

# Artificial Intelligence Applications in Supply Chain Management: A Systematic Analysis of Technologies, Applications and Performance

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**Abstract-** *The growing complexity of supply chains has made it more important than ever to use smart technologies that can make operations better help with choices and make responses faster. Artificial Intelligence or AI has become a technology that is changing the way supply chains work. It uses data to look at things predict what might happen and automate tasks. This study looks at how Artificial Intelligence's used in Supply Chain Management and how it helps important parts of the supply chain. The study reviews the research that already exists on AI technologies like machine learning, predictive analytics, smart automation and big data analytics. It looks at how these technologies used in things like predicting what customers will want managing inventory making logistics better handling warehouses working with suppliers and managing risks in the supply chain. A detailed look at the research is done to find the areas where AI is used the benefits it brings the problems it faces and what new research is happening. The results show that AI can make predicting customer demand manage inventory more efficiently improve how goods are moved help people make decisions faster and make the whole supply chain stronger. There are still problems like the cost of using AI, the quality of the data, security issues combining AI with old systems and needing people who know how to use AI. The study also finds where more research is needed and creates a model that connects AI abilities with how well the supply chain works. The results give a starting point for studies, about using AI to change supply chains and build smarter, quicker and more efficient systems.*

**Keywords:** *Supply chains, Artificial Intelligence, Machine Learning, Predictive Analytics.*

## I. INTRODUCTION

Supply chain management is really complicated these days. This is because of competition and changing customer requirements. Organizations have to work

with a lot of people like suppliers and customers to make sure everything runs smoothly. They also have to deal with problems like natural disasters and transportation issues. These problems can make it hard for organizations to plan and make decisions. There is some good news. New digital technologies are being developed all the time. These technologies can help organizations collect and analyze information from stages of the supply chain. One of these technologies is Artificial Intelligence or AI for short. AI is really good at looking at amounts of data and finding patterns. It can also make predictions. Help with decision-making. AI can be used in different areas of supply chain management, such as demand forecasting and inventory management. Machine learning and predictive analytics are also very useful in supply chain management. They can look at data and real-time data to find demand patterns and anticipate future events. This can help organizations plan production and control inventory. It can also help them find problems, like supplier delays or transportation issues. AI can also automate some tasks, which can reduce errors and make things run smoothly. AI can also help organizations run efficiently. It can help them predict demand and monitor inventory levels. It can also optimize transportation routes and delivery schedules. All of these things can help organizations reduce costs improve delivery performance and make decisions. AI can be more effective when it is used with other digital technologies, like the Internet of Things and big data analytics. These technologies can provide real-time information. Process large amounts of data. They can also help organizations share information and work together smoothly. There are also some challenges to using AI in supply chain management. It can be expensive to implement. Organizations need to have

good data and skilled professionals. They also need to be careful about cybersecurity and privacy. These challenges show that we need to understand more about how AI's being used in supply chain management. So, this study is going to look at how AI's being used in supply chain management. It will examine the AI technologies being used and how they are being applied. It will also look at the benefits and challenges of using AI and identify areas for research. This study will provide a foundation for understanding how AI can help improve supply chain performance. It will also help us learn more about transformation, supply chain visibility and operational performance. The study of AI in supply chain management is really important. It can help organizations run smoothly and make better decisions. It can also help them deal with problems and improve their overall performance. The use of AI in supply chain management is an area of research and it will continue to be important in the future. AI and supply chain management are closely related. They will continue to evolve together. The study of AI in supply chain management is crucial for organizations that want to stay competitive and improve their performance. It is a topic but it is also very important. AI and supply chain management are two areas that are closely linked. They will continue to be important, in the future.

