

A STUDY ON ROLE OF ARTIFICIAL INTELLIGENCE TO IMPROVE INVENTORY MANAGEMENT SYSTEM

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ABSTRACT

Inventory management is a critical component of many businesses' operations. Artificial intelligence is the speedier and more consistent deployment of new technology in logistics and supply chain, particularly in inventory management. Technology has changed the way activities are carried out and delivered competitive company results. The goal of this research was to investigate and discover how artificial intelligence technology could be used to improve inventory management. Two questions were provided as a guide to the writing process, and by answering them, the thesis was steered to the end result: Is artificial intelligence capable of enhancing inventory management? How can Artificial Intelligence (AI) be used to help with inventory management?

The qualitative research approach was employed, and data was gathered through a literature review conducted by a different researcher. Articles, books, and web pages were used as sources of knowledge to answer such issues by comprehending the concept of inventory management, the different types of inventory, the purpose of holding inventory, the inventory management approach, and the expenses associated in a broader context. It was also necessary to grasp the big picture of artificial intelligence technology, including how it is defined, its history, different forms of AI, and prospective applications. There was also a need to investigate which industries had used artificial intelligence and how it had enhanced their day-to-day operations.

Finally, after a more comprehensive review of research in inventory management and artificial intelligence and case study, the results show that the application of AI and machine learning can improve the activities related to inventory management. It improves data accuracy, improves productivity, quick decision-making, minimizes costs, and consistently ensures customer satisfaction. As a conclusion of the research concerning the results found, profit, accuracy, and speed in businesses are possible with artificial intelligence.

Keywords: Artificial Intelligence(AI), Machine Learning(ML), Inventory Management(IM), Artificial Neural Network(ANN).

I. INTRODUCTION

The process of ordering, storing, using, and selling a company's inventory is referred to as inventory management. This comprises the storage and processing of raw materials, components, and completed products, as well as the administration of raw materials, components, and final products.

Artificial intelligence (AI) is a broad field of computer science concerned with creating intelligent machines that can accomplish activities that would normally need human intelligence.

Artificial intelligence in inventory is generating significant and impressive results for the firms that apply it. The way inventory is maintained is about to undergo a dramatic transformation.

Good inventory management is based on a single contradiction: having enough product in the warehouse to keep the business running but not enough to deplete the company's cash reserves. This inconsistency is at the heart of the store manager's job. It's a profession where monotony is the best option, where every business need is foreseen, where many urgent calls are crisis calls caused by someone else, and still the inventory team must find a solution. All of this was accomplished without plunging the entire company's cash into non-moving shares.

So, how can artificial intelligence fit into the chaotic and fast-paced world of inventory management? Is it genuinely of any use? The answer is a resounding affirmative. However, like with any real-world use of current state-of-the-art artificial intelligence, it must be properly paired with human oversight and employed as part of the system, rather than replacing it.

However, the use of artificial intelligence in inventory is resulting in significant and impressive gains for the businesses that are using it. The way inventory is maintained is about to undergo a dramatic transformation. This revolution is the result of the widespread availability of massive volumes of real-time data created on the internet and through other means. Enterprise software systems and smart gadgets live in an interconnected environment.

Managers will need to restructure their supply-chain operations in order to make efficient use of this new data and remain competitive. Amazon, for example, has used artificial intelligence at an unprecedented scale across its inventory operations. A.I. methods such as time series prediction and reinforcement learning systems are used in practically every element of their operations. Demand from customers, supplier backorders, warehouse optimization, and stock management

Machine learning or more advanced artificial intelligence systems are guiding all levels.



The Fundamental AI Concepts

The development of AI has reached a critical level. The work has been going on for almost two decades. The advancement of AI concepts has resulted in a slew of new ideas. Big data, AI applications in medical initiatives, and self-driving cars are all examples of AI technological trends. For a thorough knowledge of the three fundamental ideas of deep learning, machine learning, and artificial neural networks. These ideas will be discussed in greater depth further down. The relationship between AI, ML, and DL is depicted in Figure 1.

Figure 1 below illustrates how AI, ML, DL relate to each other.

