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Analysis and study Artificial Intelligence to improve Inventory management

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Abstract

In many organizations, inventory management has an essential role in business activities. The faster and continuing application of new technology in logistics and supply chain, specifically in inventory management, is Artificial intelligence. The technology has transformed the way activities were performed and deliver competitive results in the business.

This study aimed to study and find out the use of artificial intelligence technology to improve inventory management. As guidance of the writing process, two questions introduced which by answering them directed the thesis to the final result: Can Artificial intelligence improve inventory management?, How can the organization utilize Artificial intelligence in inventory management activities?

The qualitative research method was used, and research information was collected through a literature review from a different researcher. Articles, books, and web pages were used as the source of information to answer those questions by understanding in the broader perspective the concept behind inventory management, the different types of inventory, the purpose of holding inventory, the technique used to manage inventories, costs involved. There were also needed to understand in the big picture the concept behind Artificial intelligence technology, how it is defined, the history, types of AI, where it is possible used. Also, there was a need to analyze which sectors implemented artificial intelligence and how it has improved their daily activities.

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.

Terminology

AI Artificial Intelligence

ANN Artificial Neural Networks

ML Machine Learning

Contents

1   Introduction

Companies today in the logistics and supply chain must find and develop a competitive edge over others to gain their market share. A competitive advantage can be reached by different means, first by improving the activities in various sectors within their organization. The logistics and supply chain have multiple sectors that can be improved with technology, one of them being inventory management. Inventory management needs significant attention in any business. Improve the inventory is a challenging task. Therefore the development of new technology seems to transform the way activities are performed. The introduction of artificial intelligence in inventory management is continuously growing. Keeping up with the recent technological advances can promote efficiency, productivity, customer satisfaction, and ultimately, the total business results.

The author suggested the research topic relative to technology advance through studying how AI as technology will improve organizations' daily activities, especially in logistics and inventory management. The research aimed to study and understand artificial intelligence technology and its utilization to improve inventory management. This research reviewed inventory management from a comprehensive perspective, the Concept of inventory level control, and the inventory control process. Furthermore, the research explored the current and future trends of AI technologies solutions behind inventory management. The research also examined the challenges of implementing artificial intelligence technology in different applications. The research employed the use of literature review as well as previous research articles about AI and Inventory management.

2   Research Overview

In total, understood that research methods depend on the spectrum. Qualitative and quantitative may depend on either side and in between a spectrum of mixed methods. The research areas they are utilized are the only way researchers can differentiate between qualitative and quantitative methods. The research that needs open-ended questions and answers uses qualitative methods, while quantitative methods are used where measurements are made of quantifiable things. Research basic assumptions, the specific method used, and the type of research strategies are another way to differentiate between them (Creswell 2018, pp.3-4.)

In selecting a research method, the researcher anticipates the type of data needed to respond to the research question. If the researcher answers the questions that need numerical data, the quantitative approach will be selected; if research questions require textural data, the approach is with the qualitative

method, and if research questions requiring both numerical and textural data, the mixed methods approach(Williams,2007).

2.1   Qualitative research

Qualitative research is used when the author of the study collects and analyses non-numeral data, for example, video, text, or audio. Also, it can be used to bring together intuition a problem or if the researcher wants to generate new ideas. Qualitative research is working opposite to quantitative research, which generally deals with collecting and analyzing numerical data for statistical analysis. In social sciences and humanities, especially in education, health sciences, sociology, and anthropology, qualitative research is mainly utilized(Mason, 2002, p.3).

Researchers can use qualitative research to study and understand how people experience the world. Qualitative research has many approaches, and they tend to be flexible and focus on retaining rich meaning when understanding data. Those approaches include action research, ground theory, narrative research, and phenomenological (Mason, 2002, p.3).

2.2   Qualitative research methods

According to findings, there are different approach used for data collection, and in the research, one or more data collection methods can be used, such as:

Observations: used to record what you have seen or heard.

Interviews: personally, asking people questions in one on one conversations

Focus groups: asking questions and generating and discussing among a group of people.

Surveys: distributing questioner contains simple questions that provide direct answers.

Secondary research: collecting already existing data in the form of texts, images, audio or video recordings, etc (Bhandari, 2020).

2.3   Quantitative research

Quantitative research is a research method that is normally dealing with the collection and analysis of numerical data for statistical analysis(coursehero.com,2021). Quantitative research is well-defined as a systematic investigation of science by gathering measurable data and performing statistical, mathematical, or computational techniques. The researchers who choose to use Quantitative research collect information from current and potential clients by using sampling methods and sending out online surveys, online polls, questionnaires, and so on. The result will be presented in numerical form(Rubert & Bouikidis,2018,p.211).

Quantitative research can be used, for example, in the health center when a patient needs to see a doctor. The survey will be conducted to determine how long time a doctor takes to attend to one patient. Also, they can use to find the customer satisfaction survey template to ask questions like how much time did they take to receive the service they ask for. There are two common methods to conduct quantitative research:

In primary quantitative research methods, the researcher focuses on collecting data direct, not depending on data collected from previous complete research.

Secondary quantitative research methods, the researcher focus on collecting data from existing data or secondary data, Summarized and collected existing data to increase the overall effectiveness of the research performed. The quantitative data are gathered from different sources like the internet, libraries, research reports, etc. This secondary quantitative research method validates the data collected from primary qualitative research.

2.4   Mixed research methods

This kind of research method is utilized when the research questions cannot answer with a single method. The researcher will select more than one method to improve the research outcome. It happens when the phenomenon is complex. The situation regarding mixed methods might appear the moment the researcher needs to explore a question at the group level and the individual level. The researcher wants to describe both. In another way, the author may plan to explore different aspects of the same phenomenon. To control complex phenomena, research normally demands more than one research method in the same project. Therefore, a researcher must be flexible and skillful at many types of research and research methods, both qualitative and quantitative **(**Williams,2007).

2.5   Method of collecting data

2.5.1   Literature Review

The literature review is a critical analysis of related literature relevant to that of the research being under-taken. It is an essential part of any research project because it outlines the subject content and academic knowledge relevant to research. The author can easily gain an understanding of the nature of the literature review if they consider how it relates to the whole research project. The following research structure is essential (Mukherrji & Albon,2010,p.201-202).

2.5.2   Case study

A case study is a research approach strategy focused on investigating one particular case. The case choice from the system is related to the topic or from the institution or a person. The understanding of why the study is performed and how. A case study approach aims to search for answering research questions using dissimilar types of sources and evidence. The approach generally adopts three methods such as interviews, observation, and document analysis. (Simon 2009, pp.3-7; Gillham 2000, p.1.)

2.5.3   Interview

An interview is a process of collecting the required data through an organized discussion. The interviewer is face-to-face or virtual with the interviewee, asking him questions. The questions are prepared beforehand, but the host has the privilege to request more needed information in detail. The role is to bring attention to the task and encourage the respondent to answer reliably and not influence the response. An interview is divided into two basic categories. Structured interview this category is the same as questionnaire; questions prepared are direct and focused, which delivers straight answers. an unstructured interview gives room for investigation for further information and exposes essential data. (Gubrium & Holstein,2001; Phillips & Stawarski,2008)

2.5.4   Observation

The process of collecting data by observation can be done by recording the event, the observation of the situations, or by experiences. The observation might be supported by recording instruments like a camera or a recorder. During the observation, the members are observed to record any change in their behavior. For a more objective view, observers can be external third-party or staff members before execution needed in advance observation plan to know what info should be given and what is not to the observed individual. Timing is also a limitation to consider. Meanwhile, different circumstances can yield different results. The knowledgeable person who knows how to examine the info should do the observation and is also able to minimize their effect on the results. (Phillips & Stawarski, 2008. pp.28-30; Walliman 2010, p.70.)

2.5.5   Survey questionnaire

 A survey is a study of different samples for the determined population. By conducting a survey, the outcome will help the surveyor acquire answers from the relationships between variables and questions about predictive relationships between variables over time. The questions will be prepared, same as interview questions. The survey question can address a much larger crowd without the presence of the interviewer. The survey questionnaire method is more useful for collecting data due to the following

advantages: Low cost, free from bias, no time or distance limitation, can utilize large population in a short amount of time, and little effort. There are some disadvantages if the survey is missing an interviewer: Low rate of return, Requires responder's cooperation, No control over the process of answering them, Inflexibility due to pre-drafted questions, Unclear answers open for interpretation, Reliability is unknown, Slower than a frontal interview. When preparing questions, the point to bear in mind is to carefully weigh how the required answers are straightforward and easy to transfer into workable information. (Creswell 2018, p.147-148; Kothari, 2004, p.100-101.)

2.5.6   Research Methods selected

The selected research methods to conduct this thesis work were qualitative because its more useful methods for the author to study, understand the broader meaning, and explain the findings' concepts. The qualitative research method is flexible and has a different approach, and its main focus is to recognize the expansion of the study. Secondary sources were used for data collection, such as books, articles, journals, and web pages.

The steps were to find and analyze the information used to write the theoretical part to answer the research questions. The literature review focuses on an overview of Artificial Intelligence and Inventory management. The review of different researches how the application of Artificial intelligence technology improves inventory management. Therefore the study aimed to investigate and find out the facts. The qualitative method through literature review and case study has provided precise results for the research.

3   Research Questions

There is a growing revolution of technologies around the globe. Many businesses have become interested in the implementation of Artificial intelligence for the improvement of their daily activities. The focus of this research is on the field of logistics in inventory management. There are many questions to answer to fulfill the aim of the study, but I have made a summary of them and come up with two main questions that I will respond to as a guide through the whole process of writing to final results. The questions are listed as follow below

1. Can Artificial intelligence improve inventory management?
2. How can the organization utilize Artificial intelligence in inventory management activities?

The thesis will go broader and deeper through chapters into a specific area and present the study results by answering the questions mentioned above.

- Understanding artificial intelligence technology and its impacts in the logistics industries
- Logistics and inventory management

- Adaptation of artificial intelligence
- Review of case study
- Research results
- Conclusion

4   Artificial Intelligence

Artificial intelligence has continuing to hit news headlines around the globe. The application of AI in different fields has grown rapidly and has transformed operation processes into high performance. Before defining AI let's get a clear understanding. According to (Sabouret 2021, pp. 1-6) in the introduction of his book has brought understanding that the human being has continuing to introduce different tools. Human-made tools for helping them hunting and also the tool used for cultivation or agriculture. Furthermore, the means of transportations used for moving a heavy load. The equipment used for making other tools. The development of devices continues to change in an advanced way. Human skills development went through difficulties and problems before the invention of machines. After the invention of several tools for hunting, agriculture, and tools for moving a heavy load, the machine called Cranes antiquity was first introduced. This machine was used to fulfill a task that was not possible done by a human. The work that needed many people was done by this machine. The following machine introduced was cars, washing machine, and so many other home appliances. Humans get used to the invention of different equipment, tools, and machines, and it becomes as common, which becomes difficult to live without considering further inventions.

According to (Sabouret, 2021), Artificial intelligence brought to our daily lives great changes. The machines are manufactured with the possibility of having able to think, self-awareness. The ability of the machines to perform their everyday task compared to the human being. This confused most of us, and it brought an opportunity to develop and improve different sectors. History is telling us even at those times, the development of new tools or ideas shocks our ancestors with hesitation machines might take over humans. This hesitation is the same at the moment when the introduction of new technology in the company sometimes is facing resistance. The states are aware of the future of their citizen against Artificial intelligence presence.

4.1   Definition of Artificial intelligence

Artificial intelligence, as defined by (Moghaddam 2020,p.25), "Is the overall concept of machines being able to perform useful tasks that human being typically does, that is Intelligence of human being reproduced by machines". The definition is giving us the general idea for a machine can perform a certain task that a human can do; the machine is adapting the intelligence of human beings.

According to the definition quoted by (Sabouret 2021,p.8) in the book understanding, Artificial Intelligence AI is defined as "the building of computer programs which perform tasks which are, for the moment, performed in a more satisfactory way by humans because they require high-level mental processes such as perception learning, memory organization, and critical reasoning."The definition provides more understanding that AI requires a written program that can perform information processing; therefore, we can call it an Artificial intelligence program.

Further definition of AI has been introduced by (Addo.2019,p.8) as "the science and engineering enabling intelligence specifically in computer programs, using the computer to understand human intelligence and other living things".In other ways, scientists have worked hard to research AI and find how a machine can be taught to recognize living things intelligence. As all know, computers are not intelligence because they depend on the human; that means humans have intelligence that is not yet discovered

4.2   AI definitions four approaches in more details

4.2.1   Acting humanly

There was an introduction of the Turing test year 1950. The purpose was to provide a clear understanding of how intelligence should be defined. The computer tested to pass the questions prepared in advance. There was no information if the outcome or response was coming from the computer or a person. For the engineers to develop a program for the computer to pass the test needed hardworking and time-consuming. To come up with the computer that can process different natural languages, the computer with communication skills in multiple languages, capable of hearing, storing data, knows, answering a question, and so forth. According to the Turing test, intelligence does not require physical contact between interrogator and computer. The computer needs vision devices to recognize objects and robots to deal with objects and some movements(Stuart&Peter 2014, pp. 2-3).

