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The Role of AI in the Automating of Inventory Management: Challenges and Opportunities

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ABSTRACT:
Advances in technology and digitalisation have led to changes in the business world. As a result of digitalisation, artificial intelligence has emerged, and its role in the modern world is growing. Artificial intelligence can be taken into use in many parts of the supply chain. However, the most important element, in terms of supply chain functionality, is inventory management, from the perspective of which the role of artificial intelligence in this study is being studied. The purpose of this study is to explore the role of AI in the automation of inventory management, as well as current challenges and opportunities. These issues are studied from the perspectives of cost savings, operational efficiency and supply chain resilience.

The study has been carried out as a literature review using thematic as well as synthetic approaches. These methods have been used to find appropriate answers to research questions. The answers are found from many different sources, most of which are related to artificial intelligence and inventory management, as well as challenges and opportunities.

The results of this study highlight various challenges in terms of data quality, as well as challenges in AI accuracy and transparency. Of the opportunities, decision-making, real-time access to data and automation are highlighted. The introduction of artificial intelligence into inventory management of a company may bring many opportunities, but one must also be aware of the challenges it presents in advance.

KEYEORDS: inventory management, artificial intelligence (AI), cost savings, operational efficiency, supply chain resilience, challenges, opportunities

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TIIVISTELMÄ:
Teknologian kehittyminen ja digitalisaatio ovat johtaneet muutoksiin yritysmaailmassa. Digitalisaation eräänä tuotoksena on syntynyt tekoäly, jonka rooli nykymaailmassa on kasvava. Tekoälyä voidaan hyödyntää toimitusketjun monessa osassa. Kuitenkin toimitusketjun toimivuuden kannalta tärkein elementti on varastonhallinta, jonka näkökulmasta tekoälyn roolia tässä tutkimuksessa tutkitaan. Tämän tutkimuksen tarkoitus on tutkia tekoälyn roolia varastonhallinnan automatisoinnissa, sekä nykyisiä haasteita ja mahdollisuuksia. Näitä asioita tutkitaan säästöjen, toiminnallisen tehokkuuden ja toimitusketjun resilienssin näkökulmista.

Tutkimus on toteutettu kirjallisuuskatsauksena, jossa hyödynnettiin temaattista sekä synteettistä lähestymistapaa. Näitä metodeja on hyödynnetty, jotta tutkimuskysymyksiin löydetään asianmukaiset vastaukset. Vastauksia etsitään monista eri lähteistä, jotka useimmat liittyvät tekoälyyn ja varastonhallintaan, sekä haasteisiin ja mahdollisuuksiin.

Tämän tutkimuksen tuloksissa korostuvat erityisesti erilaiset haasteet datan laadun suhteen, sekä haasteet tekoälyn tarkkuudessa ja läpinäkyvyydessä. Mahdollisuuksista puolestaan korostuu erityisesti päätöksenteko, reaaliaikainen datan saanti sekä automatisointi. Tekoälyn käyttöönotto yrityksen varastonhallintaan saattaa tuoda mukanaan monia mahdollisuuksia, mutta myös sen tuomista haasteista täytyy olla tietoinen etukäteen.

AVAINSANAT: inventory management, artificial intelligence (AI), cost savings, operational efficiency, supply chain resilience, challenges, opportunities

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Abbreviations

- **AI** – Artificial Intelligence
- **IoT** – Internet of Things
- **ML** – Machine Learning

1 Introduction

1.1 Research Background

Fang et al. (2024, p. 1) state that for decades, digitalisation has been a part of economic and social development, influencing for instance companies' production. They mention that as a concept, digitalisation is broad and has various dimensions. These include, for example, digital technologies and digital implementation. According to Gama et al. (2025, p. 1), digitalisation is shaping companies in different industries by transforming their structures, operations and products. They claim that it also enables them to transfer from traditional business models to digital ones.

Digitalisation is affecting many areas, and among them are supply chains. Especially, in the recent years, after COVID-19, supply chain digitalisation has drawn a considerable amount of attention (Zhou et al., 2023, p. 1). Zhou et al. (2023, p. 1) bring up that trying to keep up with the digital trend, even 84% of the executives are enhancing the usage of digital technology in supply chains. As being a crucial part of supply chain operations (Daios et al., 2025, p. 3), inventory management is likewise affected by the implementation of digital technologies.

There are multiple technologies that can be implemented in supply chain operations, including inventory management. Examples of these technologies that are reshaping production and businesses are Artificial Intelligence, Internet of Things and advanced robotics (Daios et al., 2025, p. 1). The digital technologies enable various things. For example, according to Maretto et al. (2023, p. 576) the technologies can, among other things, retrieve and analyse data in real-time, and allow physical elements and machines to connect and communicate with each other. They also state that these technologies are used more and more to support humans from making decisions to assembling activities.

1.2 Purpose, Objectives and Research Questions

Modern supply chains increasingly include digital technologies, that provide many opportunities but also certain challenges. One of the technologies that has gained a notable amount of attention in the last few years, is artificial intelligence. At present, many companies are presently assessing whether they should implement AI into their processes or not. In this research, the challenges and opportunities that AI brings when implementing it to inventory management, are examined. Thus, identifying the different opportunities and challenges is the main objective for this research.

To achieve the objective, the key challenges and opportunities need to be identified, which brings us to the first research question:

Q_1: What are the key challenges and opportunities of using AI to automate inventory management in modern supply chains?

Usually, companies are interested in saving costs and optimising their operational efficiency the best way possible across their operations. In addition to this, they want their supply chains to flow smoothly without any disruptions. However, in most cases this is not possible, and supply chains need to be not only prepared to disruptions but also have the ability to respond to them and to recover from them. Thus, the second research question is the following:

Q_2: How does AI-based inventory management impact cost savings, operational efficiency and supply chain resilience?

1.3 Research Method

To achieve the objectives and examine answers to the research questions, a literature review will be conducted. The topics included in this thesis have been included in

multiple previous research, which makes literature review an appropriate approach for this research. Findings from the previous research will be integrated to this one.

