



The Role of Artificial Intelligence in Improving the Efficiency of the Company's Supply Chain

Muh. Husein*, Harjono P Putro, Jenni Ria Rajagukguk, Kartiko Eko Putranto

Magister of Management Technology, Faculty of Engineering, Krisnadwipayana University, Jakarta, Indonesia

*Corresponding author Email: mohsenmedia17@gmail.com

The manuscript was received on 20 March 2024, revised on 1 May 2024, and accepted on 1 October 2024, date of publication 21 October 2024

Abstract

The development of technology, especially in the era of Industry 4.0, has significantly impacted various sectors, including supply chain management. Artificial Intelligence (AI), one of the leading technologies in Industry 4.0, has excellent potential to improve the efficiency and effectiveness of the supply chain. This study aims to identify the relationship between AI and the concept of supply chain management and analyze the practice of using AI to improve supply chain efficiency at PT. Pelita Media Nusantara. Using a descriptive-analytical method, this study examines various relevant literature and data. The results of the study indicate that the application of AI at PT. Pelita Media Nusantara has increased the supply chain's visibility, accuracy, and responsiveness. Implementing big data analytics, IoT sensors, and AI-based predictive systems allows companies to optimize procurement, production, and distribution processes. This case study also reveals that complex technology integration and the need for skilled human resources are the main challenges in implementing AI. This study provides important insights for academics and practitioners in developing more effective and efficient AI-based supply chain management strategies.

Keywords: Artificial Intelligence, Supply Chain Management, Industry 4.0, Operational Efficiency, PT. Pelita Media Nusantara.

1. Introduction

Technological developments are increasingly making it easier for humans to improve the business performance of an industry. To survive in the long term, industries must be able to adapt and follow technological developments. Adopting the latest technology helps improve operational efficiency and productivity and allows industries to remain competitive in an ever-changing market. For example, research shows that the application of digital communication positively impacts operational efficiency and productivity. Using digital communication tools such as email and collaborative platforms helps overcome distance and time constraints, accelerates the exchange of information, and facilitates faster decision-making. In addition, team member engagement increases through interactive communication channels, creating a more open and collaborative work environment [1].

Another thing that is no less important for a company in following technological developments is related to information technology governance. Company leaders in the digital era must articulate a vision that focuses on using technology to improve the effectiveness and efficiency of organizational communication. The formation of cross-departmental teams or committees is critical to integrating efforts between information technology and communication. In addition, the designed information technology policy needs to pay attention to security standards and data governance following the organization's communication values. Socialization of policies and regular training are essential to ensure the understanding and skills needed throughout the organization. Periodic evaluation of the implementation of the information technology governance framework shows that the ability to adapt and be responsive to changes in the organization and the external environment is the key to long-term success [1].

The development of technology is due to the need for acceleration and growth of productivity in each industry. The digital disruption that occurs has an impact on various elements marked by the industrial era 4.0, where the use of Artificial Intelligence (AI), Internet of things (IoT), Augmented and Virtual Reality (A and VR) [2] (Min.). Advance Robotics and 3D Printing have begun to develop. The role of technology is greatly needed, especially in the current industrial era 4.0, as technology can present production automation that will



increase business opportunities, effectiveness, and business efficiency and renew the environment through better asset management [3]. This is marked by an increase in the volume of data usage, more sophisticated computing technology, and reliable connectivity. A phenomenal statement, namely "machines will be able to do any job that humans can do," now artificial intelligence (AI) has developed rapidly and is getting closer to what Simon predicted more than 50 years ago [4].

This movement initially started with the development of expert systems and fuzzy logic, then matured after 2010 with the emergence of big data, analytics, various graphical processing units, and deep learning applications that have shaped what we call modern AI. Since the early 2010s, the pace of AI applications has increased rapidly, with promising results and some concerns about the future of work and business management [5].