## II. LITERATURE REVIEW

Digital technologies have greatly changed the way traditional supply chains are managed by improving connectivity, sharing of information, visibility and operational efficiency. Chauhan et al. (2023) explained that technologies such as the Internet of Things (IoT) Artificial Intelligence (AI) and Big Data help digitalize supply chain management and make supply chain visibility and sustainability better. Han et al. (2021) examined the requirements of supply chain digitalization in the context of Industry 4.0 and highlighted the importance of integrating digital technologies into supply chain processes. Similarly, Ivanov et al. (2022) discussed the role of cloud-based platforms in connecting supply chain participants and facilitating information sharing and collaboration. Joshi and Sharma (2022) further emphasized that digital supply chains can contribute to organizational performance. These studies indicate that digital technologies provide a foundation, for developing

more connected, flexible and efficient supply chain systems. Artificial Intelligence has become a technology for making better decisions and improving how things work in supply chain management. Min (2010) looked at how Artificial Intelligence's used in supply chain management and showed how it can help with things like logistics, planning, making choices and solving problems in a smart way. Toorajipour et al. (2021) did a study of how Artificial Intelligence is used in supply chain management and found several AI methods and uses across different parts of the supply chain. Fatorachian and Kazemi (2021) studied how Industry 4.0 technologies affect the performance of supply chains. Said that new digital technologies are very important, for making supply chains better. These studies show that Artificial Intelligence and related Industry 4.0 technologies can help supply chain companies by doing tasks making better choices and improving how things work. Machine Learning and Big Data Analytics have gotten a lot of attention because they can look at amounts of data and help make predictions that support better decisions. The studies reviewed show that AI, Machine Learning, Big Data Analytics, cloud computing and other Industry 4.0 technologies can be used in supply chain functions such as demand forecasting, inventory management, logistics and decision-making. Chauhan et al. (2023) highlighted how digital technologies help transform supply chain and Toorajipour et al. (2021) pointed out the expanding range of AI applications in supply chain management. Ivanov et al. (2022) also showed how important digital platforms are for linking supply chain activities. Overall, the literature shows that using AI and related technologies can make supply chain more efficient and improve decision-making. However, implementing AI tools successfully requires digital infrastructure, good data management, smooth technology integration and an organization ready to change. These findings give a base, for digging into how AI works its benefits, its challenges and how it affects supply chain performance.

## III. BACKGROUND OF ARTIFICIAL INTELLIGENCE IN SUPPLY CHAIN MANAGEMENT

Artificial Intelligence is a deal in managing supply chains these days. It is a computer system that can do things that normally need intelligence like looking at

data finding patterns and making decisions. This is really helpful in supply chains because they are getting more complicated and have a lot of data. Artificial Intelligence can help companies look at a lot of information and make plans. It is not just used for making decisions. Also, for things like Machine Learning, Predictive Analytics, Intelligent Automation and using Artificial Intelligence to look at data. Machine Learning can look at what happened in the past to figure out what might happen next. Predictive Analytics can use real-time information to anticipate problems like when a supplier's late or there is a transportation issue. Intelligent Automation can help with things like inventory, warehouses and logistics by reducing the need for people to do things manually. Artificial Intelligence is also closely related to the picture of digital transformation in supply

chains. Companies that are good at Artificial Intelligence can look at a lot of data, automate routine tasks. Make better predictions. They can also bring together information from parts of the supply chain. This helps companies move from ways of doing things to more modern and automated systems. So Artificial Intelligence is a part of digital transformation. Fig 1 Artificial Intelligence is combined with digital technologies it can do even more. Technologies like the Internet of Things, Big Data, cloud computing and digital platforms give us information from all parts of the supply chain. Artificial Intelligence can use this information to help us monitor, predict and make decisions. Studies have shown that digital technologies can make supply chains more visible, efficient and resilient.