4.2.2   Thinking humanly

The definition of thinking human is the knowledge about the human mind transformed into a programmed machine or computer. The engineers and scientists were looking for how people think—the broader knowledge concerns how the human mind works naturally. The process of learning and understanding the human mind, as presented by (Stuart & Peter, 2014,p.3), is possible introspection, psychological experiments, and imaging. These are elaborated in short, respectively: trying to interpret human thinking, observation on humans while performing a certain task, and investigating the brain when performing a task (Stuart&Peter, 2014).

After a clear understanding human mind, that knowledge is explained as a computer program. The input and output of computer programs have similar characteristics to humans. That is the conclusion same program techniques might operate on humans. The development of new technology concentrated on tracing and comparison. The scientist who invented GPS concentrated on the comparison of GPS reasoning procedure to ours for dealing with similar problems. From the AI concept, cognitive science brought together experimental techniques from physics and computer models to build knowledge of the human mind(Stuart&Peter, 2014).

4.2.3   Thinking rationally

The approach to defining AI as presented from different sources has another term called "laws of thought".This approach results in the introduction of formal logic during the 18th and 20th centuries. The statements concerning the world were able to be delivered precisely with the help of logic. The Law of thought approach contains several challenges, delivery of knowledge is mandatory by the logical system if the percentage of knowledge is less than a hundred. The idea of tackling a problem in principle and perform in practice the results have enormous differences. The approach required to prepare a guide on which reasoning steps to try when there are a smaller amount of tasks to avoid the consumption of all computation resources inside the computer(Stuart & Peter,2014, p.4).

4.2.4   Acting rationally

The definition of AI on the basis of acting rational is defined as working for aiming to achieve certain goals through a particular princeples.AI is also related to the building of rational agents. If someone is acting rationally, it means he is reasoning logically, leading to the conclusion; this means he has set the target to archive a particular goal. Finally, after the conclusion, act on that (Stuart & Peter,2014, p.4).

Meaning fo Artificial Intelligence

The way the author of the book Understand Artificial Intelligence introduced the meaning of how we should understand Artificial Intelligence was interesting. He started by bringing awareness of what AI is made for and distinguishing between a computer and AI to understand the knowledge about computer and computer sciences. "Computer science is all about the activities are done by the computer such as information processing, it takes care building, creating, and inventing the machine that process all kind of information from number to text, image or video(Sabouret,2021)".

The first machine had the ability to interpret the information-carrying numbers and arithmetic operation. This continues to advance and becomes difficult. Currently, there are machines with the capability of listening to our voices and convert into practice. For the computer to process information, the algorithm must be utilized. The algorithm is all about dealing with maths which most Engineers learned in elementary school. The practical application of the algorithm is at the manufacture of electronics devices such as calculators. A technician can turn algorithms into a form of electronic wires(Sabouret,2021).

Machine

Sabouret(2021) continues to introduce the purpose of the machine in his book by presenting the idea brought in 1936 by Scientist Alan Turing who introduced the "mathematical model of computation".It is well known as the "Turing machine".The ideas were to develop the machines that symbols can be written and moving further by using alphabets. The most likely applicable symbols in computer engineering are 0 and 1. The machine is given numerical instructions to perform different tasks. For example, 0 symbol move this box to warehouse shelve 10 and symbol 1 move this pallet 7 to receive station 9. The symbols are being examined by the Turing machine according to the current cell and continue with instructions. Whatever prepared algorithm machine obey and follow correctly. According to Alan Turing, all kinds of the algorithm, even cumbersome the machine will produce(Sabouret,2021).

4.3   History of Artificial Intelligence

The history of AI, as presented in the book "understanding Artificial Intelligence" by (Sabouret, 2021, pp. 41-44). The history of AI began in the year 1843; the first algorithm was introduced by Ada Loverace. The place she was working in needed this algorithm which is called Charles Babbage's analytical engine.The previous history of computer sciences. At that time, there were no available programmed machines. In 1801 the mechanically controlled equipment was invented and was guided with perforated cards. The

cards were used to guide the needles. At the end of the 19th century, machines equipped with computation systems and programming were invented.

In 1945, the first electronic computer, ENIAC invented. It took a century after Ada Lovelace's algorithm come into use. The artificial intelligence team was used for the first time in the year 1950 by Alan Turing. Thereafter the AI algorithm was introduced. During the 1960s, the application of computers was important in many industries and brought companies to store data and data processing. The 1970s was a shocking period when computers dominate offices. The AI topics became hot everywhere and everyone. For the period of 30 years, this means from 1980 to 2010, AI has undergone a difficult time and pay a considerable price. By estimations, few industries were willing to implement AI technology in their projects. The decision to rely on the available algorithm because was easy to use and manage(Sabouret,2021).

In the year 2010, two IBM staff at the beginning of their career dedicated their time to target AI and mad a computer program that has the ability to play chess. That computer program was able to win chess's grand champions. Therefore it was the beginning of developing a machine which is intelligence. Playing chess requires intelligence. F**igure 1** below gives the history of Artificial intelligence starting from the year 1930 till the year 2000(Sabouret,2021).
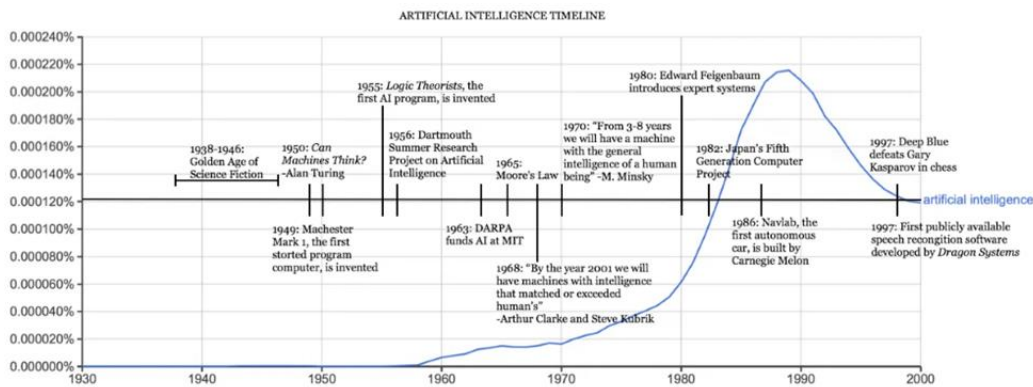
Figure 1:History of Artificial Intelligence(Anyoha,2017)

4.4 Type of Artificial Intelligence
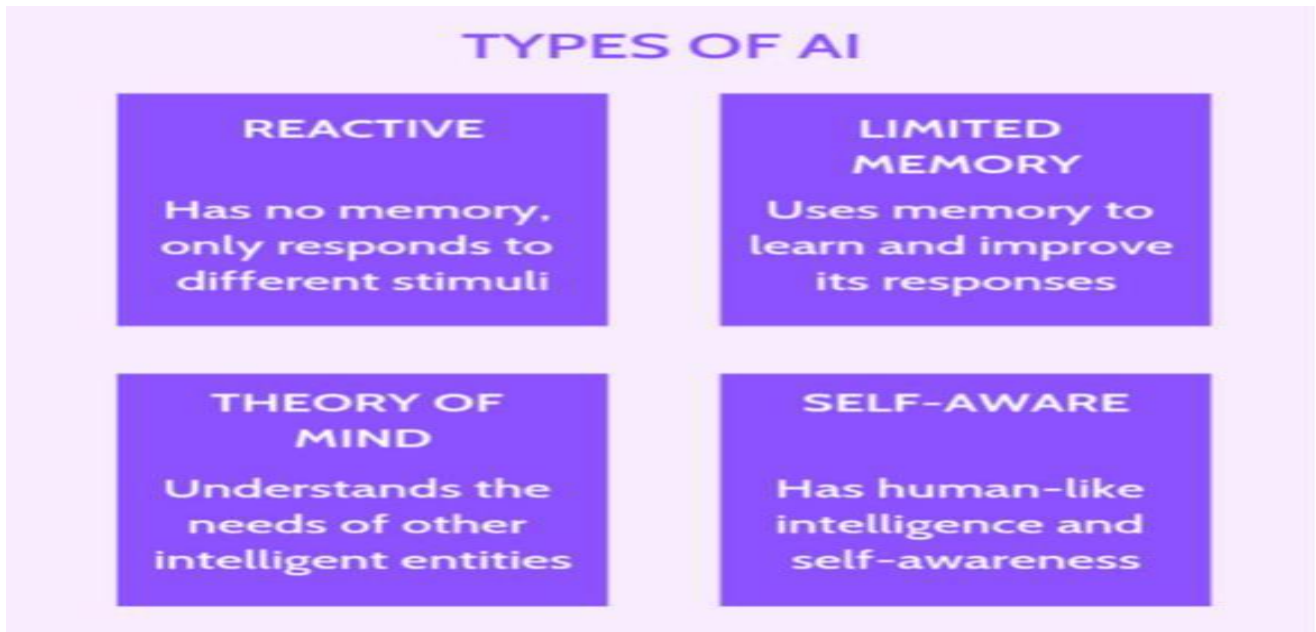
Figure 2:Types of Artificial Intelligence(Adapted from Forbes 2019).

According to (Forbes,2019), as presented in figure 2 above the AI is divided into four different types which are limited memory, reactive machines, a theory of mind, and finally, self-awareness

1 Reactive machine: This type is explained that is most applicable in the basic systems of AI. The basic AI system does not have the ability to form memories or any experience regarding the previous action. An example of this kind of machine is "Deep Blue".The computer participated in a chess game in 1960. The technology inside deep blue could detect the pieces and know-how each moves on the chessboard. Prediction of next moves for it and opponent and select the best move among the possibilities(Hintze,2016).

2 Limited memory: Artificial intelligence remembers the past action. An example of this kind of machine is autonomous cars. They operate on their own with drivers present for reacting if there is any abnormalities occurrence. But this type of AI has less observation ability at one moment because of limited memories. Machine observing particular objects and also monitoring them(Hintze,2016).

3 Theory of mind: This AI type refers to living things and non-living things under the earth to think and have the emotion that impacts their behavior. There is no clear understanding in a simple way how humans form societies. How humans managed to maintain social interaction.Human interaction even though we don't

know each other, even our environment. With the presence of AI systems in our daily lives, they will understand our thoughts, feelings, and how we need to be served. Artificial intelligence systems capable of changing their characteristics according to the environment(Hintze,2016).

 4 Self-awareness: This type of AI representing the machine's ability to express itself. The ability to act consciously, be aware of itself, predict someone else feels, and know about what they are thinking. Keeping enough energy on learning and remember the previous decisions. Learning human intelligence is a significant improvement stage. It is essential to invent the machine, which is more than expectation, by differentiating what they see around(Hintze,2016).

4.5   The Fundamental AI Concepts

The process of AI to grow is at its stage. The effort has been made for almost 20th years. The development of AI concepts brought exciting innovation. There are several AI technology trends such as big data, AI applications in medical projects, and self-driving cars. For deeply understanding through the explanation of three basics concepts that are are Deep learning, machine learning, and artificial neural networks. These concepts will be elaborated on below in more detail. Figure 3 below illustrates how AI, ML, DL relate to each other.
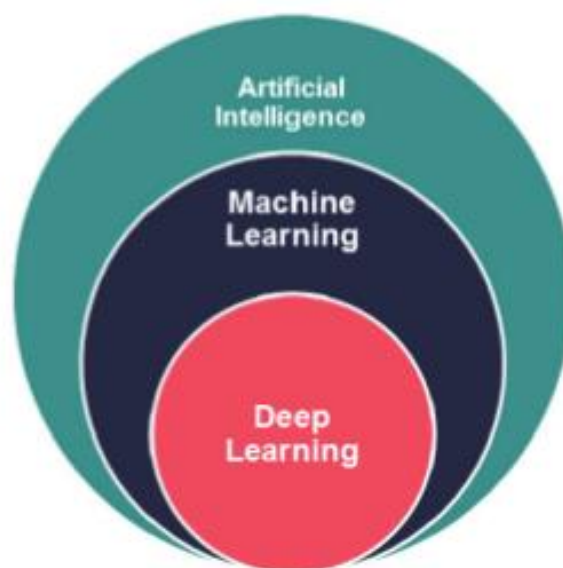
Figure 3: Relationship between AI,ML,DL(adapted from(Moghaddam 2019,p.26)

4.5.1   Machine learning

According to the author(Moghaddam 2019,p.25) defined machine learning is the main application that AI uses and AI enables the machine to use data processed by itself. Moreover, researchers (Addo et al.,2020,p.22) defined "ML explores the study and construction of algorithms that can earn from data and make decision and prediction by building model". The main goals are for the machine to predict matters incorrect way. Machine learning is the ability of a machine to study data by utilizing data. Therefore there is no need to be programmed for performing a specific job. Among other machine learning uses, it is used for teaching computers by example to recognize patterns, with no specific rules. The creation of algorithm rule and make a prediction.