AI is a field of computer science that includes developing systems capable of performing tasks that usually require human intelligence. The estimated economic contribution of AI technology reaches around \$ 13 trillion by 2030 and can potentially increase global GDP by around 1.2 percent per year. Despite its potential to disrupt the way organizations operate [6]. An estimated 37% of organizations are still looking to outline their AI strategy, while 35% struggle to find the correct application [7]. In 1955, the term "artificial intelligence" was first coined to explore the ability of machines to use language and solve problems usually reserved for humans [8]. There is little agreed upon and standard definition of AI [9]. Two-dimensional considerations for AI. The first dimension is comparing the system's performance with the human way of thinking or ideal rationality. The second dimension is whether the system matches the performance of humans in acting rationally [10].

Since its initial conceptualization in the 60s, Artificial Intelligence research has witnessed a wide variation, ranging from low interest in the topic to its rapid growth, also known as the AI craze. However, only recently has artificial intelligence begun to deliver the promised value to businesses. With the rapid development of technology to the level of artificial intelligence, there is modern trade competition between major supplier networks [11]. Supply chain efficiency is determined through information sharing and collaboration [12]. Innovation for suppliers affects the exchange of information and the speed of the supply chain. Companies' ability to increase visibility, agility, adaptability, and supply chain alignment is greatly influenced by the exchange of information and relationships between resources. Managing information to support logistics movements is critical to success in this volatile economic context. Exchanging information with environmental management providers and the financial and ecological benefits of customers and supply chain partners [13].

The supply chain is a network of companies working to create and deliver a product to the end user. These companies usually include suppliers, factories, distributors, stores or retailers, and supporting companies such as logistics service companies [14]. The supply chain is an integrated process where several entities work together to obtain raw materials, transform them into finished products, and deliver them to retailers and customers [15]. In addition to being a unit of supplier, manufacturing, customer, and delivery Processes, the supply chain is also a system where organizations distribute their production goods and services to their customers.

Supply Chain is a collection of activities related to the network of facilities and distribution options that cover the entire interaction between suppliers, companies, manufacturers, distributors, and consumers who carry out the functions of procuring materials, processing these materials into semi-finished or finished goods, and distributing these finished goods to customers [16]. In its implementation, there are various problems in managing the company's supply chain, especially in Indonesia. Several issues often occur in supply chain management in multiple companies in Indonesia [17], including the difficulty of predicting consumer demand, increasing shipping costs, long waiting times, technological developments, getting reliable shipping partners, limited labor and delays in port operations, and Poor logistics management. In addressing this, his research successfully identified that AI can help companies measure market demand and customer sentiment. Utilizing scanner data collected at point-of-sale locations and vast amounts of data from customer reviews and blog posts on social media. Artificial Intelligence can detect early signs of panic buying using significant data sources [18]. In addition to detecting changes in demand in real-time, it was revealed that Artificial Intelligence could collect and analyze data on traffic conditions at various levels of the supply chain, such as ports and warehouses. These tools can detect supply disruptions caused by shortages of supplies and workers, factory closures, and shipping delays, among other issues [18]. In addition, the challenges in supply chain management in Indonesia are increasingly complex, and advanced technologies need to be integrated to improve operational efficiency. This condition requires companies to address classic issues, such as difficult consumer demand prediction and rising shipping costs, and adopt technologies that can provide a competitive advantage. Given the strategic role of the supply chain in ensuring product availability and customer satisfaction, innovative solutions such as AI are becoming increasingly relevant. AI offers great potential in providing in-depth and predictive analysis, enabling companies to respond more to dynamic market and operational changes. Various technology applications can be effectively applied to address supply chain management challenges and improve operational efficiency.

In planning, predictive analytics technologies such as Python R and machine learning platforms such as TensorFlow and Scikit-Learn facilitate demand forecasting and inventory level optimization by leveraging historical data and market trends. This enables companies to plan inventory needs more accurately. In procurement, RFID (Radio Frequency Identification) analyzes data from point-of-sale, inventory, and shipping, which minimizes lead times and improves product availability by providing better visibility into the location and status of goods. For production, real-time analytics using data streaming technologies such as Apache Kafka and Apache Spark enable monitoring of equipment performance and identification of potential issues before they develop into major problems, thus improving production efficiency and reducing downtime.

In inventory management, Big Data Analytics and Cloud Computing enable data collection and analysis from RFID systems and big data analytics, which provides supply chain visibility and optimizes inventory levels through in-depth and responsive analysis. GPS and cutting-edge sensor technologies are used for delivery to monitor vehicle speed and driver rest time, while AI sensors can control vehicle acceleration and braking. Real-time route optimization also leverages the latest traffic conditions and demand data to determine the most efficient truck routes.