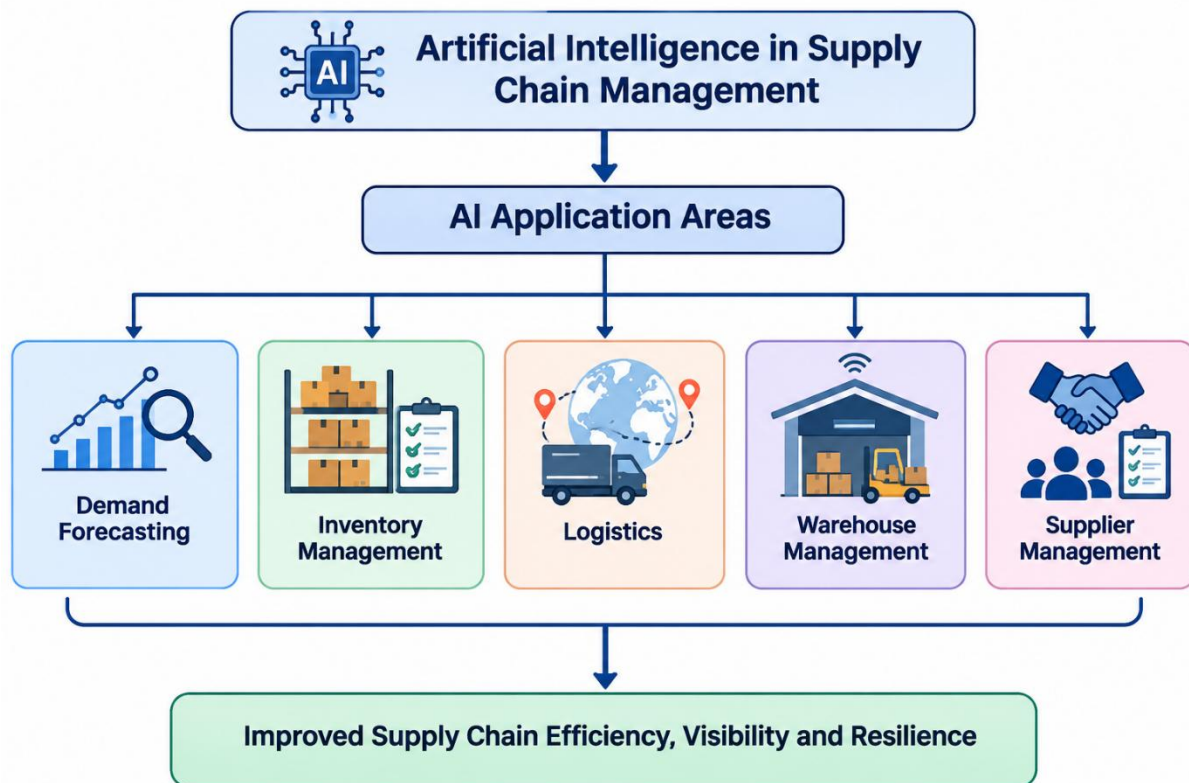


Figure 1: AI Application Areas in Supply Chain. The figure was generated using an artificial intelligence (AI) image-generation tool and subsequently edited by the authors.

One good thing that happens when we use Artificial Intelligence is that we can see more of what's going on in the supply chain. Digital systems let us watch products, shipments, inventory and information in time. This means we can find problems earlier keep an

eye on suppliers and manage inventory better. we can see what is going on we can also be more agile. This means we can respond quickly to changes in demand problems with suppliers, transportation issues and other disruptions. We can adjust production schedules,

inventory levels and logistics activities easily. In the end using Artificial Intelligence can help companies do better. When supply chains are agile companies can reduce costs get products to customers faster and keep customers happy. So, the relationship between Artificial Intelligence and supply chains can be seen as: Artificial Intelligence helps Digital Transformation, which helps Supply Chain Visibility, which helps Supply Chain Agility, which helps Performance. However, using Artificial Intelligence in supply chains is not easy. Companies may have trouble getting data working with existing systems paying for implementation keeping things secure and finding people with the right skills. These problems can make it hard to successfully implement and scale up Artificial Intelligence solutions. So, looking at

Artificial Intelligence in supply chain management shows that it is not a tool for automation or prediction. It is a capability that can help with digital transformation, visibility, agility and performance, across the supply chain. This gives us a foundation to look at Artificial Intelligence applications and how they contribute to supply chain performance in the next parts of this study.