For the subject of this research, literature review is a suitable option because the nature of it. In literature review, previous research is explored, which makes it easy to systematically identify trends, and understand the current opportunities and challenges. In addition, literature reviews tend to be a great choice for the fields where conceptual developing is ongoing and future research agenda needs to be defined (Synder, 2019).

1.3.1 Data Collection, Article Selection Criteria and Data Analysis

The data for this research was collected from multiple different databases, and different types of criteria was used to guarantee the validity and reliability of the research. The databases that were mainly used are ProQuest, IEEE Xplore, Emerald, ScienceDirect, Springer and Taylor & Francis.

To find the relevant articles form the databases different search commands were used. The commands are constructed with Boolean operators, and each theme had own commands. Mostly, the keywords were used to find the previous research. For the conceptual background, the most used search commands are provided in the Table 1.

Table 1. The most used search commands for conceptual background

Related Theme	**Search Command**
Inventory management in modern supply chains	“inventory management” AND “modern supply chains”
Artificial intelligence	“artificial intelligence” AND “machine learning”
Artificial intelligence in inventory management	“artificial intelligence” AND “inventory management”

Cost savings in inventory management	(“cost savings” OR “cost reduction” OR “cost efficiency”) AND “inventory management”
Operational efficiency in inventory management	“operational efficiency” AND “inventory management”
Supply chain resilience in inventory management	“supply chain resilience” AND “inventory management”

For the chapters of challenges and opportunities, the search commands for the three aspects (cost savings, operational efficiency and supply chain resilience) were modified to find relevant articles. For the challenges, “AND (challenges OR limitations)” was added to the search commands. To find opportunity-related articles, “AND opportunities” was added to the end of each existing command for the three aspects.

To find the most suitable and relevant articles for this research, criteria to select only the most useful articles needed to be set. The quality of the article was one of the criteria. Only peer reviewed and academic articles were searched for from the databases and selected. In addition, the publishing date was important. The articles needed to be published in the last five years to be selected for this research. However, the articles from the past three years were preferred and searched first. After, if no suitable ones were found, the timeline was extended to five years. This is because artificial intelligence has developed a lot in the recent years, so the most recent research was the most suitable one for this research. In addition to quality and publishing date, only articles written in English were selected.

The articles were selected in two steps. First, the title had to be related to the subject. Secondly, the abstract needed to match whatever was searched for. After these steps, the articles were selected and used in this research. The articles that were considered in this literature review are provided in the Appendix 1.

The selected articles were analysed by using thematic analysis and synthetic approaches. Thematic analysis was used to analyse the reoccurring themes and recognise patterns from the existing literature. In addition, synthetic approaches were used to integrate and compare the findings across the previous studies.

1.3.2 Reliability and Validity

The reliability and validity of this research are based on the criteria that are set. The criteria of only academic and peer reviewed articles ensures the high quality from the previous research. This leads to reliable and high-quality findings that are integrated into this research.

Another criterion was that the selected articles are published recently. This ensures that the previous research selected is not out-dated and that this research has current value. This ensures the validity of this research.

Also, the methods that are selected and the processes that are used, contribute to better reliability and validity. Systematic review makes the research more coherent, which contributes to the reliability. Also, articles selected from different databases that provide aspects for the topic, ensure reliability and validity of this research.

1.4 Scope and Structure of the Thesis

To define the thesis more, the topic is examined from the perspective of cost savings, operational efficiency, and supply chain resilience. These three aspects are selected because they play a huge role in supply chain management. They are also significantly impacted by AI in inventory management. To clarify the scope more, the thesis will not cover a wider application of AI in other supply chain functions. The focus is restricted to implementing AI to inventory management functions.

The structure of the thesis is the following. The second chapter provides us the conceptual background for the terms used in this thesis. It covers modern supply chains, artificial intelligence, AI in inventory management and lastly the chapter goes through the concepts of cost savings, operational efficiency and supply chain resilience.

In the third chapter, the different challenges that are faced when implementing AI to inventory management are gone through. These are viewed from the perspectives of cost savings, operational efficiency and supply chain resilience. The fourth chapter handles the different opportunities of AI when implementing it to inventory management. The opportunities are viewed from the same perspectives than the challenges.

The fifth chapter reviews the findings of the previous research and data. Finally, in the last chapter, the key findings are analysed, and the implications are discussed. In addition, future research areas are highlighted, taking the limitations into account.

2 Conceptual Background

2.1 Inventory Management in Modern Supply Chains

To understand how inventory management is operated in modern supply chains, it is necessary to first go through the concept of a modern supply chain. Modern supply chains are impacted by globalisation, technological advancements, ethical aspects, and the increased emphasis on sustainability (Puvvula, 2024, p. 118). As a result of globalisation, supply chains have become more complex in modern, globalised economy (Hu & Yao, 2023, p. 102725). Also, the emergence of the internet era has had impacts on the complexity (Puvvula, 2024, p. 118).

The different technologies, such as AI and IoT, have the ability and potential to alter supply chains and their management in multiple ways (Hu & Yao, 2023, p. 102728). Those technologies can be used to enhance supply chain performance, efficiency and decision-making (Puvvula, 2024, p. 118). When it comes to automating the traditional systems, the main objective is to train the machines to better predict the customer demand in the supply chain and inventory management and lessen the errors made by humans in the decision-making process (Smita et al., 2024, p. 2238).

Many studies also show that advanced technologies can be used to make supply chains more sustainable (Hu & Yao, 2023, p. 102727). At present, organisations are more involved with subjects related to sustainability. They are realising the importance of minimising their impact on the environment, which has led to them to not only reducing waste but also taking clean and renewable energy sources into use (Puvvula, 2024, p. 118).

As mentioned before, in supply chain and its management, inventory management is a critical element. According to Albayrak Ünal et al. (2023, p. 2605), inventory management is generally comprehended as controlling and planning an organisation’s inventory. They state that effective inventory management requires the suitable

inventory in the right place at the proper time to cut back on system costs and respond to customer needs. The tasks, that inventory management include, are the selection of suppliers, demand management, optimisation of the supply chain and planning and forecasting the inventory itself (Gutierrez et al., 2024).