Finally, in after-sales service, risk management can be improved using AI-based analytics dashboards such as Tableau or Power BI. These provide reports and visualizations on supply chain performance, potential risks, and recommended actions, helping companies make better decisions and manage risks effectively. In increasingly complex supply chain management challenges, especially in Indonesia, advanced technologies such as Artificial Intelligence (AI) can improve operational efficiency and address various issues companies face. For example, AI can forecast demand, optimize inventory levels, and monitor and analyze data in real-time. This helps identify and address possible disruptions in the supply chain more quickly and accurately.

In addition, applying technologies such as RFID, big data analytics, and advanced sensors enables companies to improve their supply chains' visibility, agility, and adaptability, which are crucial factors in dealing with market fluctuations and changing consumer needs.

With increasing data volumes and operational complexity, companies must utilize technologies that can provide in-depth and predictive analysis to remain competitive. With its extensive analytics capabilities and fast data processing, AI can help companies predict market trends, manage inventory, and optimize delivery processes.

As such, AI not only offers solutions to classic problems in the supply chain but also opens up new opportunities for innovation and efficiency that can provide a competitive advantage in an increasingly tight global market. This research explores in depth how AI technology can be applied realistically and significantly improve supply chain efficiency in Indonesia. Therefore, based on various academic arguments and phenomena described above, the author intends to conduct research on The Role of Artificial Intelligence in Improving Company Supply Chain Efficiency: Case Study at PT Pelita Media Nusantara. Problem Formulation: How can artificial intelligence relate to the concept of supply chain management? How can artificial intelligence improve the company's supply chain efficiency at PT Pelita Media Nusantara? The research objectives are to identify the relationship between artificial intelligence and the concept of supply chain management and to analyze the practice of using artificial intelligence to improve the efficiency of the company's supply chain at PT Pelita Media Nusantara. The research method uses a qualitative research method approach.

2. Literature Review

In the 21st century, artificial intelligence (AI) has become a significant research field in various sectors such as engineering, science, education, medicine, business, accounting, finance, marketing, economics, stock market, and law. The rapid development of AI makes tracking research progress a complex and challenging task [19]. Although the applications of AI are extensive, research in this field has been divided into many subfields, each emerging as a separate discipline [20]. In general, the fields in AI can be classified into sixteen main categories [21]. To provide a clear picture of the various fields of AI, the author uses a flowchart to illustrate the structure of this paper and the relationship between the different subfields of AI. Here is a brief discussion of some critical fields in AI. Reasoning in AI has been the subject of extensive research and documentation [22].

Research in this area involves several significant aspects, including developing hypotheses that provide a solid and complete logical basis for reasoning logic, investigating the theoretical properties of algorithms used for qualitative temporal reasoning, and studying the relevance of information in specific reasoning problems (independence). A significant study on axiomatic causal reasoning was conducted by [23].

In his work, Halpern developed an axiomatization of causal models defined in terms of sets of equations, as determined by Pearl. This research covers a wide range of general areas in AI reasoning, including reasoning complexity, reasoning about minimal belief, axiomatization, sampling algorithms, logic and consistency, fuzzy description logic, diagnosis, independence, domain filtering, and fusion. In another study, an algorithm for evidential reasoning was developed in large Bayesian networks. This algorithm, called Adaptive Importance Sampling Bayesian Network (AISBN) [24], shows promising convergence rates even under extreme conditions. AISBN appears to consistently outperform existing sampling algorithms, offering a better replacement for stochastic sampling algorithms that often underperform in situations with doubtful evidence [25].

AI has been applied in many fields, significantly contributing to technological advancements and operational efficiency. Here are some examples of AI applications in various sectors. In engineering, AI is used to optimize design and manufacturing processes. AI techniques such as machine learning and neural networks are used to develop automated systems to identify and fix manufacturing defects in real time. AI helps analyze complex and significant scientific data, accelerating scientific discovery and understanding of natural phenomena [26]. AI in education includes using adaptive learning systems that can tailor course materials to the needs and abilities of each student. AI is also used to develop virtual tutors to provide more personalized and effective learning assistance [27]. AI is used in medicine to diagnose diseases, develop drugs, and provide patient care. AI algorithms can accurately analyze medical images such as MRI and CT scans, helping doctors make more informed medical decisions. In addition, AI is also used to develop predictive models that can estimate patient outcomes based on historical data and medical conditions [28].