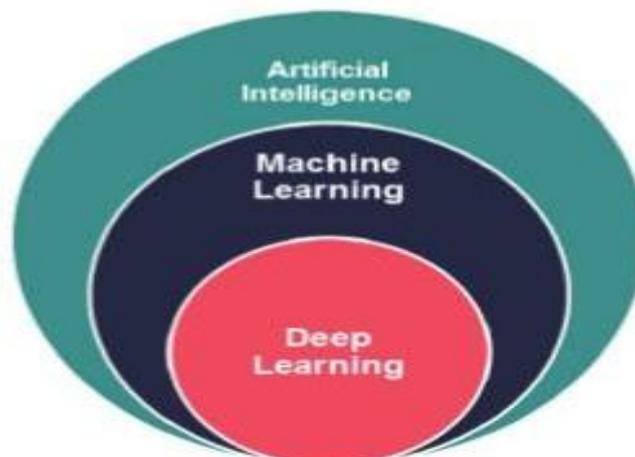


Figure 1: Relationship between AI,ML,DL(adapted from(Moghaddam 2019,p.26)

Machine learning

According to the author (Moghaddam 2019, p.25), machine learning is the most common use of AI, and AI allows the computer to process data on its own. Furthermore, according to researchers (Addo et al., 2020, p.22), "ML examines the study and construction of algorithms that can learn from data and make decisions and predictions by developing models." The key purpose is for the system to make accurate predictions. Machine learning refers to a machine's ability to study data through the use of data. As a result, there's no need to be programmed to do a specific duty. Machine learning is used for teaching computers to recognise patterns without any defined rules, among other things. Making an algorithm rule and making a prediction.

Moghaddam (2019) identified three types of ML, which are briefly described below: This sub-type of supervised learning relies on existing data to arrive at a predictable conclusion. Unsupervised learning occurs when AI agents give predictable results without having been trained to accomplish the task. Reinforcement learning is a subtype of reinforcement learning that works as a trainer for AI algorithms to detect rewards and punishment in order to deliver accurate solutions to any obstacles. As briefly mentioned above, Figure 2 depicts the categorisation of machine learning.

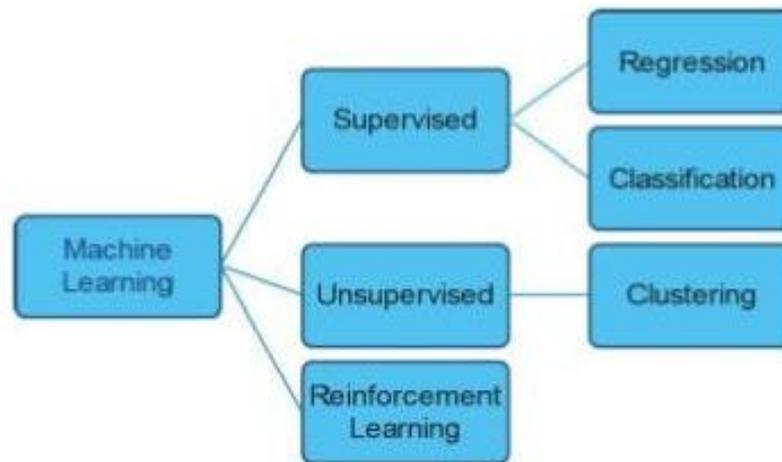


Figure 2: ML algorithm categoration(adopted from (Moghaddam 2019,p.27)

Deep Learning

"Deep learning is part of machine learning approaches based on meaningful data representations or features from the raw data," according to research by (Addo et al.,2020.p.26). The category is working on a machine that can pass information in bits and pieces. As a result, the information comes from a variety of sources. They're looked at and used to solve problems when they arise. Differential programming is another name for this type of machine learning. The technique of instructing a machine to perform many jobs in a predetermined order. Computer scientists will calculate and create entire algorithms to assist machines in training for a variety of tasks, according to the researchers. Deep learning is divided into two categories: "Python code" and "Google AlphaGO project."