According to Cheng (2024), efficient inventory management is what modern business operations rely on. It is said that especially, in the modern, fast-paced business world, the role of inventory management has become more critical. Cheng mentions it to be the decisive factor of operational efficiency, competitive advantage and financial security. In addition, Smita et al. (2024, p. 2238) mention that inventory is an important and valuable keeping, and it should be carefully handled. It is also mentioned that throughout the supply chain, managing the ideal amount of inventory is one of the biggest tasks for entrepreneurs and manufacturers. This is explained to avoid complexities in the future, such as the backorder phenomenon or the bullwhip effect. In short, bullwhip effect means that small variations in customer demand could lead to increased fluctuations when moving further up in the supply chain (Weisz et al., 2023, p. 98).

Being a component of the supply chain, inventory management in modern economy is impacted by the same factors that impact the supply chain. It is important that inventory management is up to date with the fast-paced business environment. After all, inventory management could be the crucial element in achieving the objectives of an efficient supply chain, such as controlling costs and delivering to customers in the right time window (Albayrak Ünal et al., 2023, p. 2605).

2.2 Overview of Artificial Intelligence

The term artificial intelligence does not have one agreed definition to it, and often in literature, it is reported that the definition of it has remained debatable (Sharma, 2024, p. 3). The lack of conceptualisation can be explained with shifts and turns in the history

(Uhumuavbi, 2025, p. 2). Uhumuavbi (2025, p. 2) mentions that the disagreements on the definitions are based on the conflicting views in policy, academic, practical and legal contexts.

AI requires the use of computers to complete tasks, such as learning, understanding and reasoning, that usually demand human intelligence and are run by humans (Daios et al., 2025, p. 1). This can be translated into the most common definition of AI, which is the ability of machines to perform tasks that usually require human intelligence (Gignac & Szodorai, 2024, p. 3). However, Gignac and Szodorai (2024, p. 3) argue that the definition is not accurate, since it does not define human intelligence, and it can be considered more like an objective of AI instead of definition. Nevertheless, in this research, AI will be understood by this definition.

Chite et al. (2023, pp. 895–896) bring up that unlike human intelligence, AI systems are not self-aware nor have a consciousness. Instead, according to them, AI systems' abilities are restricted to the programming and knowledge that they have. Chite et al. explain that once AI is presented with a problem that is out of its range of competence or have different data than the one it was trained with, AI algorithms fail with logic. This means that AI tends to be successful in repetitive tasks that have a clear definition and can be presented with data.

Artificial intelligence can be applied to various areas using different techniques that it has. According to Daios et al. (2025, p. 3), the key techniques of AI include optimisation, computer vision, knowledge representation, reasoning, deep learning and machine learning, to mention a few. They state that especially in complex and changing supply chains, these technologies use simulation to model, test and improve AI-based decisions. Daios et al. also explain about generative AI, which is a branch of AI. They mention that it can be used for creating multiple types of content, such as audio, video and text.

Machine learning is one of the most important techniques of AI. According to Smita et al. (2024, p. 2237), machine learning has been gaining in the recent years a significant amount of attention and even adoption across various types of industries. They mention that machine learning techniques are more accurate and efficient compared to the traditional methods, consequently the increasing implementation of ML and its techniques.

According to Teri and Musliman (2019, p. 641), machine learning performs computational algorithms and has the ability of self-educating and modifying, when large sets of data are fed to it. They also explain that the more data is fed to it, the more precise it will become. Though it needs to be trained first with datasets for it to be able to learn and recognise patterns, which can then lead to it even making its own decisions.

Related to AI, a technique that is widely used is computer vision. Some sources state that it is a subfield of AI, while other claim that it is an AI technique (Daios et al., 2025; Khan et al. 2025). Khan et al. (2025, p. 3724) mention that it is used for detecting, identifying and extracting information from multimedia files. They explain that computer vision uses AI and ML techniques for that.

Sood and Singh (2021, p. 27978) talk about computer vision, and that it is the most popular implementation of computer science. According to them, computer vision includes software, hardware and imaging techniques, and it is divided into two different approached, which are image processing and image acquisition. They explain that image acquisition converts the electronic signals from the sensor, in this case a camera, into numeric data. Then in image processing, the image is being modified to for example improve the quality and the important information is being extracted.

2.3 AI in Inventory Management

AI has been taken into use in various fields, such as finance, healthcare, transportation and manufacturing, and it has proven its worth in them (Chite et al., 2023, p. 897). Similarly, AI has taken its role in supply chain management. Integrating IoT and AI into supply chain management enables significant advancements in supply chain flexibility, transparency and overall functionality (Daios et al., 2025, pp. 3–4).

Albayrak Ünal et al. (2023, p. 2606) explain that the development in AI techniques enables the applications of inventory management to turn into an intelligent process. According to them, in this process, machine learning and deep learning have an important role. They also state that combining inventory management with AI techniques makes the management process flexible and efficient. In addition to these, AI in inventory management offers multiple other advantages, such as minimised overstocking and reduced stock-outs (Daios et al., 2025, p. 5). The techniques can also help lower operational costs and provide quicker responses and more relevant information to customers (Albayrak Ünal et al., 2023, p. 2606).

AI can be a helpful tool in decision-making. According to Daios et al. (2025, p. 4), in decision-making, the intentions in capitalizing on AI are still in a contemplation stage. They state that managers' views are also in this same phase. This is found to be a bit contradictory, since the COVID-19 crisis accelerated the implementation of AI to strengthen the business operations.

Machine learning is one of the key techniques of AI used in decision-making. Smita et al. (2024, p. 2237) mention that the role of machine learning techniques is important. They explain that its innovations help to improve decision-making. It is said that with ML algorithms, and without thorough programming, machines are able to handle and analyse a vast volume of data and create patterns and relations. This is useful in decision-making, but also in other types of tasks in inventory management processes.

One of the greatest areas, where decision-making is needed, is demand planning. Walter et al. (2025) bring up that demand planning not only is a crucial part of supply chain management but also has a direct impact on inventory management. It is explained that the concrete impacts of errors in demand planning show in inventory management. These errors show as overstocking or stock-outs. Therefore, demand planning is one of the management processes where the use of AI and its techniques is advantageous.