AI is used for business and finance market analysis, risk management, and customer service. AI algorithms can analyze market data to identify trends and investment opportunities. In addition, AI is also used to develop chatbots that can provide 24/7 customer service, improving customer satisfaction and operational efficiency [29]. Although AI offers many benefits, several challenges must be overcome. One of them is the issue of ethics and privacy. The use of AI in data collection and analysis raises concerns about individual privacy and the potential for data misuse. In addition, there are also technical challenges in developing AI algorithms that can adapt to changing and complex situations [30]. In the future, AI is expected to continue to grow and become more integrated into everyday life. Research in AI will continue to focus on developing more sophisticated and efficient algorithms, as well as applying AI in various sectors to improve quality of life and operational efficiency. AI has become a critical and rapidly growing field in the 21st century. Its wide application covers multiple sectors such as engineering, science, education, medicine, business, accounting, finance, marketing, economics, stock market, and law. Although research in AI has been divided into many subfields, each with different focuses and methods, all contribute to the development of AI as a whole. Research and development in AI will continue, offering great potential for technological advancement and improving the quality of life.

The supply chain is a network of companies that work together to create and deliver a product to the end user. These companies usually include suppliers, factories, distributors, stores or retailers, and supporting companies such as logistics service companies [14]. The supply chain is an integrated process where several entities work together to obtain raw materials, transform them into finished products, and deliver them to retailers and customers [15]. In addition to being a unity of Suppliers, Manufacturing, Customers, and Delivery Processes, the supply chain is a system where organizations distribute their production goods and services to their customers. Supply Chain is a set of activities related to the network of facilities and distribution options that cover the entire interaction between suppliers, companies, manufacturers, distributors, and consumers that carry out the functions of procuring materials [16], processing these materials into semi-finished or finished goods, and distributing these finished goods to customers [31]. Adding concretely in a supply chain, three types of flows must be managed [32]. The first is the flow of goods that flows from upstream to downstream.

An example is raw materials sent from suppliers to factories. After the products are finished being produced, they are sent to distributors, then to retailers or retailers, and then to end users. The second is the money flow, which flows from downstream to upstream. The third is the flow of information that can occur from upstream to downstream or vice versa.

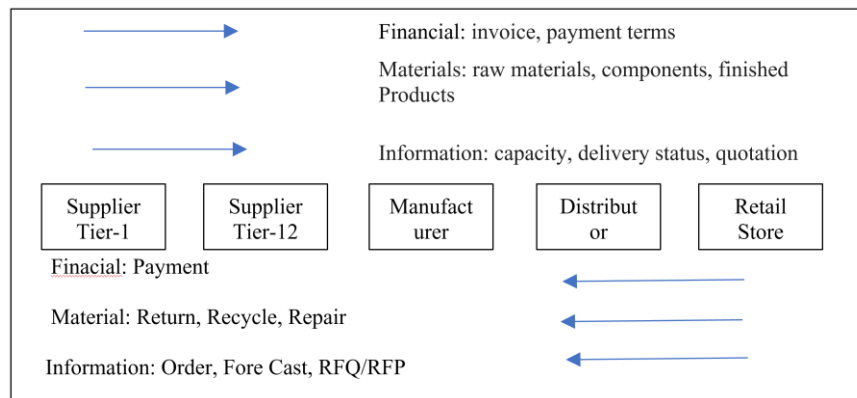


Fig 1. Supply Chain Model

Distributors and factories often need information about the stock of products in each supermarket. Factories often need information about the availability of production capacity owned by suppliers. An effective and efficient supply chain can provide a competitive advantage for a company. Good supply chain management can reduce production and distribution costs, increase customer satisfaction, and increase the company's flexibility and responsiveness to changes in market demand. One of the main challenges in supply chain management is coordination between the various entities involved.