Artificial neural network (ANN)

A "neural circuit" is an algorithm that copies or mimics the way a human brain operates, such as human senses, events, feelings, and so on. Artificial neural networks are required for deep learning to work. Neurons or human cells are adapted. Artificial neural networks are inspired by the things we find in biology, and there are applications of computer and math concepts in the neural net for dealing with how the human brain functions. In neural networks, there are three layers. Hidden layers, input layers, and output layers are the three layers that make up a neural network. A vast number of nodes are used to form the layers. The data is delivered into the system through input layers of varying weight. On their way to the destination, the nodes double input weight.They'll keep going till they reach the required information units. The data is forwarded to the next tier. If there is a difference that requires corrections, the outputs are weighed by machine for comparison (Abiodun et al., 2018).

Challenges that inventory management and supply chain faces in general;-

- **An overabundance of data;**-Because of how much data is routinely accumulated by every firm, data inventory management becomes a time-consuming procedure. While inventory management software that has been carefully created and supported can track and store data, it would still take a lot of effort from the human employees to process it all.
- **Tracking issues;**-It's becoming more difficult to keep track of every item in the inventory and derive useful information from it. Failure to track every incoming and outgoing item can have disastrous consequences for turnover, adequate demand response, timely delivery decisions, and so on.
- **Difficulties with business planning;**-Inventory management is a critical component of successful planning for businesses in any industry, particularly those that deal with consumer packaged goods. Successful growth strategies necessitate real-time data collection and processing, as well as situation-specific judgments and answers.
- **High operational budgets;**-As the company's inventory grows, it becomes increasingly difficult to maintain cost-effectiveness across the branch. Whether it's for the delivery service, analytical and data mining teams, or personnel who maintain track of stored products, funding grows in tandem with the company's size. And these figures are frequently far from satisfactory.

Inventory control in the IT world. Keeping track of every IT asset in an organisation necessitates meticulous planning. If done correctly, it will benefit a company and save asset-related expenses. Companies can use AI inventory management systems to assist them operate this process smoothly.

Let's get down to business and discover how artificial intelligence can help with inventory management right now.

4 ways to improve Inventory Management System using AI

In most of the scenarios outlined above, AI-based inventory management can be extremely beneficial. Careful implementation can result in a cost-effective, higher turnover, customer happiness, and retention boost for the entire firm. Here's what businesses can do right now:

Dealing with planning, predictions, and modeling in inventory management process;-Inventory management entails much more than simply storing and transporting products from one location to another. To be effective in terms of time, money, and labour, it both generates and relies on large amounts of data.

Failure to recognize and respond to changes in demand for a specific product is the most common cause of overstocking and under-stocking. The capacity to foresee that as a corporation necessitates highly skilled analysts and business modelling professionals. Other factors complicate the situation, such as many warehouses, location-specific demand, and so on. Managers and analysts must adapt to the idiosyncrasies of each product niche.

Artificial Intelligence has the ability to provide previously unavailable insights. With the use of powerful AI inventory models, it can handle inventory management models designed for inventory regulations, providing a robust control of operations by formulating and acting on predictions. Furthermore, AI can assess more than 50 variables, which is critical for successful delivery planning, inventory, and scheduling.

Data mining;- An AI technology demonstrates considerable competence in processing data into timely actions that can assist a firm in evolving or responding well to a specific scenario. If, for example, a local hockey club advances in the Stanley Cup, there will be a substantially higher demand for beverages and snacks on the following match day in that region. Artificial Intelligence can assess this and make a recommendation to overstock in that region. **Stocking management and fulfillment;**-Customer happiness and sense of fulfillment are greatly influenced by inventory management. In any warehouse, planning errors or insufficient stock monitoring can result in shortages and delays, reducing income.

AI is already capable of evaluating customer behaviour patterns and a variety of other aspects that aid in proper inventory planning. Furthermore, a well-trained intelligence can automate the stocking process and improve delivery efficiency by suggesting the most efficient routes.

AI inventory management reduces the risk of stocking errors and allows you to respond to client demand more quickly. An AI can also help construct effective factory-to-warehouse transportation using the insights supplied by data mining, which is especially critical for more volatile products with shorter expiry times.

AI-based robotics :- Robots aren't exactly new on the market. Robots are already being used by companies like Amazon in their day-to-day logistical activities, and there are a number of advantages that put robots ahead of human employees, especially in regular operations.

Robots can carry products around warehouses indefinitely, find wares, and scan their conditions. Machines may work 24 hours a day, seven days a week, and with more ideal time per activity. This alone can save a significant amount of money, allowing more personnel to be assigned to more important and time-sensitive activities that require human intellect.