Moghaddam (2019) presented three categories of ML which are defined shortly below: Supervised learning, this subcategory depending on existing data to reach a predictable conclusion. Unsupervised learning, For some reason, happens when AI agents deliver predictable outcomes without previous training to do the task. Reinforcement learning, this subcategory is working as a trainer of AI algorithm identify rewards and punishment to provide solutions for any challenges accurately. Figure 4 below shows the categorization of machine learning as shortly explained above.
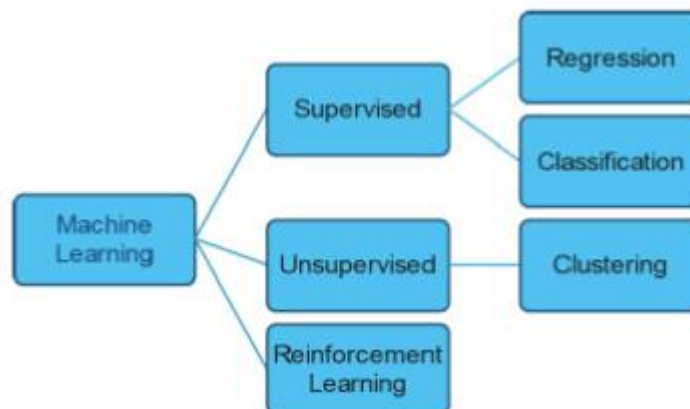
Figure 4:ML algorithm categoration(adopted from (Moghaddam 2019,p.27)

4.5.2   Deep Learning

According to research conducted by (Addo et al.,2020.p.26) "deep learning is part of machine learning methods based on useful data representations or features from the raw data". The category is working on the machine capable of passing scattered pieces of information. Therefore the data are provided from several sources. They are examined and used to solve the problems that arise. Furthermore, this category

of ML has also known as differential programming. The process of teaching a machine to study multiple planned tasks. Researchers noted that computer scientists will calculate and formulate whole algorithms for assisting machines in training several tasks. There are two known deep learning: "Python code and Google AlpaGO project".

4.5.3   Artificial neural network (ANN)

This is an algorithm that copies or mimics the way the human being's brain works, a "neural circuit," for example, human sense, events, feeling, etc. For deep learning to work needs artificial neural networks. It adapts neurons or human cells. The things we find in our biology inspire Artificial neural networks, and there are applications of computer and math ideologies in the neural net for coping with how the human brain works. There are three layers in neural networks. Inside neural networks comprise three layers such as hidden layers, input layers, and output layers. The layers are constructed with a large number of nodes. The data are fed inside through input layers with a certain weight. The nodes multiply input weight on the way on their way until reaching the required information units. The information is passed to the next layer. The outputs are weighed by machine for comparison if there is a difference that requires corrections(Abiodun et al., 2018).

4.5.4   Other Relevant Concepts in AI

The concepts that bring more understanding concern AI are presented by (Techslang,2020) below.

- **Categorization**: To construct a successful AI system, usually need to categorize different specific field to benchmark. The machine uses these principles to detect a problem. Further examination was conducted for detecting heading to the required solutions(Techslang,2020).

- **Classification:** AI concepts can categorize the problems it is going through, the causes of those problems, and find a better solution to overcome. The health sector applies this kind of AI concept for medical diagnostics also the detection of sickness(Techslang,2020).

- **Collaborative filtering:** Reffed to AI system able to decide and approach itself related to knowledge learned from previous user actions. Advertisements available in the media which recommend users to buy goods are one of collaborative filtering(Techslang,2020).

- **Natural language processing (NLP):** The concepts represent a neural network that has an advanced capacity for learning a task and provides the results. Natural language processing relates to computer science. Computer science is working on making computers that will translate natural

language through listening and reading. The concepts are used in conversational AI platforms such as chatbots and messaging apps(Techslang,2020).

- **Data mining:** This concept comprises mining data that is not structured from different sources. Typically AI systems use the statistic method for analyzing information by arranging them in sequence to deliver new information(Techslang,2020).

4.6 Possibility of usage

According to news journals, articles, and ebooks, which are excellent sources for finding information, Eurobarometer news journals (2017) have presented several areas to apply artificial intelligence. For many years human has used AI without noticing such as shopping online. In the business sector, AI is widely used to recommend people based on their previous searches. For example, you have searched for a certain kind of smartphone. The AI will bring the ads for various smartphones whenever you open the browser to search for something. AI is applied in logistics and supply chain activities such as inventory management in demand forecasting, inventory planning, inventory level, replenishment, monitoring, etc(Eurobarometer 2017, EU-28).

In addition, media platforms are among areas where AI is applied. The use of search engines that understand a massive amount of data. The user provides the information to deliver relevant search results. Smartphones use AI to provide service to users appropriately, daily routines, planning, answering questions, and providing recommendations have become universal.AI use software for language translation machine based on spoken or written text. Artificial intelligence helps to improve translation; for example, inside devices like televisions, there is an automated language substitute, the presence of intelligent towns, intelligent homes, and infrastructure powered by AI. An energy server in our house detects our movement and monitors the temperature, intelligence thermostats.AI used to control traffic and lower congestions(Eurobarometer 2017, EU-28).

However, the development of self-driving vehicles has not yet reached the complete required standards, but cars currently are equipped with functions that use AI to maintain safety. The European Union assisted in funding VI-DAS, which are automated sensors used to detect dangerous situations and accidents. Navigation devices are primarily applying AI. Moreover, AI systems can identify and fight against cyber-attacks. Fight against pandemics like Covid 19, the problem we are facing at the moment Covid-19, the thermal imaging devices AI-powered, has been used in airports and many other places to fight the spread of Covid-19. In medicine, it helps to know infection from computerized tomography lung scans and provides information(Eurobarometer 2017, EU-28).

Moreover, AI is used to detect disinformation and manage the users for fighting against that. There is plenty of fake news circulating online, and with AI noticed, where are their sources used. In health, the researchers are on the learning task of using AI to investigate a large amount of health information to discover medicine and improve diagnostics. Therefore, the development of an AI program that answering emergence calls that can detect the possible danger of the attended customer easily and in repeated times. Developing services that see multiple languages quickly for people looking for medical information. EU co-funded KConnect(Eurobarometer 2017, EU-28).

Likewise in the transportation industry, AI is used to improve the safety of users, accuracy, efficiency, and speed. For example, in railway transportation, reducing friction in wheels increases speed and empowers autonomous driving. "The data collected by Eurobarometer show that "88% Although 61% of Europeans look favorably at AI and robots, 88% say these technologies require careful management" (Eurobarometer 2017, EU-28).

 According to the news from (European Parliament,2020) explain the application of AI in manufacturing, when we think about the manufacturing sector, we have seen Europe, and America shift to Asia to search for low labor cost and raw material availability. Applying AI could be more efficient and enable European and American manufacturers to rethink moving factories back and utilize the AI technology available. Therefore, technology will improve business activities such as sales and reliable maintenance.AI facilitate the introduction of intelligent industries.

Production of food and farming: In the sector of food production, AI is used for the production of sustainable food procedures by supervising the production of healthy food.The applications of new technology in food production by reducing the uses of pesticides, irrigation, and reducing uses of fertilizers. The approach will bring a positive contribution by increasing productivity and decreasing environmental impacts. Robots can do multiple farming activities. In The EU, farmers already using AI for monitoring the weather, how much food animals consume, and tracking their movement.AI is used in the public sector for detecting a numeral variety of data, provide on-time detection of natural disasters. It allows the county to prepare and moderate the consequence effectively(European Parliament,2020).

5 Inventory management theory

5.1 Introduction

In many organizations, several activities are operating depending on each other functions. There is a connection between functions, and at some point, are overlapping. Companies have a different essential aspect that plays a crucial role, such as inventory supply network management and important business functions that keep the operation running. Inventory management and its functions are a clear indicator for managers to control the finance of their organization.

Managing Inventory and its functions is a roadmap for the companies monitoring the supply chain, which impacts the annual report on the company financial situation. There are enormous challenges for the company to maintain what Inventory is required at the right time and the way to avoid running out of Inventory, also on overstock, all these aspects have an impact on the company's finances.

The nature of Inventory is not static; it is always changing. To manage those changes, the organization has a task for evaluation and careful dealing with the factors that arise, inside the organization or outside. Therefore, for the company to continuously improve, there is a need to direct their effort on, review Inventory, better control, and planning. Also, there is a need to separate some functions to improve productivity, such as planning, monitoring, finance review of Inventory, purchasing, production, and production.

According to the research aim, the utilization of technology for the improvement of inventory management. There is a need to define inventory management and its functions. The organization's purpose is to hold Inventory, the cost involved, the techniques used for managing Inventory, and calcifications of Inventory.

5.2 Definition

Inventory management has been defined by (Viale,1996,p.3)as "Is to replace a very expensive asset call Inventory with less expensive asset called information". The definition brought the understanding that information is a key player in managing the Inventory. With the help of new technology like artificial intelligence, the information will be available and executed accurately. The Viale continue to elaborate the collection of appropriate, precise, dependable, and constant must be considered. Knowledge concern inventory management delivers the overview of how companies work on maintaining the required amount of

Inventory according to variation in customer demands. Also, for maintaining vendor deliveries and forecasting. Organizations have a reason for managing their inventories. Firstly, it will maximize the customers' service, increase production, increase procurement efficiencies, increase companies' finances, increase profits, and invest in Inventory maximized.

However, Inventory management comprises several activities such as Planning Inventory, Inventory controlling, inventory ordering, Inventory storing, and also how the Inventory kept are used for the production of items its sale. There are several categories of Inventory in Inventory management. There are raw materials, finished goods ready for delivery, components used for maintenance and other purposes, warehousing, and working in processing (Viale,1996).

5.3 Inventory

Before starting a deep overview of the topic concern "Inventory management "let me introduce the definition of Inventory presented by (Viale,1996, p.ix) as follows, "Inventory is a very expensive asset that can be replaced with a less expensive asset called the information". The correct information and data management within the business will contribute to transforming the expenses of Inventory.

When it comes across with the term inventory has a different meaning depending on where it is used in the USA and UK. In business and accounting, American English inventory is referred to as materials and goods bounded in the business that waiting for resale. American define stock as capital invested while British English stock shared define the same meaning. The rest of the world, who are English speakers, commonly use stock and Inventory as a substitute(Viale,1996).

After explaining the different meanings of Inventory depending on different countries, here we discuss what kind of inventories are found in organization inventories, such as materials stored for production purposes. This means materials are stored waiting to be processed. Every year companies are preparing annual reports, and the inventor plays a significant role in the business's balance sheet. For example, the report shows how many assets are contained in raw materials inventory, items, components, ready products, unfinished goods, etc. The inventory managers are working harder to overcome the circumstances that may arise by holding Inventory. The some tied in the Inventory does not bring any income; therefore, for the companies to continue with the operation, they have to incur costs from a loan, expenses for keeping material stored, and maintain durability. The Inventory is generally classified into few categories that are:

- **Raw materials** This is an inventory of direct materials and parts procured for production from start to the end products.

- **Work in progress**; this is inventories on the continuous production line such as assembly line moving to the final products.

- **Finished goods**, this is an Inventory that has a ready product ready for delivery to customers.

- **Maintenance, Repair, and Operational Supplies (MRO)** The inventories used to facilitate the productions, for example, the materials and equipment used during maintenance, the items used in the production process such as packaging materials, etc. (Hong-Mo Yeh, D., 2021).
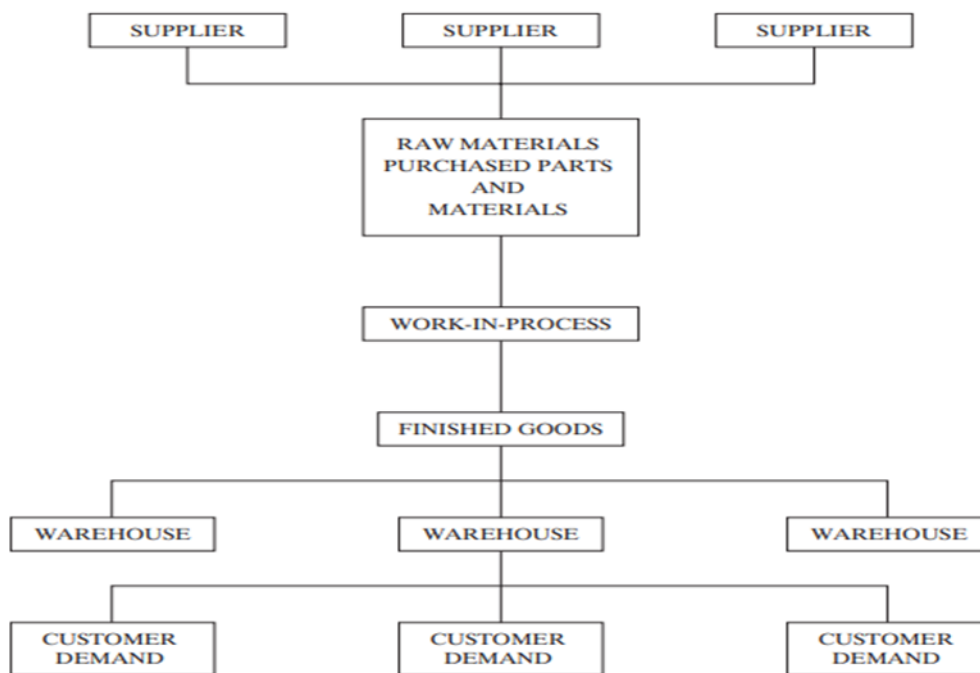
Figure 5:Inventories and flow of materials(Arnold et al., 2007)

The mentioned above inventory types depend on the nature of the business. For example, Manufacturing contains less finished goods, more work in progress, and raw materials. If compared to distribution, most of their goods are finished goods for resale (Muller,2011, p.23).