2.4 Concepts of Cost Savings, Operational Efficiency and Supply Chain Resilience

To comprehend the research more, it is important to go through the concepts of cost savings, operational efficiency and supply chain resilience. These terms are central when trying to understand the utilisation of AI to inventory management to optimise the performance of supply chain.

2.4.1 Costs Savings and Inventory Management

Cost savings can also often be referred to as cost reduction or cost efficiency. Rojas et al. (2022, pp. 2–3) bring up that often, when companies try to optimise their supply chains, it is done to lower their costs and to gain more competitive advantage. They also mention that several studies indicate that costs savings can be enabled by optimising inventory management. Though these savings from inventory management are said to vary. The variations are explained to be caused by the category of the product or the performance of the company that relies on its internal strategy.

Understanding inventory holding costs is a crucial part of any industrial logistics systems management, since these costs are broadly implemented in traditional management models for inventory management (Azzi et al., 2012, p. 109). Holding inventory can cause many types of costs. These costs could be insurance, taxes, the physical storage space

and also the loss of the value of inventories, if goods are not sold promptly (Fang et al., 2024, p. 1).

Albayrak Ünal et al. (2023, p. 2606) explain that additional costs in inventory management are caused by inaccurate estimations. These additional costs are mentioned to be for instance lost revenue, excess inventory or shortages. They explain that while over demand could lead to empty inventories, additional costs can be caused by overestimating it.

Fang et al. (2024, p. 4) note that traditionally, a model that has been used in inventory management is the economic order quantity model. They explain that it has been used for a long time to reduce costs and maximise the profit. In short, the economic order quantity means that, while keeping the costs at a low-level, the company should order the optimal quantity of items to align with the customer demand (Alnahhal et al., 2024, p. 1).

2.4.2 Operational Efficiency and Inventory Management

Operational efficiency is one of the aspects that companies need to focus on and continuously improve in the current era of globalisation and increasing competition (Puspitawati et al., 2024, p. 1). In supply chains, operational efficiency means that the resources, processes and the time are being optimised to maximise the productivity and cost efficiency while simultaneously maintaining the quality. When applying different AI techniques, in this context machine learning algorithms, it can provide significant transformations to better precision in forecasting the demand, a better knowledge of patterns of consumption, and lastly, a more efficient optimisation of inventory levels (Gutierrez et al., 2024). These implementations are practical examples of enhancing operational efficiency.

In inventory management, operational efficiency refers to the ability to control and monitor the movements of the inventory efficiently, optimise the stock levels, lower operational costs and preserve regularly the optimal stock levels (Gutierrez et al., 2024). These components are the key aspects of operational efficiency in inventory management. Many of them also include parts, where AI can be implemented to further enhance the operational efficiency.

Traditionally, before AI techniques, a way to improve the efficiency in a supply chain has been through lean thinking. Bubber et al. (2023, p. 2) explain that with the lean philosophy, companies can enhance not only their supply chains but the whole process. They explain that this can be done by eliminating waste and removing those exercises that are non-value added, which is the key idea of lean thinking. These actions lead to cost reductions, which then leads to operational efficiency.

2.4.3 Supply Chain Resilience and Inventory Management

While supply chain resilience is not directly a sub-branch of inventory management, they have a close relationship. Riad et al. (2024, p. 2) state that “supply chain resilience refers to the ability of a supply chain to anticipate, prepare for, respond to, and recover from unexpected disruptions.” They also mention that at present, the resilience of a supply chain is important for companies that are trying to stay open and competitive in the middle of numerous different disruptions.

Riad et al. (2024, p. 2) bring up that traditional supply chain models are vulnerable. This has been proven by the increasing frequency and rising intensity of catastrophes, such as geopolitical conflicts, natural disasters or pandemics. Consequently, they pointed out the need for developing the supply chains and their systems to be more flexible, resilient and intelligent.

A good example of a pandemic is COVID-19, which highlighted the importance of resilient supply chains (Riad et al., 2024, p. 2). Particularly after the pandemic, the pressures of increased digitalisation and globalisation have increased the use of complicated technologies, such as artificial intelligence and renewable energy systems (Arora et al., 2024, p. 272). After COVID-19, the supply chains had to recover. Recovery is explained as the ability to swiftly continue normal operations after a disturbance (Riad et al., 2024, p. 3).

When talking about the relationship of supply chain resilience and inventory management, Guo et al. (2024, p. 451) state, if a company desires to build supply chain resilience, effective inventory management at different parts of the supply chain is a necessary strategy. According to them, when a company has holding inventory, it provides instant solution for the need if demand increases rapidly. They add that in supply disruptions, on-hand inventory also serves the same cause. This is why holding inventory in companies have a crucial role in softening the disruptions that are targeted to the supply chain. Though, it is also mentioned that only relying on inventory pre-positioning does have its restrictions in disruption risk managing.

3 Challenges in Implementing AI for Inventory Management

According to Daios et al. (2025, p. 8), at present, AI itself faces multiple challenges concerning things, such as data privacy, cybersecurity and ethics. They also state that there might be challenges in implementing it to companies' processes. The implementation challenge can be caused because of the lack of trust or inadequate knowledge of the personnel (Walter et al., 2025).

Implementing AI and its techniques for inventory management also faces different challenges. In this chapter, the key challenges of implementing AI for inventory management will be discussed from the aspects of costs, operational efficiency and supply chain resilience. It is good to note that in the available literature, challenges or limitations are more complex to find than benefits, since most authors have the tendency to examine the benefits more.

3.1 Cost-related Challenges

Implementing artificial intelligence into inventory management can help the companies to achieve cost savings. Though, there are still a lot of aspects that need to be considered regarding the costs that the implementation and maintenance might cause. High implementation costs are considered to be one of the key barriers when a company is adopting AI (Teixeira et al., 2025, p. 24).