#### IV. COMPARATIVE ANALYSIS OF AI APPLICATIONS IN SUPPLY CHAIN MANAGEMENT

##### 4.1 Comparison of AI Applications

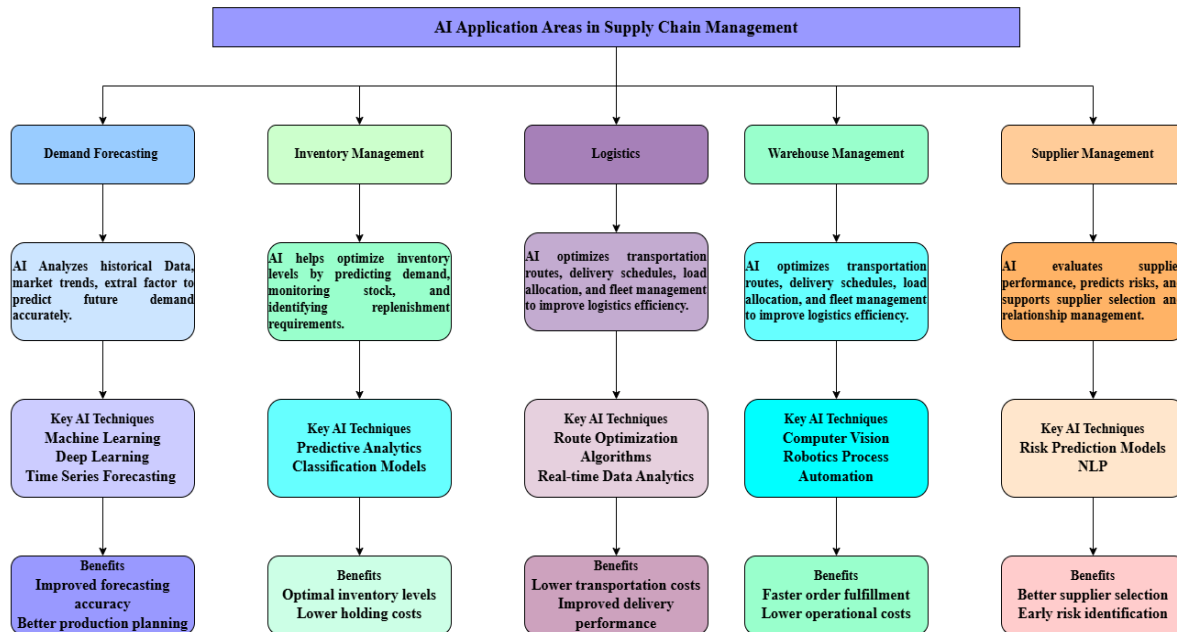


Figure 2: Comparison of AI Application Areas

Artificial Intelligence is used in areas of the supply chain. Each use of Artificial Intelligence is meant to solve a problem. When it comes to figuring out what customers will want Artificial Intelligence uses Machine Learning and other tools to look at what happened in the past and what is happening now. This helps us see patterns and guess what customers will want in the future. Fig 2 information is very helpful for planning what to make and reducing the uncertainty of what customers will want. Managing inventory is

another area where Artificial Intelligence is used. Here Artificial Intelligence uses Machine Learning and other tools to watch how stock we have guess when we need to restock and make sure we have the right number of products available. This helps us balance having products with not wasting money on too much inventory. In logistics Artificial Intelligence is used to plan how to transport things find the routes, schedule deliveries and use resources wisely. Table 1 helps companies save money on transportation and get

things to customers faster. Warehouse management also uses Artificial Intelligence to watch inventory make decisions about storage, process orders and use resources. This makes the warehouse run smoothly and reduces the need for people to do things manually. It comes to working with suppliers Artificial Intelligence uses Machine Learning to evaluate how well suppliers are doing find problems and guess when suppliers might cause disruptions. This helps companies choose the suppliers and make good decisions. Overall Artificial Intelligence is used in different ways in the supply chain. Figuring out what

customers will want is about making good guesses. Managing inventory is about finding the balance. Logistics is about getting things from one place to another. Warehouse management is about using machines and computers to get work done. Working with suppliers is about evaluating how well they are doing and finding problems. All of these uses of Artificial Intelligence help companies make decisions work more efficiently and be more responsive, to customers. This makes the whole supply chain run smoothly.

Table 1: AI Techniques and Applications Across Supply Chain Functions

| AI Application       | Main AI Techniques                     | Primary Objective                    | Expected Supply Chain Benefit                   |
|----------------------|----------------------------------------|--------------------------------------|-------------------------------------------------|
| Demand Forecasting   | Machine Learning, Predictive Analytics | Predict future demand                | Forecast accuracy, reduced uncertainty          |
| Inventory Management | ML, Predictive Analytics, Automation   | Optimize stock levels                | Reduced holding cost, fewer stockouts           |
| Logistics            | ML, Optimization, Predictive Analytics | Optimize routes and transportation   | Reduced cost and delivery time                  |
| Warehouse Management | AI, Deep Learning, Automation          | Optimize warehouse operations        | Faster processing and resource utilization      |
| Supplier Management  | ML, Predictive Analytics               | Evaluate suppliers and predict risks | Better supplier reliability and risk management |