5.4 Types of Inventory

As presented by (Viale, 1996, p.8), "there are two components of any inventory cycle stock and safety stock". Cycle stock comprises the "active" items, which are held as Inventory, and safety stock which is similar to buffer stock. The purpose of keeping buffer stock is to prevent challenges brought by demand and supply changes. Buffer against alteration of customer orders, forecast, and delayed delivery from suppliers. These Inventory types are essential in every organization because they act the time demand and supply are

fluctuating. They carry no value-added, but they are needed to maintain high customer satisfaction. Many companies face challenges when trying to minimize Inventory while maintaining the customer service level.

5.5   Significance of holding Inventory

Customer satisfaction is one of the major purposes for holding Inventory, however as discussed for the companies to operate their activities smoothly, need to hold Inventory. As presented by (waters, 2003, p.266), "The main reason for holding such stocks is to give a buffer between variable – and uncertain– supply and demand". A good approach of holding Inventory with purpose is that the retail stores are delivered with many items, but they are sold to individual customers with smaller numbers. The stock allows the retail shop to continue operating when there is any delay from the supplier and if there is a fluctuation of demands.

There are also economic factors behind Inventory holding, such as the costs involved when repeating ordering the same Inventory. If the company orders a significant quantity, there is a possibility of getting a discount, avoid opportunity loss on sales, and utilize the free space of their facility for other operations for reduction of overall expenses. There is no way to avoid Inventory. The only thing is to utilize the available technology and methods for maintaining Inventory(waters, 2003).

5.6   Inventory Management objectives

Inventory management's logistical objective is referred to the business to sufficiently manage their daily demands and improvement of the entire supply chain. There are different processes within the supply and distribution network that, if not well-connected during the transfer of products within the supply chain, challenges might ascend. Therefore, this aims to hold inventory on the whole process to respond to the demand of the following procedure (Gleissner & Femerling, 2013,p.160)**.**

The above general explanation about the objective of Inventory management is accompanied by "A review of American industry balance sheets reveals that many businesses have 20-40% of their total assets tied up in inventory" (Richard,1994, p.20). The author trying to give clear ideas that managing inventory appropriately will minimize the cash tied in the Inventory. Furthermore, the purpose of keeping managing the Inventory is to make sure the needed level of Inventory is kept and avoidance of shortage and excess of Inventory. Inventory management systems are utilized to cut down the expenses of carrying Inventory and

ensure that the supply of unprocessed material and finished products remain continuous all through the company operations. Below there are four objectives of inventory management with an explanation of each (Tersine, 1994, p.20).

Maximizing customer service: As presented by (Viale, 1996,p.4), "Inaccurate customer forecast, a multitude of changes to the original customer orders." for the organization managing their Inventory, and fulfill their objectives by working on correct forecast concern customer requirement and be able for the delivery of customer demands on time. Management of business account is also a key role for customer satisfaction, and the financial situation must be well. To maintain customer service level, need a clear focus on often delivery of customer demands on time. Set goals that lead to 99.99% of customer satisfaction that means on-time delivery.

Maximizing the efficiency of purchasing and production: The organizations follow the ideas of purchasing a great number of materials or semi assembly items more than what is required for the reason of benefits on cost efficiencies. This advantage is not only during purchasing but also at the time when the materials are transported to the production site. The strategy is well applicable to the mass production of a single product (Large lot size). The manager's performance indicator is by the quantity produced for an extended period of production runs(Viale, 1996,p.4).

Minimizing Inventory Investment: Any business that keeps Inventory there is cash bounded, which cannot be used for other operational purposes. More Inventory, the tremendous amount of money tied, results from the complex circulation of money with the organization. Excessive Inventory must be avoided for the business's development and try keeping Inventory as lower as possible(Viale, 1996,p.4).

Maximizing Profit: The only way companies could increase profitability on their operations is by making an effort on increasing income and manage to lower the operation costs. Strategically inventory management might result to maximize company profits. Saving inventory cost is an easy way of gaining profit than the profit may come from selling products(Viale, 1996,p.4).

To conclude, these remarks concern the organization's significant purposes to manage their Inventory, if all objective explained above reached the business will be successful and productive, thus increasing return of investment RIO and return of Asset (ROA).

5.7   Functions of inventory

5.7.1   Safety Stock

Safety stock is an essential function in inventory management. As noted, concern safety function, "stock is kept ensuring the availability of goods at all time" (Herald &J. Christian,2012, p.162). An additional amount of stock is kept in Inventory to act against unpredictable changes in demand or supply. Any delays in the supply of raw materials will be solved with safety stock, and there is no shutting down the operations. If demand forecasting was done wrong and customer demand becomes greater than Forecasting, a stock shortage will occur. Safety stock is utilized to overcome these volatile events and prevent interruptions in manufacturing. Another name of Safety stock is buffer stock (Hong-Mo Yeh, 2021).

5.7.2   Lot-size Inventory

Lot size inventory, also called working stock, is purchased and held in advance of needs; raw materials are prepared on a lot of sizes instead of the requirement basis. The lot size inventory has advantages because ordering a large number of raw materials, there is a possibility of getting a discount, shipping costs, and set up costs decreases. However, there is an increase in the holding charge. Lot-size Inventory reduces gradually as customer orders come in and regularly replenish when suppliers' orders are received(Hong-Mo Yeh, 2021).

5.7.3   Decoupling Stock

Pile up Inventory between dependent activities or steps to reduce the coordinated operation's requirement. Decoupling stock separates individual systems from the next to allow them to operate independently. This Inventory increases the utilization of facilities(Hong-Mo Yeh, 2021).

5.7.4   Pipeline Inventory

The Inventory put in transportation to allow for the time taken to receive materials at the input end, send materials through the production process and deliver products at the output. Flow-through intermediate stocking points. This kind of pipeline inventory externally is in ships, trucks, and railcars or a literal pipeline. Internally, it is being processed, waiting to be processed, or being moved(Hong-Mo Yeh, 2021).

5.7.5   Anticipation Inventory

Inventory built up to correspond with peak seasonal demand, unpredictable requirements such as promotional programs, strikes, vocational shutdowns, or production capacity deficiencies. It is supplied or produced in advance of requirements and depleted during peak demand to keep production rates and stabilize the workforce(Hong-Mo Yeh, 2021).

5.7.6   Psychic stock

This is a retail display inventory conducted to accelerate demand and act as a silent salesperson. It is increasing the chance an item is spotted and considered for buying. Full shelves boost sales by exposing customers to as much stock as likely and creating greater product visibility. Under-stocked shelves as well as running out of stock can lead to dropped sales and lost customers. While other stock types backing low-cost operations, the psychic stock is a revenue generation category. It is involved with revenue making via demand creation versus expense minimization, which is supply orientation (Tersine,1994, pp.7-8).

5.7.7   Hedge Inventory

Hedge inventory is Inventory purchased to either protect against or take advantage of price fluctuations. These price changes could be the consequence of seasonal demand, inequalities in supply and demand, or other reasons. Hedge inventory is a form of protection that guards against increasing prices. For example, suppose the organization is supplying baking ingredients, and they know that the price of sugar is about to rise because of a lower sugarcane harvest. In that case, purchasing hedge inventory in the form of excess sugar is a good idea before the cost goes up. The company will be able to provide to its customers a better price than its competition can in the future (Schaefer,2020).

5.8   Inventory Control

Inventory control is defined as all cash invested for the raw material and supplies, unfinished products, and finished products needed continuous management. Because of the complexity of supply chain and production processes, risk management over Inventory or less Inventory has continued to challenge many Companies. There are tools introduced by the innovation department that provides a possibility to balance Inventory and shortage. The well famous inventory management methods are MRP (materials requirement planning) and JIT (just-in-time).

5.9 Inventory costs:

According to (Müller,2002, p.2), "Inventory brings with several costs, the costs can include: Dollars, space, labor to receive, check the quality, put away retrieve select, pack and account for deterioration, damage, and obsolescence, theft". The activities included in Muller (2002) note produce costs in a different process. There are commonly known costs that are costs for ordering Inventory and costs for holding Inventory. When talking about ordering costs, it is the cost that has no relation to the ordered products' price. Organization incurs the cost of requesting goods, such as employee salaries costs relating to moving the Inventory.

The holding costs defined by Muller (2002,p.2) "include the costs of capital tied up in inventory(the opportunity cost of money)".The expenses included in holding costs are the cost for paying storage facility, the prices used for purchasing equipment utilized for caring, the cost for paying salaries of warehouse and stock control employees, the costs incurred if there is any stock loses because of theft practice or obsolescence and finally costs for paying different government taxes.

The costs that pile up when holding inventory are divided into four major categories and explained below by (Rushton et al., 2014, p.230).

Capital cost: The costs used when investing cash for buying machines, building, and technology. From a logistics point of is, an investment in warehouse machines and the technology used Also cashes for keeping the operation running, taxes, etc.

Service cost: these are costs used for paying insurance in case of an accident, Charges for keeping inventory in appropriate condition. Maintain the facility such as cleaning and so on.

Storage cost: The costs happen regarding inventory size, weight, and shape, costs for different activities related to storage such as packing, moving, sorting, etc.

 Risk cost: relates to the changing condition of the goods stored, for example, damage, end of usage time, spoilage, loss, or stolen.

The amount of cash tied for the company warehouses is approximately 20 – 30 percent of logistics costs, for holding inventory is about 18 – 20 percent. (Rushton et al. 2010, p.233)

5.10 Inventory Management Techniques

For an organization to control and improve its inventories apart from the application of new technology. Researchers and other sources present different techniques. The methods are essential for business operations and managing inventories. The implementation of the inventory management techniques will provide clear advantages like cost reduction, increase customer satisfaction, improve supply chain, increase knowledge for employees. The techniques contribute important needed knowledge for the benefits of businesses. Some of the techniques will be elaborated further below.

5.10.1 Forecasting

According to a writer (Vaile,1996,p.29), "Forecasting is a key to all successful business planning system. "For the better customer demand delivery faster and on time forecasting is essential tools, the future demand can be forecasted and come up with demand estimation. The calculation with the use of formula and information from other sources might be used for estimating customer demands.

In order for Forecasting to be productive, the information gathered must be timely and on a daily basis. For better performance in Forecasting must comprise forecast tools that use previous results to estimate the forthcoming sales, creativity and data collection, manage gathered information, and information about what kind of product produced. The key indicators for good Forecasting are: Increase customer service level, minimize Inventory, high productivity, and improve deliveries(Vaile,1996).

5.10.2 Determining Inventory needed

Another inventory management tool presented by (Vaile, 1996) is for the business to determine what Inventory is needed at the right time. This technique depends on how accurately the forecast of product for sales was conducted. The business needs to minimize the forecast errors and keep only the inventory level required to serve customers. The results of less Inventory provide the outcome such as less space for storage and well use of machine capacity. The Inventory will not be kept if not needed.

For the organization to have a clear understanding for the demand of material required three traditional demand are presented below as follow:

- **Deterministic methods**, where the requirements are calculated based on the production program.
- **Stochastic methods**, which make use of consumption statistics and forecasts.
- **Heuristic methods,** which allow making inferences as to the requirements employing comparisons with similar products (analogous estimation) or intuitive estimations without relying on numerical data (Gleissner & Femerling, 2013,p.160).