One of the most important issues that the companies have faced when adopting AI has been the compatibility of the existing systems (Riad et al., 2024, p. 17). The previous infrastructures that the company has could be outdated, which could also make them complex (Teixeira et al., 2025, p. 24). This is related to the high implementation costs. These legacy systems might often lack the support for the integration of AI, which could mean that they should be updated. As a result, the implementation costs are increased.

Another issue related to high costs of artificial intelligence is the high costs of maintenance of infrastructures and systems (Gutierrez et al., 2024). AI is also developing, and the systems have the need to stay up to date. Thus, the updating of the systems is also highlighted as one challenge (Riad et al., 2024, p. 18). In addition to the systems, also AI needs to be adapted and kept up to date to answer to the needs of the changing industrial environment (Sinha & Lee, 2024). Keeping the systems and AI up to date can also be one of the causes for higher costs when adopting AI.

Keeping systems up to date is important, but also keeping the personnels knowledge and skills up to date related to AI is important (Teixeira et al., 2025, p. 24). Riad et al. (2024, p. 17) note that the lack of skilled personnel is considered to be a challenge. They add that ensuring smooth transitions, investments should be made to workforce development. Even though a training for the personnel might not seem that costly, in the long-term, the trainings can accumulate costs overtime contributing to the overall costs.

AI techniques enable companies to adopt it into decision-making. Teixeira et al. (2025, p. 25) mention the necessity to select the most appropriate AI model for each task in the supply chain, and that this has remained as a challenge. They bring up an example of demand forecasting, and that the inputs and parameters should be carefully selected since the operation needs to provide reliable and accurate information. Thus, it is mentioned that companies need to allocate resources to research and development in order to optimise AI-based forecasting techniques for their specific supply chain requirements. Increased input to research and development could mean higher costs for the company. Since the development cycle can be going on from months to even years, and the costs are constantly running, the total costs can potentially reach millions of dollars (Sinha & Lee, 2024).

When implementing AI, specifically machine learning, a challenge regarding data and its availability and quality has also risen (Gutierrez et al., 2024). AI and machine learning

rely heavily on the data given to it and can be improved by providing them with more high-quality data. Data quality is something that effective implementation of AI relies on (Rugiubei & Stoica, 2025, p. 208). Poor quality of data can lead to errors in forecasting (Rugiubei & Stoica, 2025, p. 213), which can lead to potentially missed opportunities for cost savings.

Related to costs, there is a challenge to estimate the real value of AI since there is insufficient evidence on the return of investment of it (Daios et al., 2025, p. 8). According to Sinha and Lee (2024), firm AI models need data from long periods of time, which requires considerable amount of investment from a company. They mention that many companies find this challenging, if there is not a significant return on investment.

3.2 Challenges in Operational Efficiency

For operational efficiency, AI can bring a lot of benefits but there are also the other side to it, the challenges that it brings. Some of them stem from the same root-cause than the challenges related to costs. These challenges need to be addressed alongside the efficiency gains, as they can significantly hinder the full potential of AI in inventory management.

Concerning personnel, one of the challenges that is related to operational efficiency could be their lack of knowledge. Shortage of skilled personnel itself is seen as a barrier (Riad et al., 2024, p. 17), but it can also affect the operational efficiency. As AI is being implemented into inventory management, the personnel, without training, might not have the right capabilities to perform with the new systems. This affects operational efficiency directly. However, also the training can cause challenges in operational efficiency. Trainings for example take time away from the personnel's daily tasks, which can slower the ongoing operations.

Another challenge concerning the personnel and the operational efficiency is the resistance of the implementation. The resistance could arise from the concerns of data privacy, biases of the algorithms and the interoperability of the previous systems (Teixeira et al., 2025, p. 25). Also, it is possible that the resistance stems from the lack of understanding and lack of support from the management's side (Walter et al., 2025). The resistance brings up challenges in operational efficiency, because the possible advantages of the implementation of AI cannot be taken into action straight away, which delays the benefits and slows down the implementation period.

The resistance can be well explained with technology acceptance model. According to Aljarrah et al. (2016, p. 862), with the model, the acceptance of new e-technologies and e-services has been explored in research. They explain that the users' beliefs about the usefulness of a technology are closely linked to their attitudes towards it and the intentions of using the technology. Technology acceptance model is said to consist of perceived usefulness (PU) and perceived ease-of-use (PEOU). PU is explained to be the extent to which the user believes that the usage of the system will improve their job performance. PEOU on the other hand is explained as the extent that the user believes that the usage of the system will be effortless and easy. It is brought up that PU is the one variable of the model that shows the most compatible relationship with the usage than others.

Gutierrez et al. (2024) mention that the challenges when implementing AI include the challenge of data availability and quality. According to them, when ensuring effectiveness, the quality of the data is a key component. If the data that the company provides is poor, it is possible that AI makes errors or false predictions. This impact inventory management broadly and leads to challenges in the operational efficiency.

Since continuous updates are needed (Riad et al., 2024, p. 18), not keeping the systems and models up to date could also lead to potential errors and false predictions. Without

updating them, the data and the models are outdated, and they can become less accurate. This can also lead to increased number of errors.

Decision-making is considered to be a key component of operational efficiency an inventory management. Implementing AI into decision-making can lead to biased decisions (Teixeira et al., 2025, p. 25), since AI has its algorithmic biases (Daios et al., 2025, p. 8). Biased decision-making can lead to unjust and unfair outcomes (Sharma, 2024, p. 5). This is a challenge since in companies biased decision-making can reduce the reliability and trustworthiness of operational processes.

3.3 Challenges in Supply Chain Resilience

For the resilience of the supply chain, the implementation of AI could potentially mean challenges. The challenges concerning supply chain resilience are mostly related to data privacy, transparency and system security. These challenges need to be highlighted when implementing AI into inventory management.

Sinha and Lee (2024) address that implementing AI systems introduce a broad scale of security vulnerabilities. These systems are mentioned to be exposed to potential cyber threats, from data burglary to hostile attacks. They bring up that AI systems are usually handling sensitive data, so data breaches can cause the leakage of confidential data and disrupt the operational intactness. It is mentioned that attacks of hackers can include them manipulating the data. This can mean errors and inaccurate predictions, which can potentially lead to incorrect decision-making in responding to disturbances within the supply chain.

