predict the behavior of systems like in tie up foretelling. Management functions of AI are also getting used at road intersections and route steerage. Pattern recognition are helpful in knowing the behavior of client and its desires and automatic incident detection. The employment of machine learning techniques are going to be regularly increasing with the appearance of additional advancement in provide Chain and also the coordination of entities would be additional helpful.

VI. Conclusion

Due to the world connect and because the times and area unit dynamic are changing, stiff competition and rivalry among organizations area unit increasing. Technological advancement is occurring at associate degree exponential rate and companies' area unit sport for growth and revenue generation. We are able to see in several sectors; artificial intelligence is adopted to meet difficult tasks. Companies' area unit currently adopting automation in each field to try up human and machine operating. Withal, the evolution of AI can become additional sophisticated than it already is, and this flip of events can intensify the collaboration of human & AI to a fair larger height wherever it might translate to something ground-breaking not solely in provide chain, however conjointly different vital sectors likewise.

Machine learning could be a crucial tool in provide chains because it permits computing models to regulate to sure conditions, changes, and developments during a business atmosphere with the power to boost on its own over time. Aside from that, machine learning algorithms discover new patterns in provide chain data with little or no manual interference whereas still providing correct information and prediction that helps the business. By exploitation machine learning technology and incorporating it, provide chains area unit conferred with improved accuracy in numerous branches of their business-like provision, operations, planning, and hands.

VII. References

1. Gunasegaram, A., 2004. Supply chain management: Theory and applications. European Journal of Operational Research 159(2), 265–268.

2. Herbrich, R., Keilbach, M.T., Graepel, P.B.-S., Obermayer, K., 2000. Neural networks in economics: Background, applications and new developments. Advances in Computational Economics: Computational Techniques for Modeling Learning in Economics 11, 169–196.

3. Pelckmans, K., Suykens, J.A.K., Van Gestel, T., De Brabanter, J., Lukas, L., Hamers, B., De Moor, B., Vandewalle, J., 2002.

4. Marr, Marr. & quot; A Short History of Machine Learning - Every Manager Should Read" Forbes. Retrieved 28 Sep 2016.

5. Leon, S. (2017) 'Integrating the Chatbot'. Retrieved from: https://www.capgemini.com, accessed on 15/09/2017.

6. Bhardwaj, R. (2018) 'AI in Transportation – Current and Future Business Use Applications' https://www.techemergence.com/ last accessed on 28/11/2018.

7. Bhardwaj, R. (2018) 'Artificial Intelligence in Supply Chain Management – Current Possibilities and Applications' https://www.techemergence.com/ last accessed on 28/11/2018.

8. https://www.techemergence.com/cognitive-procurement-enterprise.

9. https://www.visionetsystems.com/blog/where-to-apply-machine-learningsup ply-chain- optimization.

10. https://www.forbes.com/sites/louiscolumbus/2018/06/11/10-ways-machinel earning-is- revolutionizing-supply-chain-management/#641245933e37.

11. Pham, D.T, A.A. Afify, Machine-learning techniques and their applications in manufacturing, April 2005,Proceedings of the Institution of Mechanical Engineers Part B Journal of Engineering Manufacture 219(5):395-412.

12.https://www.mckinsey.com/featured-insights/artificial-intelligence/notesfrom -the-ai-frontier-applications-and-value-of-deep-learning-33.

13. https://www.forbes.com/sites/louiscolumbus/2018/02/18/roundup-ofmachin e-learning- forecasts-and-market-estimates-2018/#2ad15baf2225-34.

14. Rumelhart, David E., Hinton, Geoffrey E., Williams, Ronald J., Learning representations by back-propagating errors, Nature-35.

15. Ferrandez S.M et.al. "Optimization of a Truck-drone in Tandem Delivery Network Using K- means and Genetic Algorithm" Journal of Industrial Engineering and Management, 9(2): 374-388, 2016.