The department of procurement calculates the type of raw materials and components needed. The figure below shows the types of requirements. Primary demand relies on external factors and is usually caused by the frequently changing demand, changing economy, and short-time demands.
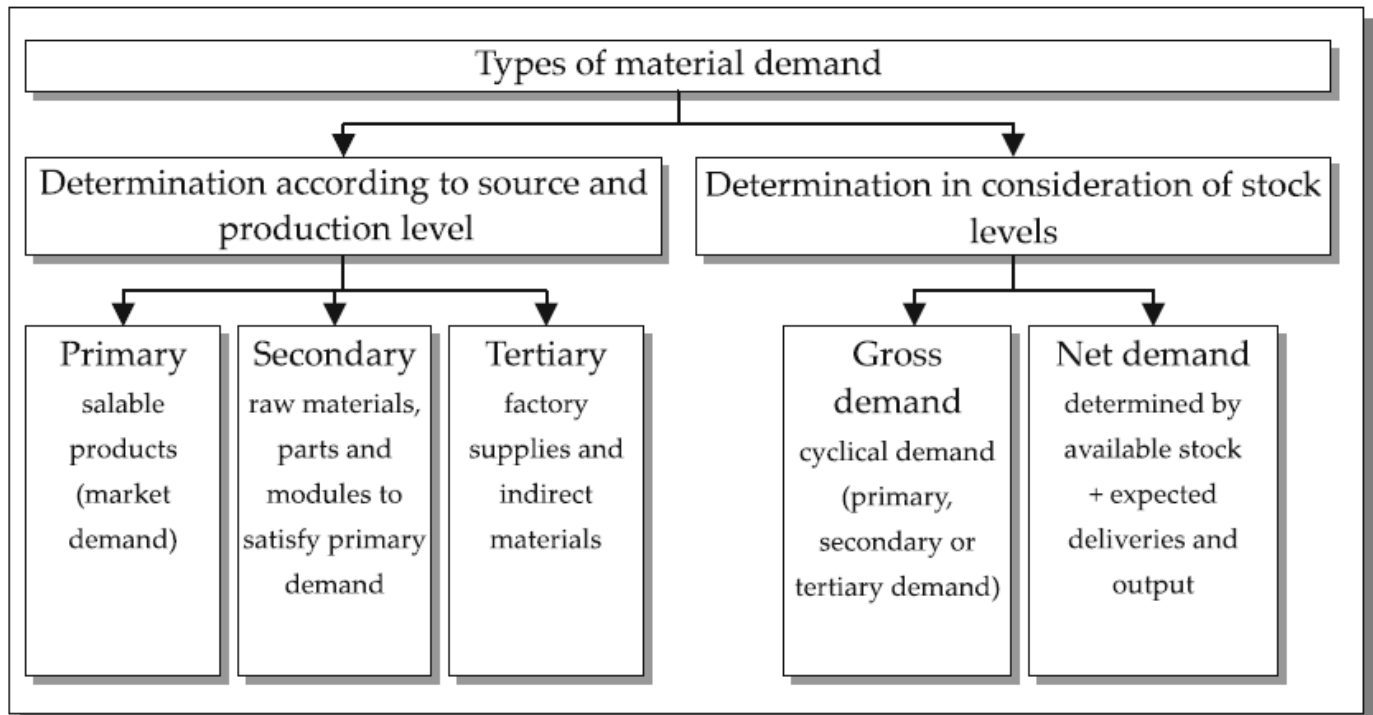
Types of material demand

Determination according to source and production level			Determination in consideration of stock levels	
Primary salable products (market demand)	Secondary raw materials, parts and modules to satisfy primary demand	Tertiary factory supplies and indirect materials	Gross demand cyclical demand (primary, secondary or tertiary demand)	Net demand determined by available stock + expected deliveries and output

Figure 6:Distinguish types of material demand(Gleissner & Femerling, 2013,p.161).

Secondary demand depends on the primary demand. Tertiary demand does not bring any attention because it is ordered once needed. To differentiate gross and net demand are identical to the time at what kind of demand occurs. The consideration of demand categorization is relatively dependent on the type of demand mentioned in the figure above(Gleissner & Femerling, 2013,p.161).

5.10.3 Economic Order Quantity

Economic order quantity is a technique applied when dealing with demand. It contains the formula to calculate and estimate the number of products purchased or manufactured by finding out the minimum costs of purchasing or producing. The technique considers the costs as well as carrying Inventory. The organization uses the Economic Order Quantity (EOQ)formula to determine the minimum number of units to be procured or manufactured and the minimum costs per unit. The outcome of the calculation will enable the

managers to know which delivery to select, which contributes to the investment cost used in Inventory(Rushton et al. 2014).

Furthermore, the technique (EOQ) used to estimate the amount of stock to order to replace the ones used, "the EOQ method is an attempt to estimate the best order quantity by balancing the conflicting costs of holding stock and of placing replenishment orders"(Rushton et al. 2014, p.238). This note is elaborated on in figure 7.
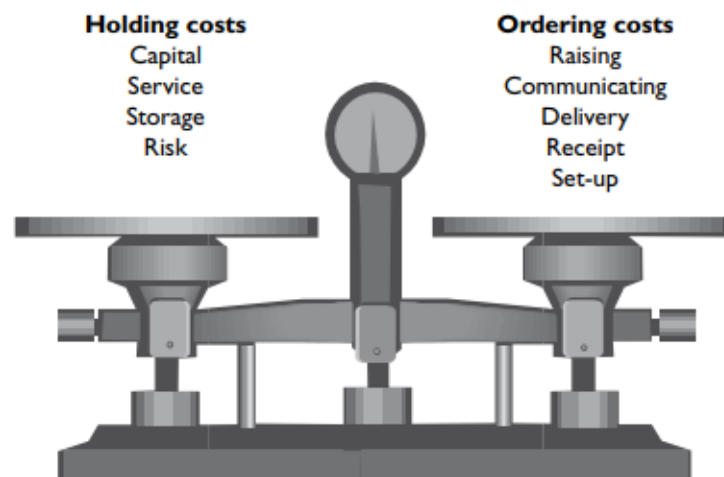
Figure 7:The EOQ balance (Rushton et al. 2014, p.238).

The utilization of (EOQ) techniques gives a great advantage for the business to order a larger amount of goods and reduce costs. Still, we need to remember that ordering a large quantity. There is a possibility of carrying a larger average Inventory resulting in a rise in holding costs. Instead, the act of ordering less quantity will lower the stock average, but because of frequently ordering, the price of orders will increase. As explained before, EOQ aims to balance the costs of holding inventory and costs of ordering to replace the

stock used. Figure 8 elaborate how the balance of these costs reached, that is EOQ principle
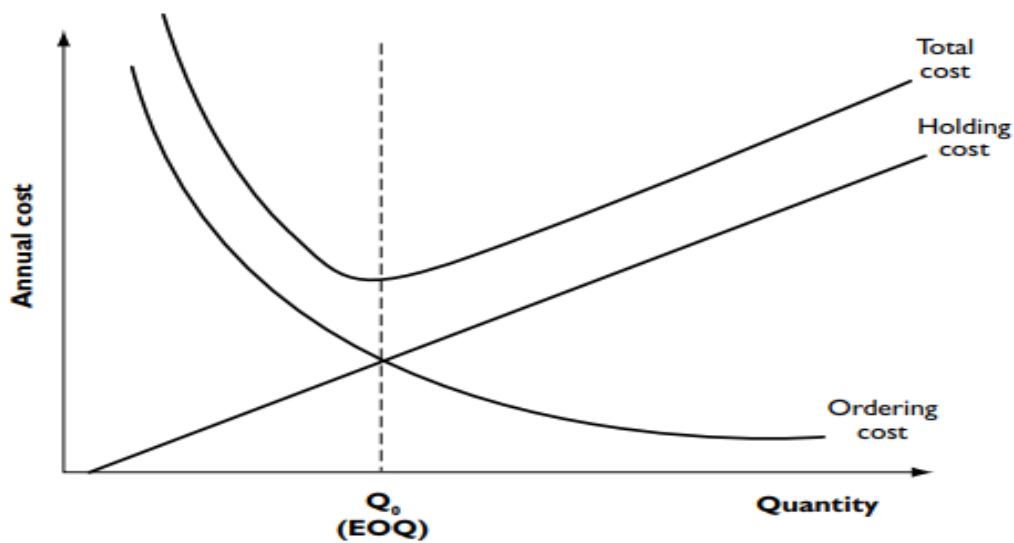
Figure 8:The Economic Order Quantity (EOQ)principle (Rushton et al. 2014, 239)

The application of (EOQ) model of inventory management can bring out the following expectations:

- There is no fluctuation in demand.
- Constant and direct decreasing of inventory.
- There is no consideration of cost reduction for the number of units ordered.
- Fixed time from the moment order submitted to the time order received.

At the beginning of introducing (EOQ) method is a mathematical approach that uses a formula. Figure 4 is a simple formula that elaborates on how to find the amount of unit demand and the price of unit per dollar (Rushton et al. 2014).

1. Units: $EOQ = \sqrt{\dfrac{2US}{IC}}$

where
U = Annual usage in units
S = Setup or ordering costs
I = Inventory carrying cost
C = Unit Cost

2. Dollars: $EOQ\$ = \sqrt{\dfrac{2AS}{I}}$

where
A = Annual usage in dollars
S = Setup or ordering cost
I = Inventory carrying cost

Figure 9:The EOQ Formula (Units and Dollars)

5.10.4 Vendor-Managed Inventory (VMI)

This is a technique used with businesses for creating excellent and transparent collaborations with critical suppliers for the serious Inventory. Big companies mainly apply this. VMI is a business strategy used by organizations to outsource some of their activities relating to inventory control. There are several different outsourcing methods, such as the organization using a third party to deal with the control of whole inventory management activities or another organization taking care of Inventory but does not hold Inventory (Waters,2003, p.289).

By taking an example, let's assume there is a department that deals with the storage of sports shoes; the store company manages its inventories when it needs more stock prepare order and send it to a wholesaler. According to the VMI point of view, this means the wholesaler is taking control of the Inventory, and whenever it is needed, they send it to the department store. The technique gives the supplier advantages of arranging the Inventory in a larger perspective. The supplier applies better inventory policies that contribute to a competent transportation plan, a more comprehensive collaboration network within the supply chain, constant customer service, and satisfaction and appropriate data collection regarding demands (Waters,2003, p.289).

5.10.5 Just-In-Time

This is another essential inventory management model, which is explained as ordering new materials or inventory according to requirements just in time. Most businesses with expensive inventory items like Airbus preferred (JIT)method. Those items cost a considerable amount of money during purchasing time. This means the costs of holding inventory of this kind are high, and at the same point, their demand is low. The (JIT) is used to control the unnecessary costs that develop when ordering required stock. Supplier is a key player on this JIT approach to succeed by ensuring on-time delivery. This is to avoid the expenses that might occur by a customer running out of materials. Better utilization of JIT has benefited many big companies. For example, Toyota is a well-known company uses JIT in its car manufacturing factories. JIT improves the return of cash invested, decreases the works that are waiting for value-added and other costs associated with inventory control (Jose et al,2013).

5.10.6 ABC Analysis

The application of ABC analysis or Pareto Analysis has been seen in many businesses. It is a process of categorizing which items or Inventory the organization will give more attention to. ABC analysis is a tool used to specify and group items according to their importance. From the inventory management point of view, the ABC system introduced by (Jose et al. 2013,p.5) is, "technique to identify inventory items for the aim of inventory control". This means the analysis will give the inventory managers clear knowledge on which inventory to focus more on and which inventory needs less focus. The advantages of ABC categorization allow customer service levels to increase successfully, increase productivity, deliver reliable delivery, and reduce the unpredictable inventory shortage.

As presented by (Waters,2003, p.274), "an ABC analysis puts items into categories that show the amount of effort worth spending on inventory control. This is a standard Pareto analysis or 'rule of 80/20". Waters idea here can be elaborated more like there are inventory with less number but need significant consideration relating the amount of money used for control, but the stock with larger quantity but less money used for control. ABC can be defined as follows:

- A Special attention inventories with high.
- B Average attention inventories with normal.
- C Slight attention inventories with low price.

The (B) inventories with average attention organization can decide to hand that by automation systems. For (A), inventories need deeper examination by managers for the avoidance of possible difficulties before concluding. The (C) inventories will fall on manual operation. The figure below elaborates the typical results for an ABC analysis "Pareto rule" graph, representing the collective price over a collective ratio of items.