Each entity in the supply chain has its own goals and interests, so good coordination is needed to ensure the smooth flow of goods, information, and money along the supply chain. Information and communication technology (ICT) is vital in supply chain management. By utilizing technologies such as supply chain management systems, companies can integrate and automate various processes in the supply chain, from procurement of raw materials to delivery of finished products to customers. This technology allows companies to monitor and control the flow of goods, information, and money in real time, thereby increasing the efficiency and effectiveness of the supply chain. One example of the application of technology in the supply chain is the Enterprise Resource Planning (ERP) system.

ERP is an information system that integrates all departments and functions in a company into one computerized system that can meet all the company's needs. By using ERP, companies can manage their various business processes more efficiently and effectively, including supply chain management. In addition to ERP, another technology often used in supply chain management is Radio Frequency Identification (RFID).

RFID technology uses radio waves to identify and track objects automatically. By using RFID, companies can monitor the flow of goods along the supply chain more accurately and in real time. In addition to technology, the proper management approach is also essential in supply chain management.

One approach that is widely used is Lean Supply Chain. Lean Supply Chain is a supply chain management approach focusing on reducing waste and increasing efficiency. This approach involves various techniques and methods such as Just-In-Time (JIT), Kaizen, and Six Sigma. Just-In-Time (JIT) is a production system that aims to produce goods exactly when they are needed, thus reducing inventory and storage costs. Kaizen is an approach that focuses on continuous improvement in business processes, while Six Sigma is a methodology used to identify and eliminate defects in the production process.

Implementing a Lean Supply Chain can provide various company benefits, including reducing production and distribution costs, improving product quality, accelerating delivery times, and increasing customer satisfaction. However, implementing the Lean Supply Chain also faces various challenges, including changes in organizational culture, team member training and development, and investment in technology and infrastructure.

In addition to the Lean Supply Chain, another approach widely used in supply chain management is the Agile Supply Chain. Agile Supply Chain is an approach to supply chain management that focuses on flexibility and responsiveness to changes in market demand. This approach involves various techniques and methods, such as Demand Forecasting, Inventory Management, and Supplier Relationship Management. Demand Forecasting is a technique used to predict future product demand so companies can better plan production and procurement of raw materials.

Inventory Management is a technique used to manage inventory efficiently, thereby reducing storage costs and the risk of stockouts. Supplier Relationship Management manages relationships with suppliers, ensuring the smooth flow of raw materials and reducing the supply chain disruption risk.

Implementing Agile Supply Chain can provide various benefits for companies, including increasing flexibility and responsiveness to changes in market demand, reducing the risk of disruption in the supply chain, and improving customer satisfaction. However, implementing Agile Supply Chain also faces various challenges, including good coordination between different entities in the supply chain, sophisticated information technology, and investment in infrastructure and team member training. Sustainable Supply Chain Management (SSCM) has recently gained increasing attention. SSCM is a supply chain management approach focusing on environmental, social, and economic sustainability.

This approach involves various techniques and methods such as Green Supply Chain, Socially Responsible Supply Chain, and Economic Sustainability. Green Supply Chain is an approach that focuses on reducing the environmental impact of supply chain activities, such as reducing greenhouse gas emissions, reducing waste, and using resources more efficiently. Socially Responsible Supply Chain is an approach that focuses on improving the social welfare of workers and communities involved in the supply chain, such as improving working conditions, fair wages, and eliminating child labor. Economic Sustainability is an approach that focuses on the financial sustainability of supply chain activities, such as increasing cost efficiency, improving product quality, and increasing customer satisfaction. The implementation of SSCM can provide various benefits for companies, including improving the company's reputation.

3. Research Methods

The location of this research is PT. Pelita Media Nusantara has its office in Jl. MH. Thamrin No.17, RT.002/RW.001, Panunggan Utara, Kec. Pinang, Tangerang City, Banten 15143. The study was conducted from May to June 2024. The informants of this research were the Supply Chain Manager and Head of Division at PT. Pelita Media Nusantara. The philosophy of this research refers to the positivist approach, which is based on the belief that valid knowledge can only be obtained through empirical observation and objective measurement of the phenomena being studied. Positivism, as one of the most influential schools of philosophy of science, emphasizes the importance of using scientific methods to gain an accurate understanding of reality.