According to Beta et al. (2025, p. 965), a challenge concerning transparency in decision-making is referred to as the “black box” problem. It is mentioned that transparency in this context means how the systems work, in which way the decisions are done and how data is being used. It is said that transparency indicates the clarity and openness of these

things. They add that this kind of lack of transparency is known as the “black box” of AI. They also explain that in decision-making, the transparency of AI is uncertain, and it might be difficult to understand who the designer of the algorithms is and what criteria do they have. For stakeholders, the lack of transparency brings challenges, in addition to understanding, in trusting and managing the decisions of AI. In the context of inventory management, the lack of trust and understanding to the decisions of AI can lead to difficulties when disruptions occur.

As it is mentioned before, AI needs continuous updating (Riad et al., 2024, p. 18), and outdated or poor-quality data can lead to inaccurate predictions, made by the AI (Rugiubei & Stoica, 2025, p. 213). Continuous updating and monitoring of the models is also important for them to adapt to the changing conditions (Gutierrez et al., 2024). This could also mean challenges with supply chain resilience. If data is not updated, AI works with historical data. Eventually, when unexpected disruptions occur, the AI-based decisions are not up to date and thus can be inaccurate for solving the disruption.

4 Opportunities in Implementing AI for Inventory Management

According to Puvvula (2024, p. 122), the modern supply chains are making the most of technology to benefit in terms of optimisation in the decision-making, streamlining processes and improving the visibility of the supply chain. This is said to result in cost savings, improvement of customer service and better agility to adapt to the changing conditions of the market. Therefore, it might be beneficial to implement digital technologies to modern supply chains.

Even though there are challenges in implementing AI for inventory management, there are even more opportunities found from the literature. In this chapter, the key opportunities of AI will be inspected from the aspects of cost savings, operational efficiency and supply chain resilience. These opportunities illustrate how AI can act as a strategic tool for improving inventory management and consolidate the supply chain performance overall.

4.1 Opportunities in Cost Savings

In costs savings, AI brings a lot of opportunities. According to Boršoša and Koman (2025, p. 14), the technologies of AI, for instance predictive analytics and machine learning simplify better planning of inventory management. They state that this leads to cost reduction.

Implementing AI in inventory management, offers advantages for instance in reduced stock-outs and minimised overstocking (Daios et al., 2025, p. 5). This is related to demand planning. AI can help with improving the accuracy of demand forecasting, since its techniques can quickly analyse diverse and large sets of data (Albayrak Ünal et al., 2023, p. 2606). Reduced stock-outs could potentially lead to cost savings. Usually,

ordering with a quick delivery, additional costs are generated. With fewer stock-outs, there is no need for fast deliveries. Fewer stock-outs can also help with preventing lost sales and increasing the company's revenue. Since there is an optimal amount of stock, there is always something to sell to the customers. Even the little improvements in the accuracy of forecasting can have improvements in the company's revenue (Puvvula, 2024, p. 121).

In addition to demand planning, systems powered with AI are able to assist with inventory optimisation (Daios et al., 2025, p. 5). These enable cost savings in inventory management. If the inventory is optimal compared to the demand, there are no additional costs due to overstocking. Holding inventory could after all cause additional costs, for instance the costs of the physical inventory space (Fang et al., 2024, p. 1).

The co-operation with AI and robotic systems enables the automating of different operations like packing, picking and inventory counting (Daios et al., 2025, p. 5). This means that there is less manual labour needed in the warehouse. Less manual labour could possibly lead to cost savings, if using the systems instead of humans is more beneficial in terms of costs.

4.2 Opportunities in Operational Efficiency

For operational efficiency, implementing AI brings a lot of opportunities for organisations. Automation of the operations through robotic systems and AI can lead to cost savings but it also contributes to operational efficiency. Villegas-Ch et al. (2024, p. 2) bring up that a technique of AI, computer vision, has proven its importance as a support system in inventory management. According to them, systems that are automated and use computer vision to identify products and count them have been improving the accuracy of inventories significantly. It is also explained that these systems can reduce errors made by humans and improve operational efficiency by having the ability to fast recognise products, count accurately and read barcodes and labels.

In addition to automating the warehouse operations, AI can be used to automate decision-making (Smita et al., 2024, p. 2238). With AI, automating operations can provide data in real-time (Villegas-Ch et al., 2024, p. 6) and it also enables the tracking of the inventory levels in real time, which offers accurate data to improve the processes of control and restocking (Riad et al., 2024, p. 5). These themselves can help a company to achieve better operational efficiency, but they also enable real-time decision-making (Teixeira et al., 2025, p. 22). Automation of the tasks improves operational efficiency by reducing the human errors, increasing the speed and overall efficiency (Riad et al., 2024, p. 6).

Garg et al. (2025, p. 3) explain that real-time decision-making happens with the AI analysing not only historical patterns but also real-time feeds of data. This is said to allow the managers to preventively modify inventory levels, which can also help to avoid expensive delays. Thus, real-time decision-making enhances operational efficiency (Puvvula, 2024, p. 119).

Beta et al. (2025, p. 952) mention that AI also enhances real-time visibility of the supply chain, and it can track goods and monitor stock levels across the whole supply chain. This visibility across the entire supply chain is explained to make the operations to flow smoother. Smoother operations ensure better operational efficiency.

Another opportunity from AI to enhance operational efficiency is related to demand forecasting. The ability to fast analyse diverse and large sets of data makes the forecasting more accurate (Albayrak Ünal et al., 2023, p. 2606). This improves operational efficiency, since human errors are reduced.

4.3 Opportunities in Supply Chain Resilience

Even though implementing artificial intelligence for inventory management might bring privacy issues and other challenges, there are also many opportunities that it brings. AI has risen as a critical component for the improvement of the supply chain resilience (Teixeira et al. 2025, p.22), and it can play versatile roles in enhancing its agility, sturdiness and responsiveness (Riad et al., 2024, p. 7). According to Beta et al. (2025, p. 952), the ability of AI to forecast supply and demand accurately is also an opportunity for supply chain resilience. They explain that data analysing algorithms that analyse great amounts of data from multiple sources and make predictions, can complete the forecasting during times of uncertainty and when information is inaccurate.