Artificial Intelligence is used in parts of the supply chain. Each part of the supply chain uses Artificial Intelligence to do a job. Demand forecasting uses Machine Learning to look at new data. It tries to find patterns in the data and predict what customers will want in the future. This helps plan production and reduces uncertainty about demand. Inventory management uses Machine Learning to watch stock levels and predict when to restock. It also tries to balance having products with not having too many. This is done to save money on inventory costs. In logistics Artificial Intelligence is used to plan transportation find the routes, schedule deliveries and use resources wisely. This helps companies save money on transportation and deliver products faster. Warehouse management uses Artificial Intelligence and automation to watch inventory make storage decisions, process orders and allocate resources. This makes the warehouse run smoothly and reduces the need for people to do tasks manually. Supplier management uses Machine Learning to evaluate suppliers find problems and predict when suppliers

might have issues. This helps companies choose the suppliers and make good decisions. Overall demand forecasting is about predicting what will happen inventory management is about making the use of resources logistics is about moving products efficiently warehouse management is about using automation and supplier management is about evaluating performance and predicting risks. All these Artificial Intelligence applications help companies make decisions be more efficient and respond to problems quickly. They also help the whole supply chain work. Artificial Intelligence is really important, for the supply chain because it helps with different tasks. Artificial Intelligence makes the supply chain more efficient and effective.

#### 4.2 AI Application–Performance Relationship

The artificial intelligence applications help the supply chain work better. They do this by making predictions more accurate finding the ways to do things automating tasks and helping people make good decisions. For example, demand forecasting is very

useful. It helps companies figure out how much of something they will need in the future. This means they can plan what to produce and how inventory to keep. Companies manage their inventory well they keep the right amount of stock. This helps them save money because they do not have much inventory that they have to pay for. Artificial intelligence also helps with logistics. It makes transportation planning better chooses the routes and makes deliveries faster. It even helps manage warehouses. This means companies can process things faster and use their resources wisely. The artificial intelligence applications also help companies keep an eye on their suppliers. They can see how well the suppliers are doing and find any problems on. All of these improvements add up. They make the supply chain work smoothly reduce costs and help companies respond quickly to changes. They even make the supply chain stronger. So, the artificial intelligence applications are very important, for the supply chain. They help with planning seeing what is going on making decisions and working together. This makes the whole supply chain perform better.

#### V. BENEFITS OF AI ADOPTION IN SUPPLY CHAIN MANAGEMENT

Artificial Intelligence is really good for supply chain operations. It helps organizations look at data and figure out what might happen in the future. This means they can do things automatically and make decisions on time. Artificial Intelligence can also help with predicting what people will want to buy. This helps organizations make things and store them in a way that makes sense. They can keep the number of things in stock and not waste money on things they do not need. In terms of getting things from one place to another Artificial Intelligence can help find the way to do it. It can plan deliveries. Make sure that the people and things used to move stuff around are being used well. This means that things get to where they need to go on time and it does not cost much. Artificial Intelligence can also help in warehouses. It can make things run smoothly and help organizations use their resources in a better way. It comes to the people that supply organizations with things Artificial Intelligence can help figure out if they are good to work with and if there are any problems coming up. You put Artificial Intelligence with other technologies, like the Internet of Things and Big Data it can really help organizations

know what is going on. They can see everything that is happening in their supply chain and respond quickly if something changes or goes wrong. So, using Artificial Intelligence is an idea. It can help organizations save money. Do things more efficiently. They can make decisions and respond quickly to things that happen. It can also help them use their resources in a way and make their supply chain stronger.