Artificial Intelligence (AI) can help to improve the procedure even more. When combined with intelligence capable of evaluating data, forecasting demand trends, and recommending best delivery routes, it becomes a powerful tool capable of entirely automating internal warehouse activities.

There are two key implementations of artificial intelligence for inventory.

Demand Prediction for Inventory Management:-This is the simplest way, and it may be quite revealing if done right. As the name implies, the goal is to create a time series prediction model that can forecast demand for the next few days for all items in your inventory. If your organization has its own development staff with machine learning experience, we've discovered that lstm/rnn models with sliding windows, old school logistic regression with a few adjustments, and finally certain probability models are currently some of the highest performing time series approaches. One of the advantages of demand forecasting is that you may include external data sources into the system to see if they affect demand. We've created systems that consume the data to see if that impacts on prediction.

Reinforcement Learning systems for full-inventory management:- This is a more advanced artificial intelligence strategy that entails a model taking full management of inventory operations, with human checks and balances in place. Reinforcement Learning is an artificial intelligence arena in which models do more than just make predictions or classifications; they act on them. Giving an artificial intelligence the ability to act on what it predicts is the goal. This is accomplished by rewarding and punishing the model for inappropriate behaviour. In this situation, we usually impose penalties for allowing an inventory item to run out of stock, as well as for keeping stock of a greater value for an extended period of time. We generally focus on ordering things within a safe window before demand for rewards. Without prior experience, Reinforcement Systems are difficult to implement - you'll need to be conversant with simulation models and RL to get anywhere with Inventory. However, when done correctly, they produce incredible effects. One of our projects resulted in a 32 percent cost decrease across the board.

Factors you need to look for beginning to implement any new software such AI.

Integration with your existing inventory management;- For inventory management, you may be using SAP, Xero, or any other number of programmers, depending on the size of your firm. We usually integrate the AI model with their APIs and create a separate dashboard for the inventory team to easily acquire information.

These models are data hungry;- Unfortunately, artificial intelligence systems are notoriously data hungry, and building a competent model often takes a few years of inventory data. When clients ask how much data we need, we always say "as much as you can give us." This could be the largest issue with AI solutions right now, simply because there isn't enough data.

Inventory items are not homogeneous;- When looking into artificial intelligence models for inventory, it's also vital to realise that each item is unique and requires different treatment. Some items are highly predictable and consistent in their movement, while others are highly unpredictable yet equally important to keep in stock. Before you construct any artificial intelligence systems, think about doing some significance testing. This enables you to determine what external data is required to forecast an item's demand and to determine which products are predictable or not.

Disadvantages AI in inventory and supply chain management;-

a) The Cost of Integration ;- There is no debating the high cost of AI technology. While AI systems can be quite expensive, the true problem is integrating them owing to one simple fact: they are all unique. Most

software and hardware aren't like AI systems. It is made up of a number of separate systems that must be integrated and installed in order to function properly.

- b) The Operational Costs of AI;-** Individual processors, relays, and other components make up an AI-driven machine's network. To ensure operational integrity, each of these components must be replaced on a regular basis. The issue is that these components might be rather costly. Computer chips, for example, are constructed of exceedingly rare elements like selenium. AI devices need to be updated on a regular basis, which includes replacing the internal battery, which is also rather costly.
- c) Fewer Human Jobs;-** With greater automation, it is unavoidable that the workforce would shrink. Unfortunately, the people who currently hold these roles are the ones who will suffer as a result of this efficiency increase. As a result of the integration of AI solutions, the corporation must either find new tasks for its people or let them go.
- d) The cost of training;-** Like any new technological solution, training is another aspect that requires a significantly very costly and needs well trained staff.

Problem Statement

Knowing what, when, where, and how much stock to order and keep is a key difficulty for manufacturing organizations. SME's have usually calculated this by hand, using Excel, Google Sheets, or other software. These solutions can be automated to some extent and are usually sufficient. Traditional solutions, on the other hand, are prone to human mistake and are dependent on the employee's ability. As a result of human error, incorrect estimates and over/under-stocking can occur. As a result, the following questions arise.