Related to forecasting is predictive analytics. Predictive analytics can also help enhancing supply chain resilience. The core idea is that predictive analytics allow the managers of supply chains to anticipate disruptions before the occurrence of them (Beta et al., 2025, p. 953). In practice, predictive analytics can assist in designing supply chains to be more resilient by enabling accurate forecasting, timely decision-making and faster returning to normal operations after the occurrence of disruption (Zamani et al., 2022, p. 609). AI can also recognise trends and patterns that indicate possible risks like spikes in demand, failures related to suppliers or issues in logistics (Beta et al., 2025, p. 953).

Forecasting demand and predictive analytics is related to anticipating disruptions. Another way to prepare to disruptions is scenario planning. Lu et al. (2025) bring up that artificial intelligence enables scenario planning that is automated. It is used to plan and consider different various scenarios of disruption.

According to Teixeira et al. (2025, p. 22), supply chain collaboration driven by AI promotes transparency and trust between the partners of the supply chain. They explain that this allows rapid responses to alterations and uncertainties in the market. In addition, Beta et al. (2025, p. 952) mention that AI enhances cooperation and sharing of

the knowledge across the whole supply chain. It is also mentioned that it improves communication and flexibility of the supply chain and reduces unnecessary shifts in it.

Real-time data is also important in supply chain resilience. Beta et al. (2025, p. 952) mention that, in the supply chain, AI enhances real-time visibility by monitoring stock levels over different locations and tracking the movement of the products. They mention that in every step of the supply chain, algorithms of ML and IoT sensors gather and analyse data. It is said that this kind of real-time visibility throughout the whole supply chain helps to quickly recognise and address challenges, for instance quality issues, bottlenecks or delays. All this makes it possible for an organisation to have smooth operations and fast response times regarding disruptions.

5 Research Results

In this chapter, the key findings of the research will be presented. Also, the research questions are answered. First, they key challenges and opportunities of implementing AI for inventory management will be presented. Then, the impacts for the selected three aspects will be reviewed.

5.1 Key Challenges and Opportunities

The first research question that needs to be answered to achieve the objective of this research is the following:

Q_1: What are the key challenges and opportunities of using AI to automate inventory management in modern supply chains?

The findings of the key challenges and possibilities are presented in the Table 2.

Table 2. Key findings of challenges and opportunities in implementing AI for inventory management

Dimension	**Challenges**	**Opportunities**
Cost savings	High implementation and maintenance costs, uncertain ROI	Potential to improve inventory optimisation and demand forecasting
Operational efficiency	Personnel's lack of knowledge, resistance to change, data quality issues	Possibility to automate tasks and improve data-driven operations
Supply chain resilience	Data privacy, transparency	Use of predictive analytics and scenario planning to support preparedness

The key challenges of implementing AI for inventory management are in the state of implementation and maintenance. For costs, high implementation and maintenance costs are considered to be one of the key challenges of AI (Teixeira et al., 2025, p. 24). After implementation, the maintenance of the systems and infrastructure cause costs (Gutierrez et al., 2024). There can also be a lot of indirect costs of AI after implementing it. These costs can for example be caused by keeping the personnels knowledge up to date (Teixeira et al., 2025, p. 24). One cost-related challenge of AI is also the return on investment. There is not enough evidence, whether implementing AI has value compared to the costs of it (Daios et al., 2025, p. 8).

AI can also provide a lot of opportunities in cost savings. A key opportunity is that AI can help to improve demand forecasting and optimise inventory (Daios et al., 2025, p. 5), which both have an impact on cost savings. The automation of processes is another key opportunity that AI provides for cost savings (Daios et al., 2025, p. 5).

For operational efficiency, the key challenges stem from the personnel. The personnel's lack of knowledge (Riad et al., 2024, p. 17) can lead to resistance of the implementation (Walter et al., 2025). For operational efficiency, another key challenge is the availability and quality of the data (Gutierrez et al., 2024).

AI can help streamline the workflows (Riad et al., 2024, p. 6), which affects operational efficiency and is one of the key opportunities. With AI, automating the processes and operations is also possible to improve operational efficiency (Villegas-Ch et al., 2024, p. 2). In addition to automation, AI brings benefits to data-driven operations.

One key challenge related to the resilience of the supply chain is related to data privacy. It is possible that the systems are hacked, and that the confidential data is leaked, since AI handles also sensitive data (Sinha & Lee, 2024). Transparency can also rise as one of the key challenges (Beta et al., 2025, p. 965).

Lastly, the key opportunities in supply chain resilience are mostly related to the predicting the disturbances. AI is able to provide predictive analytics, which gives the managers the possibility to act before the occurrences (Beta et al., 2025, p. 953). Another benefit of AI is its ability to do scenario planning, which also helps to prepare (Lu et al., 2025). The last one is the opportunity is that AI allows faster responses to the disruptions (Beta et al., 2025, p. 952).

5.2 Impacts on Cost Savings, Operational Efficiency and Supply Chain Resilience

The second research question for this research is the following:

Q_2: How does AI-based inventory management impact cost savings, operational efficiency and supply chain resilience?

From the cost savings aspect, AI improves demand forecasting by improving the accuracy of the forecasts (Daios et al., 2025, p. 5). It can also improve inventory optimisation due to this. By automating the operations and processes, AI brings cost savings to the company, since less manual labour is needed (Daios et al., 2025, p. 5). Though, the cost challenges of implementing and maintaining can lead to a loss of these cost savings.

AI impacts operational efficiency in many ways. AI improving the accuracy of demand forecasting (Daios et al., 2025, p.5) also impacts operational efficiency in a positive manner. AI brings accuracy also to other operations of inventory management, which improves operational efficiency (Albayrak Ünal et al., 2023, p. 2606). Also automating can improve operational efficiency by reducing errors made by humans (Villegas-Ch et al., 2024, p. 2). However, these impacts can be overrun by the challenges from the personnel or the bad quality of the data.