The mathematical approach is conducted by computation of the sum of annual needed all categories by its price. The result is used to plot the graph as shown below.
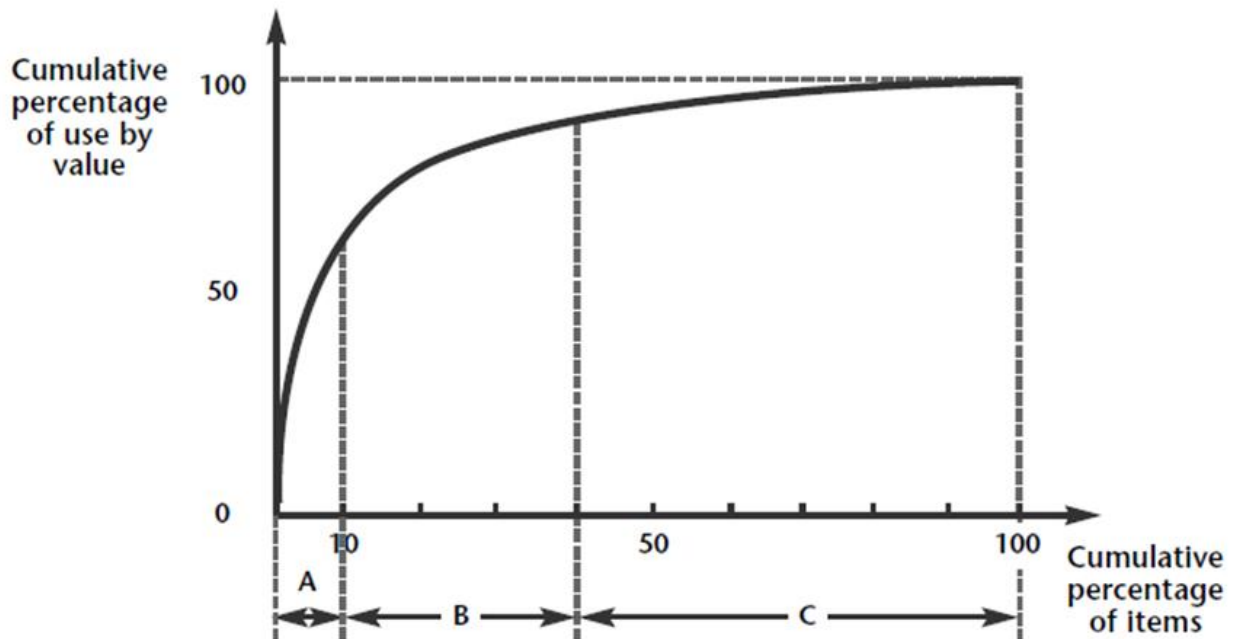

Figure 1: Typical result for an ABC analysis (Waters,2003, p.274)

 A requires more care, **C** needs less consideration, and **B** needs average.

Here the author Donald water insisted attention when applying ABC categorization, and it can provide ambiguous guidance. The consideration of the price of inventories for the whole year may provide unreasonable results, the inclusion of not used protection kit. The typical production line does depend on all items with the required standard for continuous running no matter how much it cost (Donald,2003, 274).

VED analysis

VED analysis technique as introduced by the researcher (Sinha and Shunmugasundaram,2021, pp. 84-85) and other techniques elaborated below are classified the same as ABC analysis. There are three different categories of inventories depends on their requirement. These kinds of inventory techniques the required inventory rely on a specific time on placing orders. VED can be introduced:

- **V:** Vital item inventories, the continuously ordered inventories that will be kept all the time to make operation run.
- **E:** Essential item inventories, these inventories are monitored not to reach the lowest level before ordering more inventory.
- **D:** Desirable item inventories are low essential inventories, and the shortage does not affect the operations.

HML analysis

HML is Among inventory management techniques that are categorized according to the cost of units. HML stands for High, Medium, and Low: That means the inventories are classified into three different groups. The inventory with high, medium, and low values per unit(Sinha and Shunmugasundaram,2021).

Aging schedule of inventory

The aging schedule of inventory which in other name known as FNSD analysis. It is based on categorizing inventories according to their holding time. The technique is used in the organization to provide information about the inventories' situation and manage scheduling orders and reorder. Unlike the previous analysis, the aging schedule of inventory is categorized into four: Fast, Normal, Slow, and Dead moving inventories(Sinha and Shunmugasundaram,2021).

SDE analysis

SDE analysis inventory management technique that categorizes inventories regarding which market the needed inventory available. Does the item exist in the market, and where? The technique helps the organization make a different kinds of strategies relating to inventories by providing insight concerning any shortage of materials or supplies. SDE stands for Scarce, Difficult, and Easy inventories. The classifications are explained as follows, S: Scarce means the products inventories that have shortage supply. D: Difficult inventories that not found within the same production country or city

E: Easy inventories that are easy to find near to the production or service area(Sinha and Shunmugasundaram,2021).

LIFO

LIFO is a technique applied in many logistics functions. This term is explained as last in, first out. The items inventories received will be sold first, and the old received items will be sold last. The technique plays an essential role in inventory management(Sinha and Shunmugasundaram,2021).

FIFO

This procedure is applied in inventory management that the product or items received first will be the one which sold first or delivered first. FIFO can be defined as a fist in, first out. This technique's main goals for the organization maintain the value of the product according to seasonal demand; for example, the retail store products like shoes or closes, the more they keep the item inventories, the less value it becomes(Sinha and Shunmugasundaram,2021).

HIFO

Inventory management method used with businesses by first sell the product with the highest values to reduce income taxes(Sinha and Shunmugasundaram,2021).

6 The revolution of inventory management.

The researcher Lusk (2017) noted in his article the transformation of Inventory management. The nature of business has made the inventory process change and increase accuracy and productivity. Currently, there is the application of new technology in logistics and supply chains. The technology based on real-time, the internet of things, and artificial intelligence used to monitor and track inventory and consignments. Like many other processes, evolution is driven by the need for greater efficiency and accuracy. Research has provided information on how we reach where we are in advanced technology as follow:

6.1 Manual Counting

During old age, the management of inventory was performed manually. The storekeepers and wholesalers worked so hard to count the number of items in their inventories to find out how many units have been sold and how many remain. These were daily activities and done manually. The process was consuming time with multiple errors. Keeping records of inventory enables to provide insight into predicting future demand; however, the manual process results in forecasting error and overstocking or running out of stock(Lusk,2017).

6.2 Punch Card System

As the world connects to the Industrial Revolution, which comes with mass production, inventory management starts its transformation. In the 1930s, the scientist from Harvard University introduced the "punch card system". The card is designed capable of monitoring the inventory items and has the ability to carry information that a computer can access. The customer demand information will be transferred to the warehouse staff for the customer order delivery. The records are kept concerned with the product purchased that recorded in the customer punch card. This process's disadvantage is that it was not faster and involve costs also mismatches with the business challenges (Lusk,2017).

6.3 The Modern Bar Code

The scientist continues developing new technology that in the 1940s and 1950s came into presenting a new and first type of bar code inventory solution. Therefore, the system was "composed of ultraviolet light-sensitive ink and reader to track items for sale" (Lusk,2017). The system took almost thirty years improvement path to reach a more outstanding performance. A bar code system with an established computer that uses

software transforms the old bar code to the modern bar that took years of application. The scanner application starts; however, item data loaded to the computers performed by hand(Lusk,2017).

6.4   Radio Frequency Identification (RFI)

This technology has changed many businesses in managing information. Previous technology bar code the information is entered in the computer by hand but RFID us electronic chip which stored products information. Therefore, an RFI device with an onboard microchip is used for data collection. The technology reads product information accurately. The vendor has benefited from RFI technology because it provides current information about the availability and sales data of items (Lusk, 2017).

6.5   Robots and Drones

Robots are taking over the activities physically done by a human being. Robots have transformed logistics and supply chain, especially in inventory management. The utilization of robots has grown steadily. The robots used AI for improving the speed and accuracy in several inventory management activities such as sorting, transportation in the warehouse, production, sales, and inventory forecasting. The figure below shows the essential driver of AI(Lusk,2017).
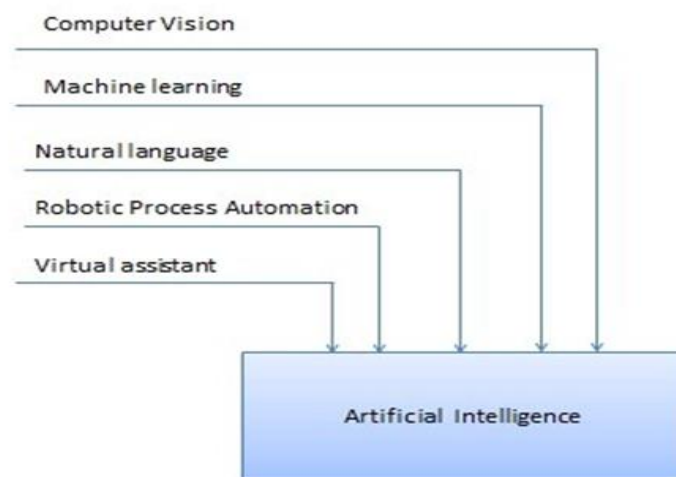
Figure 10:Artificial Intelligence Driver(Pandian,2019)

Moreover, Robots that applied in the warehouse has navigation devices such as temperature detector, sensors, camera, and audio. Advanced technology such as AI and machine learning systems support examining information for decision-making (Pandian,2019).

Additionally, numerous businesses implement drone uses to support the increased presence of intelligence automation in logistics and supply chain operations. The researchers note that "In the area of inventory management, drones can be used for the following tasks: inventory audit, inventory management, cycle counting, item search, buffer stock maintenance, and stock-taking" (Wawrla et al.,2019,p.6). This has attracted more organizations to invest in drone and Robot technology in their daily operations. A good example is giant eCommerce company Amazon applying drones currently and intelligence robots for its operating system such as packaging and distribution.

Furthermore, AI has transformed the business by improving accuracy in operations and efficiency.AI powered drones and Robot are operating in the warehouse. Therefore, new technology for scanning items such as bar codes, QR codes, radio frequency identification (RFID), and artificial intelligence (AI) helps automated drones and robots perform their operations. Additionally, robots and drones are mounted with computer and effective algorithms regarding the nature of the operation. The advantage of automated robots and drones is flexibility and ease to perform a complex task(Wawrla, 2019).

6.6   Inventory management models and artificial neural networks

The inventory management model is used to control the policy used in inventory control concerning costs. There is no yet available standard model for inventory management globally that introduced so fur. However, according to the researcher who presents the mathematical model called Economical Order Quantity (EOQ), unique solutions are working regarding circumstances that arise. The model is working on delivering a specific size of the order with a single product inventory. The idea assumed while using (EOQ) model is; there is a manufacturing procedure without volume limitations, and also, the demands are continuous (Sustrova, 2016).

The less capability of EOQ brought affluence for the scientist to introduce another model called the economic lot scheduling problem (ELSP). ELSP came with slight changes with capacity limitations, but still, the demand is constant. The EOQ continues its development path until the application of neural network methodology by researcher MC Neill (2003) to deal with inflation forecasting in the united states and European area. Artificial neural network models can well solve the inventory management problem in activities such

as demand forecasting and production planning. It can also solve lot size by using a neural network by controlling the difference of demand time against constant scheduling prospect (Sustrova, 2016).

In addition, Sustrava(2016) notes that the ANN model is built with the MathWorks MATLAB program. However, several steps are followed while constructing neural networks, such as collecting input and output data, designing, training, and validating neural networks. Therefore the data are arranged in the format of input and output forms. According to the research, a study of the neural network model improved the quantity of current inventory. The process was conducted by selecting the parameters that are input and output. Figure 11 below shows the factors that need attention during deciding the number of products or items to order.
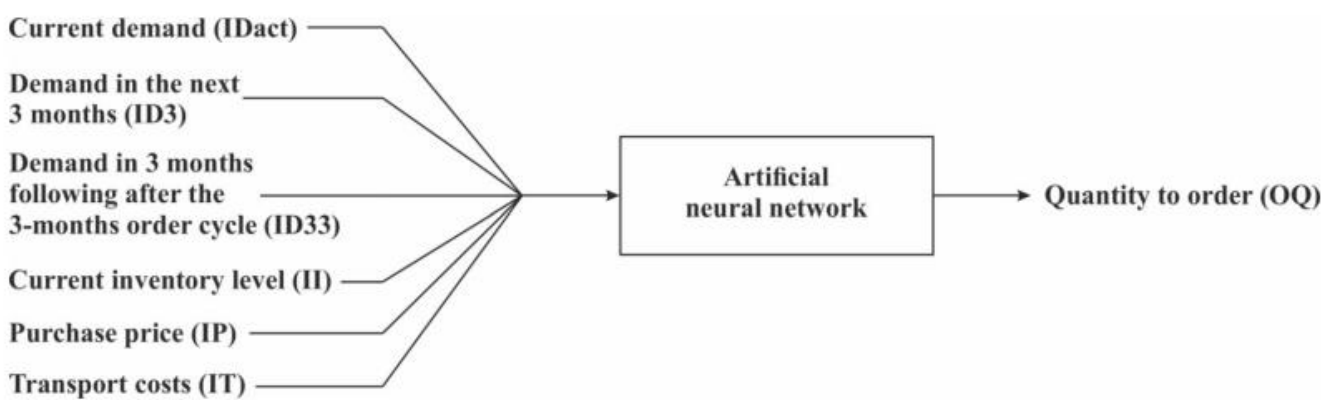

Figure 11:shows inputs and output of constructed neural network(Sustrova, 2016)

The research works continue to present different artificial intelligence, which is combined and for hybrid intelligent systems. The combination system's purpose was to solve demand forecasting, done by applying Autoregressive Integrated Moving Average models and neural networks. The outcome displays correct forecasting, improve sales, and reduction on inventory level. Therefore, Implementing the artificial neural network model in predicting has greater results with avoidance of forecasting error if compared to other methods.