- ◆ Can Artificial intelligence improve inventory management?
- ◆ How can the organization utilize Artificial intelligence in inventory management activities?

Objective of Study

- Understanding benefits AI in inventory management system
- To study how to get optimal solution of managing massive amount data in inventory management by using AI
- To study how AI helps in demand forecasting

II. LITERATURE REVIEW

"AI techniques such as expert systems offer a promising new approach to inventory control and planning problems of great magnitude and complexity due to their powerful knowledge representation language, which is capable of capturing inventory pattern throughout the entire SC at all levels of detail," according to Taylor and Francis (March 24, 2009).

"AI enables automated compliance, which lowers costs and improves the efficiency of a value chain network" (Treleaven and Batrinca 2017)

"Through automation, AI can assist in the simplification of time-consuming jobs in warehouse operations." Companies like Amazon and Ali-baba are already deploying AI-driven robots to improve supply chain productivity and efficiency. Every minute and every mile count in the supply chain, and AI uses algorithms to assist reduce time and costs by optimizing routes and delivery" (Wen et al.2018)

"AI can process, analyse (automatically), and most importantly, predict data; it provides accurate and reliable demand forecasting, allowing businesses to optimise their sourcing in terms of purchasing and orders processes, lowering transportation, warehousing, and supply chain administration costs." (July 2019 article) Rupa Dash, Mark McMurtrey, Carl Rebman, Upendra K.Kar,

"AI may provide you a competitive advantage by seeing possibilities and forecasting future trends, and it may even inspire new creative designs." By proactively alerting drivers, pilots, and captains to anticipated problems with other vehicles as well as other traffic dangers, vehicle to vehicle (v2v) communication mixed with AI can reduce collisions and congestion." Samir K. Srivastav (November 2019)

In today's changing business climate, AI has a big impact on improving the predictive capabilities required for demand forecasting. Customers' interactions can be personalized by AI-driven bots, which can be incredibly

efficient. These bots can assist in tracking the progress of an item's delivery and are further supplemented by echo users who are assisted by the customer service team (Huang and Rust 2020).

"In the supply chain, AI has the ability to allow smart and agile decision making to predict difficulties." As a result, a proactive AI system aids in improving on-time and undamaged delivery." (Wamba et al 2020b; Toorajipour et al 2021).

III. RESEARCH METHODOLOGY

The study was conducted in a qualitative manner. carried out a thorough review of the literature on inventory management functions. Identified numerous roles of AI in inventory management using conference papers, technical publications, and web resources.

The procedures were to locate and analyse the data utilized to compose the theoretical section in order to respond to the research questions. The overview of Artificial Intelligence with Inventory Management is the topic of the literature review. The review of many studies looks at how artificial intelligence technologies might improve inventory management. As a result, the study's goal was to explore and discover the facts. The qualitative method, which included a literature review and a case study, yielded exact research results.

IV. RESULT OF THE STUDY

The globe has gone through multiple industrial revolutions, from the first to the fourth, all of which have resulted in technological improvements. Artificial Intelligence has revolutionized the way businesses are conducted. As a result, the ability to create or provide services without the assistance of humans is possible. The goal of the study was to look into and investigate artificial intelligence's capabilities to help with inventory management. The entire method of obtaining the results was directed by the research questions. The study goes through a number of processes, including a thorough analysis of the literature and a thorough grasp and overview of artificial intelligence and inventory management. The information used to compile this report came from a variety of sources, including books, articles, journals, and web pages.

V. CONCLUSION

The goal of the research was to investigate and comprehend the impact of artificial intelligence (AI) in the corporate sector, particularly in logistics and supply chain. To look at the use of artificial intelligence (AI) in logistical functions such as inventory management and how it might be used to improve. This thesis was written utilising a qualitative research method that included a literature review and case studies. Several academics conducted a review that led to a better grasp of how AI has recently transformed activities. Many logistical processes, particularly inventory management, have been transformed by AI technology, which has established a value chain. An organization's rise in productivity and efficiency operations translates to cost savings and increased investment return.

The research reveals how inventory management has progressed from manual to automated processes. To summarize, the literature review and case study presented the findings of numerous researchers, demonstrating that artificial intelligence plays a key role in enhancing inventory management tasks.

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