AI impacts supply chain resilience by providing real time data, which allows fast responses to possible disruptions (Beta et al., 2025, p. 952). By having the ability to analyse large sets of data and a variety of it (Albayrak Ünal et al., 2023, p. 2606), AI can provide predictive analytics and possible scenarios to enhance supply chain resilience.

6 Discussion and Conclusion

This research examined the challenges and opportunities that AI brings when it is implemented for inventory management. The focus was in three aspects: cost savings, operational efficiency and supply chain resilience. The key opportunities and challenges were highlighted and analysed.

The challenges that were repeated multiple times in the existing literature were related to the quality of the data, accuracy and transparency. The quality of data was mentioned in all aspects, since it can lead to inaccurate predictions that may have an impact on cost savings, operational efficiency and supply chain resilience. For the accuracy, it is brought up multiple times that AI can make mistakes, partially due to the poor quality of data. This has impacts on all three aspects.

The challenge of transparency was also repeated many times during the research. It is said that AI might cause the lack of transparency for instance for supply chain resilience. This causes the “black box” problem. Though, it is contradictory, since other existing research imply that implementing AI can enhance the transparency and visibility throughout the supply chain.

For the opportunities, repeated impacts of AI were related to decision-making, automation and real-time data. Decision-making can be improved by AI or even automated by it, which affects all three aspects. Automating processes has the largest benefit to operational efficiency. Lastly the ability of AI to provide data in real-time affects mostly supply chain resilience and operational efficiency.

For inventory management, AI can provide a lot of opportunities and provide improvements in cost savings, operational efficiency and supply chain resilience. Though, there must be awareness towards hidden indirect costs, lack of understanding and privacy issues. If only the benefits or opportunities are looked at when implementing AI, multiple surprising challenges can occur.

This research is limited to only inventory management perspective on the subject. Thus, it cannot be more broadly implemented to supply chain management. Also, literature review has its limitations and there is no empirical data to support this research.

There are areas on this research that have not been examined thoroughly. Future research could handle the return on investment of AI after it has been implemented into company's operations. This subject is important for practitioners to gain the knowledge of the real value of AI. Another subject that could be further examined is how the resistance of change impacts processes in different cultures.

In summary, this research examined the implementation of artificial intelligence for inventory management and its challenges and possibilities. These were examined from the aspects of cost savings, operational efficiency and supply chain resilience. While significant challenges still exist, AI does have the ability to enhance inventory management operations in many ways. The findings of this research contribute to deeper understanding on how AI can support the modern data-driven supply chains in terms of inventory management.

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Appendices

Appendix 1. List of the reviewed articles according to the theme

Author and year	Title of the article	Related theme(s)
Albayrak Ünal et al. (2023)	Applications of Artificial Intelligence in Inventory Management: A Systematic Review of the Literature	Cost savings, operational efficiency, opportunities
Alnahhal et al. (2024)	Economic Order Quantity: A State-of-the-Art in the Era of Uncertain Supply Chains	Cost-related challenges
Beta et al. (2025)	The role of artificial intelligence on supply chain resilience	Supply chain resilience, challenges, operational efficiency, opportunities
Boršoša and Koman (2025)	Overview of Current Research on Artificial Intelligence in Logistics	Cost savings, opportunities
Bubber et al. (2023)	Toward increased business productivity: interlinks between lean thinking, process quality, inventory management, and productivity	Operational efficiency
Cheng (2024)	Research on the Inventory Management in the Modern Business	Inventory management in modern supply chains

Author and year	Title of the article	Related theme(s)
Daios et al. (2025)	AI Applications in Supply Chain Management: A Survey	Cost savings, challenges, opportunities
Fang et al. (2024)	Unlocking the potential of inventory management: Integrating digital transformation with firm practices	Cost savings, opportunities
Garg et al. (2025)	Impact of strategic performance measures on performance: The role of artificial intelligence and machine learning	Operational efficiency, opportunities
Gutierrez et al. (2024)	Benefits, challenges, and limitations of inventory control using machine learning algorithms: literature review	Cost savings, operational efficiency, supply chain resilience, challenges
Lu et al. (2025)	Whose AI matters? Examining the bilateral effects of AI capability orientation on supply chain resilience	Supply chain resilience, opportunities
Puspitawati et al. (2024)	Enhancing inventory efficiency: The role of strategic management accounting and integrated management accounting information systems	Operational efficiency

Author and year	Title of the article	Related theme(s)
Puvvula (2024)	Modern Supply Chain: Unleashing the Power of Data and Technology	Operational efficiency, cost savings, opportunities
Riad et al. (2024)	Enhancing Supply Chain Resilience Through Artificial Intelligence: Developing a Comprehensive Conceptual Framework for AI Implementation and Supply Chain Optimization	Cost savings, operational efficiency, supply chain resilience, challenges, opportunities
Rugiubei & Stoica (2025)	Challenges in Adopting Artificial Intelligence Technologies in Supply Chain Management in Romanian Companies	Cost savings, supply chain resilience, challenges
Sharma (2024)	Benefits or concerns of AI: A multistakeholder responsibility	Operational efficiency, challenges
Sinha & Lee (2024)	Challenges with developing and deploying AI models and applications in industrial systems	Cost savings, supply chain resilience, challenges
Smita et al. (2024)	Systematic literature review of machine learning for manufacturing supply chain	Operational efficiency, opportunities
Teixeira et al. (2025)	Intelligent Supply Chain Management: A	Cost savings, operational efficiency, supply chain

Author and year	Title of the article	Related theme(s)
	Systematic Literature Review on Artificial Intelligence Contributions	resilience, challenges, opportunities
Villegas-Ch et al. (2024)	Optimization of inventory management through computer vision and machine learning technologies	Operational efficiency, opportunities
Walter et al. (2025)	Application of artificial intelligence in demand planning for supply chains: a systematic literature review	Operational efficiency, challenges
Zamani et al. (2022)	Artificial intelligence and big data analytics for supply chain resilience: a systematic literature review	Supply chain resilience, opportunities