6.7   Benefits of AI Inventory optimization

The organization's inventory management depends on the kind of activities conducted. The implementation of technology such as AI will improve the management of inventory in the company. According to the research conducted by (Kvartalnyi,2021), the benefits provided by Artificial intelligence to manage and improve the inventory management functions are mention and elaborated below as follows.

- Inventory monitoring automation
- Data mining
- Robot automation
- Error reduction in forecasting
- Customer experience improvement

Inventory monitoring automation

This function is working by automation powered with artificial intelligence and eliminates the use of manual tracking of inventory. Therefore the machine is performing all tasks, and the staff concentrates on another critical task. The advantage of growing technology has increased the number of companies that invest more in changing their logistics operations in full automation. Also, automation has improved the inventory management procedures by minimizing error, improve inventory and actual item tracing(Kvartalnyi,2021).

Data Mining

The collection of information is faster and accurate when using AI. The machine learning algorithms are used to follow customers' data according to what they are interested in. The technology assist company to understand the customer expectation and apply that for development of their businesses. In addition, the information collect will help the organization to predict and make a plan in advance(Kvartalnyi,2021).

Robot automation

The robots equipped with AI inventory management software perform inventory operations that were done manually, such as checking, fulfilling, and restocking. Therefore robots guided by algorithms work on processing customer orders and move them with sensors' assistance. The utilization of Robot automation reduces the time for task completion and increases overall business revenue(Kvartalnyi 2021).

Error reduction in forecasting

For a Company to be competitive, it needs to pay attention to how to reduce forecasting errors. In logistic and supply chain management, forecasting is challenging if done inappropriately. With the help of AI, data

management and prediction is possible to be done accurately and consistently, and the calculation regarding customer demands are updated from the data to ensure enough inventory for future service. According to a study, forecasting powered by AI reduces errors by 30-50% in supply chain networks. This leads to the increased accuracy, and 65% of lost sales reduction, which was mainly due to inventory being out-of-stock, and, also, warehousing costs decrease by 10-40%" (Kvartalnyi, 2021).

7   Implementation of Artificial Intelligence in different sectors

7.1   Healthcare system

According to the research purpose about organizations, consideration utilizes artificial Intelligence to optimize inventory management. In the healthcare sector, inventory management has a significant contribution to combat the shortage of drugs. The supply chain of drugs is complex because of the unknown scarcity of medicines caused by different circumstances for exitance during production, lack of materials, delay delivery, and other supply problems (Zwaida et al., 2021).

Solution for combating such problems of drug shortage in the hospital, there is a need for better inventory management to operate productively. Therefore, the application of technology such as artificial Intelligence for inventory replenishment is required. The findings from research presented by(Zwaida et al., 2021)shows deep Reinforcement Learning (DRL) model is a subset of artificial intelligence that can solve the problem of drugs shortage with the help of automation, examine the situation online and make orders for replacing the drugs that already used(Zwaida et al., 2021).

The researchers proceeded that health care systems dealing with drug inventory management consist of a significant amount of costs. Costs for better control of health center supply chain and drugs need special attention to meet usage requirements. Furthermore, the efficiency maintains of drugs and minimizing waste. There is a considerable risk if the hospital is running out of drugs. The solution is to find another substitute to keep them operational. According to the theory introduced in the previous chapter in inventory management, there is safety stock. Safety stock is kept and applied whenever there is fluctuation in demand and delay in supply. The approach is essential but has the drawback of costs of keeping an inventory, purchasing, and maintaining the drugs in good condition during storage(Zwaida et al., 2021).

7.2   ANN for demand forecasting

An artificial neural network has shown more comprehensive application in different supply chain activities: "lot-sizing problem in the supply chain by application of metamodeling simulation. Determines the optimum level of finished goods inventory as a function of product demand, setup, holding, and material costs" (Sustrova,2016). Furthermore, the artificial neural network is used to produce Ammonium sulphate to forecast the demand for economical orders quantity for inventory management. A forecast is essential for any business to estimate any future plan. The organization applies different predictions for their item or products, technology, and finances. The implementation of ANN in forecasting the total demand for Ammonium sulphate was much better than the traditional method. The researcher made a comparison between the exponential smoothing method and the artificial neural network method. The study results show attractive benefits of utilizing ANN in forecasting, such as reducing stock out, inventory level minimizes cost by 20%, accuracy forecasting, and increase profits (Mathew et al., 2013).

The automobile parts industries use BP neural network model for the prediction of inventory level. The model improves productivity and prediction accuracy if compared to another BP algorithm. To summarise, the application of artificial neural networks in inventory management has a significant contribution to lot size by improving performance and problem avoidance (Sustrova, 2016).

7.3   AI in eCommerce

Artificial intelligence is applied in the leading fast-growing global business strategy industry called eCommerce. The AI is used to help the organization on managing the plenty of data involved in the eCommerce industry. "AI is highly expertise in handling the customer data and forecasting the purchase behavior of customers" (Kiran,2018). The customer data are managed with the help of automation by sending information for any demand changes and enabling the organization to make a plan for the following products to fulfill the customer demand in a more productive way.AI has transformed the eCommerce industry by increasing automation level(Kiran,2018).

The logistics activities have been improved by autonomous. The data are used to run the supply chain inside a huge leading company globally. The application of AI has optimized the operations in Amazon inventory management activities such as lead time and forecasting. The operations are utilizing a "Machine learning system (MLS), a subset of AI solves the cognitive problems associated with human intelligence and helps to optimize logistic speed and quality" (Kiran,2018). The powered AI machine is trained and equipped with human intellect to perform the tasks done by human beings(Kiran,2018).

The increase of e-shopping has increased the challenges for the retail organization to control and manage their inventory. Thanks to the scientist who continues to research and innovate new technology like AI algorithms that has managed to fight against any challenges such as overstocking, inventory costs, and market fluctuations. The repeated changes in the market might be solved by the AI technology proposal of systematic forecast models. The models' main task is to analyze the general cause that challenges customer orders' speed. Organizations practice predictive AI analytics and algorithms for effective utilization of space, and efficiency.AI can be applied with the maintenance department for receiving the information that predicts the time for maintenance of equipment, conveyors, vehicles and justifies expenses(Kiran,2018).

7.4   Amazon Go

The AI technology applied in eCommerce giant Amazon in their online stores is the "combination of machine learning, computer vision, and cameras" (Kiran, 2018). This Technology is automated to act as a standard store cashier, but it is more advanced to take care of the product's replenishment. The system will monitor customer activities in the store and send the purchase information to the customer's smartphone. Moreover, amazon uses the Technology called just walk-out Technology in their retail shops for the customers who do not want to stay on the line for checkout. The Technology is monitoring the products taken and if item not taken return it to the shelve. In addition, it checks the customer's virtual cart, and information is recorded to find out the amount of item that has been purchased by the customer are correct and payment is done through mobile phone(Y Li & Frank Hung, 2018).

The development of new technology has contributed significant advantages for Amazon to implement AI artificial to perform all tasks related to inventory management. Therefore at least all operations are powered by Artificial Intelligence. The systems installed are time series prediction and reinforcement learning. The inventory management functions are guided by machine learning or other advanced artificial intelligence systems(Ai, 2019). Figure 12 below, adapted from technology

news, is one of the moving robot technologies used for inventory management in Amazon warehouse.

Figure 12:Amazon AI inventory management(Ai, 2019)

In addition, Amazon implements ANN to solve the problem of dependent and independent variables. The technology is utilized to smoothen the process of prediction of future stock and with high accuracy. The ANN has provided customer satisfaction by analyzing the data concerning what customers need and what customers search from their store. For that matter, Amazon has increased the revenue by a minimum of 20 percent. Moreover, the application of cloud-based service is powered by machine learning technology by visual recognition tools to predict which factor will be applied. There are three different types of machine nodes included by Amazon when building the prediction model: Binary classification model, Multiclass Classification Model, Regression Model(Kiran,2018).

According to a study done by (Kiran 2018), figure 13 below illustrates the process of machine learning applied by Amazon to perform prediction. The process is starting by introducing the problem and inter to the machine learning model to perform framing. The process will follow the prediction steps as shown below.
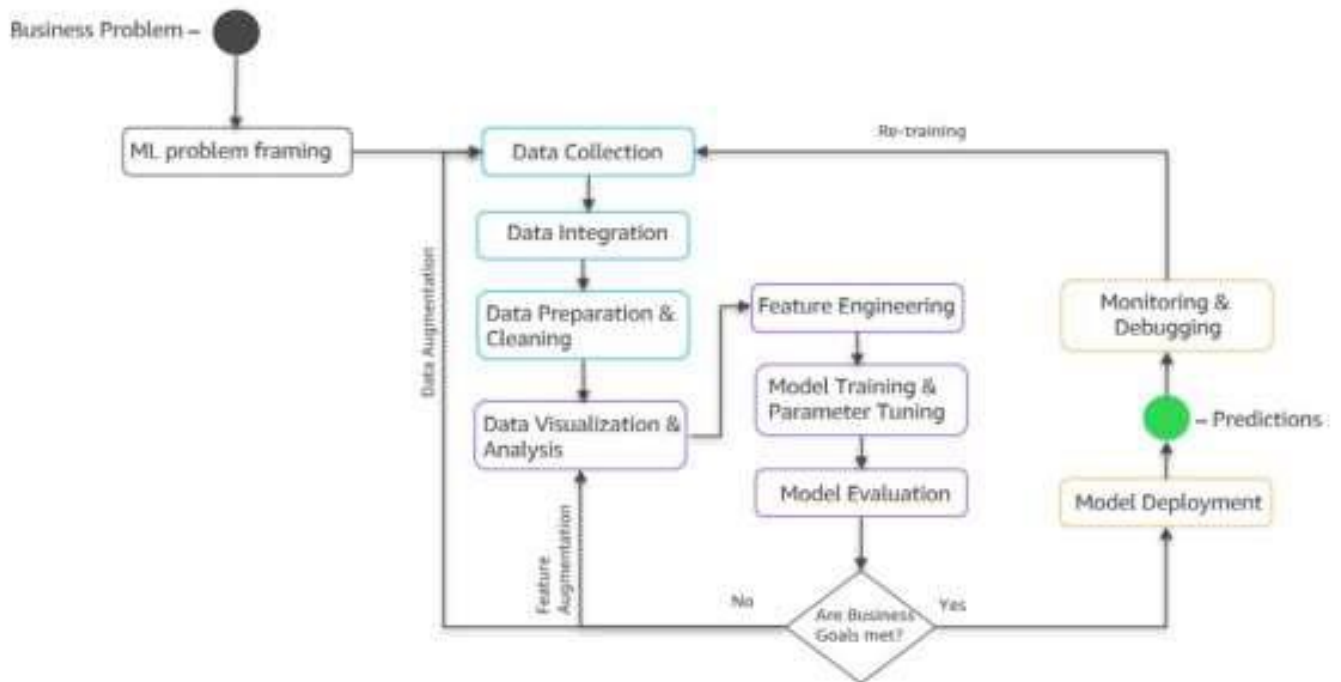
Figure 13:Amazon Machine Learning process(Kiran,2018)

7.5   AI in Coca-cola

The researcher Subbiah (2017) noted that the power of AI has continued to change the way businesses dealing with the supply chain, especially in manufacturing industries. Several companies face the problem of managing the challenges relating to inventory management that have affected their performance for a long time. Coca-cola company has introduced the use of AI visual recognition software in their area of inventory management.

Therefore, AI technology is used to automate all activities that were performed manually, such as monitoring, planning, restocks and ordering. The AI application has given the company a chance to concentrate and relocate their employees and money on other activities. Moreover, productivity and efficiency have improved by onetime check on inventory level whenever they want by using a mobile phone or other electronic devices(Subbiah,2017).

Besides, AI technology is used to process order procurement automatically to ensure the inventory level remains at the required level. That means eliminating human presence prevents errors while improving manufacturing accuracy. AI speeds up the collection of information regarding business and customer per-

ceptions.AI similarly provides a chance for the organization to use background data relating to their operations. "AI is helping businesses to get almost 100% accurate projection and forecast the customer demand" (Dash et al.,2019). Therefore, the possibility for the organization to reach total operation yield is essential for customer satisfaction and costs reduction.

The presentation was conducted by a Chief Scientist from salesforce about Einstein AI technology. The technology can learn and recognize, identify and provide the amount and varieties of bottles stored in the coca-cola cooler display unit. Therefore the technology using the salesforce platform to analyze the data inform of photo taken by iPad or iPhone (Supply Chain 24/7,2017).

8 Result of the study

The world has undergone several industrial revolutions from the first to the fourth revolution where technological advancements are at the moment. Artificial Intelligence has transformed the way of conducting business. Therefore, the ability to manufacture or providing services is possible without the intervention of human beings. The research objective was to analyze and study artificial intelligence's ability to improve inventory management. The research questions have guided the whole process of finding the results. The research undergoes several literature review steps and a deep understanding and overview of artificial Intelligence and inventory management. The information utilized to gather information was obtained from different sources such as books, articles, journals, and web pages.