#### VI. CHALLENGES AND BARRIERS TO AI ADOPTION IN SUPPLY CHAIN MANAGEMENT

Artificial Intelligence is really helpful for managing supply chains. It has a lot of things to offer. There are some big problems that can stop it from working well. One of the problems is that Artificial Intelligence needs good data to work properly. This data has to be accurate and easy to use. If the data is not good then Artificial Intelligence will not be able to make predictions or decisions. Another problem is that Artificial Intelligence systems have to be connected to computer systems that the company is already using. This can be very hard to do. Companies also have to spend a lot of money to get Artificial Intelligence working. They need to buy computers and hire people who know how to use them. Artificial Intelligence also has some security problems. Since it uses a lot of data there is a chance that someone might steal this data. There are not people who know how to use Artificial Intelligence and manage supply chains. This makes it hard for companies to find the right people to do the job. Some other problems, with Artificial Intelligence are that it can be hard to understand how it makes decisions. It can also be hard to make it work for companies. So, if we want Artificial Intelligence to really help with supply chain management, we have to solve these problems. We need to make sure that Artificial Intelligence is working well and that it is safe to use. This way companies can use Artificial Intelligence to manage their supply chains in a way.

#### VII. RESEARCH GAPS

Artificial Intelligence is useful in supply chain functions but there are still some things we do not know. We have looked at how Artificial Intelligence helps with demand forecasting, inventory

management, logistics and risk management. However, we need to understand how all these things work together to affect the supply chain. Many people have studied technologies or specific jobs but it is hard to see the big picture. We need to know how Artificial Intelligence, transformation, supply chain visibility, supply chain agility and operational performance are all connected. Most of the research has been done in places that're already developed and we need to know more about how Artificial Intelligence works in developing countries. We also need to study companies that are using Artificial Intelligence, not just theoretical ideas. There are challenges when it comes to using Artificial Intelligence, such as having good data getting all the technology to work together keeping everything safe having workers with the right skills and making sure companies are ready. We need to learn more about these challenges so we can help companies use Artificial Intelligence successfully. All of these things we do not know provide a chance for us to learn more, about how Artificial Intelligence can help with transformation and make supply chains better. Artificial Intelligence can support transformation and improve supply chain performance and we need to study this more. Artificial Intelligence is a part of making supply chains better and we need to understand how it works.

#### VIII. CONCLUSION

Artificial Intelligence has become a technology for making supply chains work better. It helps improve how fast they respond how well they make decisions and how efficiently they run. This study looked at the areas where Artificial Intelligence is used. These areas include predicting how much people will want to buy, managing stock moving goods around handling storage and working with suppliers. The research shows that Artificial Intelligence can help with predictions, better stock control, better plans for moving goods smart ways to do tasks checking suppliers and spotting possible problems in different parts of the supply chain. These uses can help save money make operations run smoothly help make better decisions give a clearer view of what is happening make the supply chain more flexible and make it stronger when things go wrong. Using Artificial Intelligence successfully is not easy. It needs to fix problems with getting data making different systems

work together spending money on new tools keeping information safe having the right people to use the technology and making sure the company is ready for change. The study also found that more real-world testing is needed. It also says that more research is needed to connect how Artificial Intelligence works with the success of supply chains. Based on these results a simple model was created. This model connects Artificial Intelligence capabilities with changes how clear the supply chain is, how quickly it can change and how well it works. This model gives a starting point for studies, on how Artificial Intelligence can change supply chains. It also helps in making supply chains smarter flexible stronger and more efficient.

#### IX. FUTURE RESEARCH DIRECTIONS

Need to do research on making supply chain models that use artificial intelligence work together. This is better than looking at how artificial intelligence is used in one area. Other studies can look at how artificial intelligence affects supply chain visibility, supply chain agility and how well a company runs, using data from companies. We should also pay attention to supply chains in countries that are still developing because they may use artificial intelligence in different ways than richer countries. Future research can look at how artificial intelligence works with technologies like the Internet of Things Big Data, Blockchain, cloud computing and digital twins to make supply chain systems more connected and smarter. We should also look at how the quality of data, cybersecurity, cost whether a company's ready and whether we have enough skilled workers affect how well artificial intelligence is adopted. We can do studies over time to see if using intelligence really makes companies better, at saving money being efficient responding to problems dealing with tough situations and providing good service. Artificial intelligence and supply chain models are important because they can help companies run better. We need to keep studying intelligence and supply chain models to make sure we understand how they work together. This will help us make supply chain systems that're more connected and intelligent. Artificial intelligence is a part of this and we need to keep researching how it affects supply chains.

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