8.1 Literature review summary

In the process of answering the two main questions of this paper, the careful selection of sources of information was conducted, starting with the definition of artificial Intelligence and Inventory management in a bigger perspective as presented in the literature review chapter. Moreover, the study concerns the possible application of artificial Intelligence in different sectors. Also, the technique utilized to manage the inventories and possible costs. Literature review about different kinds of inventories and artificial Intelligence. While analyzing information from the books, articles, and web pages, the result displays a clear picture of Artificial Intelligence's contribution in logistics and supply chain, especially in inventory management.

8.2 Impact of Artificial Intelligence

The investigation from other research shows the increase of application of Artificial Intelligence because of changes in customer behavior and shift to online shopping. The results show the improvement of inventory management functions by the technology able to perform multiple tasks. The robots and drones can per-

form repetition operations that were not possible if done manually and before automation it was time-consuming and much more errors. In that case, the organization able to save money, increase productivity, save time and improve customer satisfaction level.

In the health sector, the investigation shows the importance of utilizes artificial Intelligence to optimize inventory management. Therefore, inventory management with technology has a significant contribution to combat the shortage of drugs. The application of AI and machine learning has resolved the drug shortage. The deep Reinforcement Learning (DRL) model is a subset of artificial intelligence that can solve the problem of drug shortage with the help of automation, examine the situation online and make orders for replacing the drugs that are already used. The result shows that the technology can deal with accurate customer demand forecasts and a more remarkable ability to manage data and predict future demand.

In production industries, the coca-cola company's introduction of Einstein AI technology to its cooler units has improved the productivity and faster response to the replenishment of its products. The technology can recognize, identify and count the changes of stock by examining images taken by iPad or iPhone.The results show there was no need for physical counting. The Visual recognition engine Einstein's vision is used to take stock, prediction, calculate restock orders, weather information, recognize upcoming promotions(Supply Chain 24/7,2017).

The application of ANNs in forecasting results shows numerous applications in different logistics activities such as lot size problems by applying metamodeling simulation. The simulation is used to deliver the information about the best level inventory of ready goods, setup, material costs, and holding costs. The implementation of ANN in forecasting the total demand for Ammonium sulphate was much better than the traditional method. The researcher made a comparison between the exponential smoothing method and the artificial neural network method. The study results figure 14&15 below show the attractive benefits of utilizing ANN in forecasting, such as reducing stock out, inventory level, minimizes cost by 20%, accuracy forecasting, and increasing profits (Mathew et al., 2013).

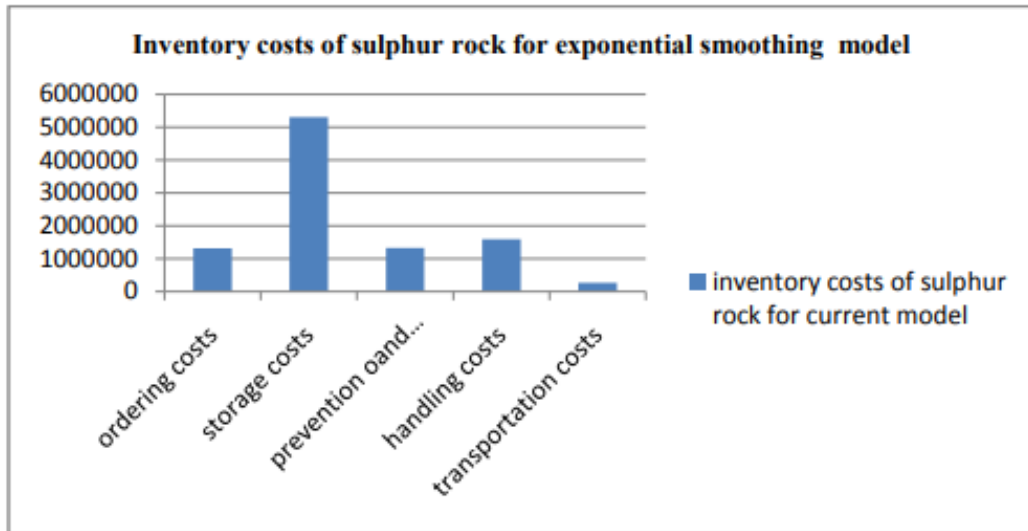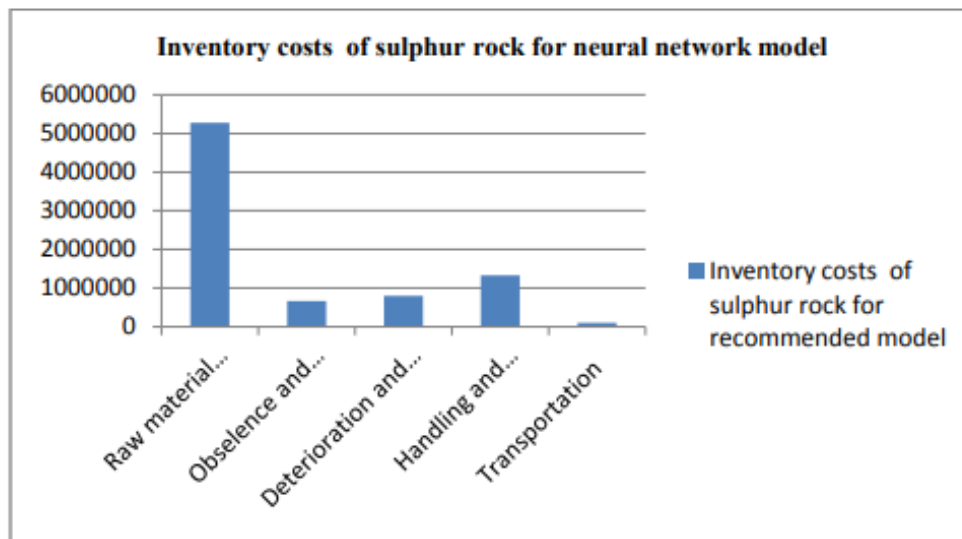**Figure 14**: Inventory costs of sulphur rock for exponential smoothing (Mathew et al., 2013)

Figure 15: Inventory costs of sulphur rock for artificial neural network (Mathew et al., 2013)

The above figure shows how the organization implements the artificial neural network for demand forecasting against the traditional exponential smoothing methods by calculating ordering costs and holding costs.

8.3   Benefits and challenges of artificial intelligence in businesses

8.3.1   Benefits

According to the literature review, several research studies investigate the benefits that businesses might achieve by applying AI in their different activities, especially logistics and supply chains. Researchers have defined how a machine can learn and capable of understanding information. In that case, the development of new technology is used to perform tasks accurately.

According to (Anica--Poppa et al.,2021), the application of AI branches such as machine learning through supervised, semi-supervised, and unsupervised algorithms to teach machines with software agents likewise deep learning constructed on ANNs technique to conduct problematic responsibilities. The introduction of A.I. has immense contribution to the development of the business/commerce industry in product customization, market trend analysis, target marketing, customer relationship management, and web personalization.

According to the researchers (Zhuo et al., 2021), presented the benefits achieved by implementing AI to their businesses. Firstly, it improves the organization's operation freedom on repetitive tasks and allows the employee and resources to be directed to other vital areas. Therefore, the technology transformation manages the activities done automatically and repeated with robots without human presence. Secondly, it improves performance by removing errors that were caused by manual operations, and sensors are used to recognize default in the items that were not possible to be detected by a human. Thirdly, the organizations that implemented AI in their production line has improved the productivity because of minimum error occurrence, moreover, the employee has up to date data that enhance their performance and accuracy decisions.

Moreover, this advanced technology provides the organization incredible advantage of processing power to examine a larger amount of data. However, Deep Neural Networks (DNNs), as investigated in different research and literature reviews, can control other technologies, including computing, big data, and the Internet of Things. In addition, they are empowering general-purpose machine learning algorithms (GPML) to control information based on audio, text, and video for efficient item demand forecast by investigating customer behavior. Therefore, by organization's ability to use advanced technology to the specific purpose and other technological features based on digital has improved the management of customer perception and expansion of their business worldwide.

8.3.2 Improving customer experience

After elaborating the general advantage of AI when applied in the organization to perform different activities, let look at how the technology might improve customer satisfaction. Researcher Clack (2020) has presented in this finding concern AI and machine learning for their ability to collect and analyzing information from several sources in the world society. The technology has provided incredible advantages for the organization to gain knowledge about the customer perspective. Moreover, the utilization of technology enables the business to directly cooperate with a customer and better performance in dealing with customer demands and anticipation. Furthermore, AI has gone far in the application by world big retail shop H&M introduction of chatbot platform that can operate online and offline to search for product and personal assistance (Anica-Poppa et al.,2021).

8.3.3 Challenges

Apart from the advantages that AI provides when introduced to the business, the research investigation has provided results showing that there are challenges involved during the implementation of new technology. The limitation concerns the costs and time consumed may contribute to the delay for the organization to decide if they are going to shift from the traditional system to the most advanced technology like artificial intelligence. The economic factor is crucial, and shortage of personnel with knowledge regarding the introduction of AI systems to fulfill the successful installation and future maintainability. Additionally, the investigation shows that the technology does not gain experience by itself like a human being because of doing the same job for a long time; instead, it gets wear and tear. The technology is depending on plenty of data to perform. Its operation in the way that it can change with the changes of environment like human intelligence. Furthermore, there is a possibility of violating the individual privacy artificial intelligence extract data from cloud base and apply them online basses, and if will not be managed well there is the possibility to fall on the hand of the cyber attacker. Companies spend an enormous amount of cash on cybersecurity(Zhuo et al.,2021).

9 Conclusion

The research work aimed to study and understand the impact of AI in the business in the faster-growing technology competition worldwide, especially in logistics and supply chain. To investigate the presence of AI in the logistics functions such as inventory management and how it can be applied to improve. The situation facing the world at the moment Covid 19 leads the author to conduct this thesis by applying qualitative research method using literature review and case studies. The review performed by several researchers has brought the understanding of the way AI has transformed activities recently. AI technology has changed

dramatically and created a value chain for many logistics activities, especially in inventory management. The increase of productivity and efficiency operations in an organization contributes to cost-saving and increased investment return.

According to changes in customer behavior by moving to online shopping and services, the leading eCommerce Companies have benefited from applying AI to fulfill the customer requirement and day-to-day operations. Use of cloud application chatbot to visit the company's website and look for products or services. AI has given the organization ability to manage multiple information from customers accurately and demand to forecast. The control of inventories of finished goods and saving ordering costs and holding costs. In the fourth industrial revolution, digitalization, most companies are working hard to implement intelligent operations for effective inventory management. For example, Amazon is using an intelligent vendor to save their customer needs without human interaction. The utilization of AI-powered automatic machines such as robots and drones to perform several operations in a warehouse. The collection of accurate data and timely has contributed a lot to improving inventory processes that influence companies to adopt AI technology. Coca-Cola Company has introduced the use of AI visual recognition software in their area of inventory management. AI technology is used to automate all activities that were performed manually, such as monitoring, planning, restocks and ordering.

The application of ANNs in forecasting results shows numerous applications in different logistics activities such as lot size problems by applying metamodeling simulation. The simulation is used to deliver the information about the best level inventory of ready goods, setup, material costs, and holding costs. The review of this study has provided the insight that AI application benefited many sectors in logistics activities. The logistics activities are essential for any organization to move the material and information from one point to another at the right time and right place.

The study shows the evolution of inventory management from traditional operations to automatic operations. To summarise through the literature review and case study that presented the findings from several researchers has provided the understanding that Artificial intelligence has a significant role in improving inventory management activities.

Discussion of research questions

1. Can Artificial intelligence improve inventory management?

As presented from the thesis, a selection of different sources defines the critical subject that shows artificial intelligence contributes numerous solutions to solve the challenges that have affected the

business for a long time in inventory management. Adopting AI has improved prediction, demand forecasting, inventory level control, Accuracy data management, customer satisfaction, and reduced costs by having excessive inventory or running out of inventory. The technology is continually developing and used in different sectors.

2.   How can the organization utilize Artificial intelligence in inventory management activities? Artificial intelligence has gain attention in different industries, and many companies investing in this technology increased steadily. The companies utilize AI in inventory management activities for planning prediction and modeling inventory management processes. The application of AI in data mining, the extraction of data related to their business and use the efficiency and on time. In addition, the organizations use the technology to manage the stock and its fulfillment, stock monitoring, effective delivery of customer demand without delay, the automated stocking processes—the use of visual recognition of inventory activities used by Coca-cola company. In health, The deep Reinforcement Learning (DRL) model is used to solve the problem of drug shortage with the help of automation, examine the situation online and make orders for replacing the drugs that are already used. To conclude, the investigation conducted by the researcher referred during writing this thesis has managed to provide answers for the two research questions that were critical leaders of this research concern Artificial intelligence impact on inventory management.

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