This approach isolates specific variables in a controlled context to identify cause-and-effect relationships that can be tested empirically. In the context of this research, positivism was chosen as the basic philosophy because it follows the research's purpose of evaluating the application of artificial intelligence (AI) in supply chain management at PT. Pelita Media Nusantara requires objective measurements and reliable data to assess the effectiveness of the technology [34]. Positivism underlies this research by demanding systematic data collection and analysis based on empirical evidence. The data collected must meet high validity and reliability requirements so other researchers can retest and verify research findings. This approach allows researchers to produce findings relevant to the company where the research is conducted and have broader generalization value in implementing AI in supply chain management. Positivism emphasizes the ability to measure phenomena quantitatively, where each research result can be repeated and produces consistent data.

On the other hand, positivism also requires a distance between the researcher and the research object to ensure that data collection and analysis are free from subjective bias. In this study, the researcher was not directly involved in the company's day-to-day operations but acted as an independent observer who collected data through interviews and secondary sources such as scientific literature and company data. This aligns with the view that researchers must maintain objectivity and not allow personal perceptions to influence research results [35]. By adopting the philosophy of positivism, this study also emphasizes using quantitative methods that utilize measurement and statistical analysis to evaluate the effectiveness of AI implementation.

This approach allows researchers to identify patterns that may not be visible through qualitative methods alone. For example, through quantitative data analysis, researchers can measure how much influence AI has on supply chain efficiency, such as reducing production time, optimizing inventory management, or increasing delivery speed.

The research approach used in this study is a qualitative approach with a descriptive-analytical method. The qualitative approach was chosen because this study aims to understand the implementation of Artificial Intelligence (AI) in supply chain management at PT in depth and holistically. Pelita Media Nusantara. Qualitative research allows researchers to explore various aspects that influence the implementation of AI in the supply chain, including contextual and dynamic factors that are not easily measured quantitatively [34].

In qualitative research, the main focus is on understanding and interpreting the phenomenon being studied through the perspective of participants or individuals directly involved in the process. Thus, this approach not only looks at the result of AI implementation but also tries to uncover the methods, experiences, and meanings associated with implementing this technology in supply chain management. As explained by [36], qualitative research seeks to capture the complexity of the social world through flexible and adaptive methods, which allow researchers to understand situations in a broader and deeper context.

In addition, the analysis was also supported by a review of relevant literature, which provided context and a theoretical framework for understanding the findings generated from the interviews [37]. A qualitative approach also allows researchers to explore the nuances and complexities associated with AI implementation, including how employees receive the technology, the challenges faced during the implementation process, and the broader impact on organizational culture and relationships between departments within the company. This approach is suitable for research that seeks to understand complex phenomena that cannot be directly measured through numbers, such as the perceptions, attitudes, and experiences of individuals involved in the AI implementation process [38].

One of the main advantages of a qualitative approach is its ability to capture participants' perspectives in depth and detail. In the context of this study, in-depth interviews with supply chain managers at PT Pelita Media Nusantara provided rich insights into the strategies, policies, and practices used by the company in implementing AI. Through these interviews, the researcher explored views and experiences that may not be revealed through surveys or other quantitative methods. In addition, interviews allow the researcher to adapt to situations that develop during the research process, for example, by asking additional questions or exploring topics that arise during discussions [39].

However, the qualitative approach also has some limitations, primarily related to the issue of generalization. Qualitative research results are often contextual and may not generalize to a broader population. Nonetheless, in this study, the main focus was on an in-depth understanding of the application of AI in the specific context of PT Pelita Media Nusantara rather than on making generally applicable conclusions. Instead, this research offers rich and detailed insights that can contribute to understanding the challenges and opportunities in applying AI in the supply chain management sector [40]. This research uses a qualitative approach to comprehensively capture the complexities and dynamics of AI implementation at PT Pelita Media Nusantara. This research focuses on the end result, processes, and interactions during AI implementation. Through this approach, researchers can explore various dimensions that may be overlooked in quantitative research, such as how AI affects team member relationships, organizational power dynamics, and work culture changes. Thus, the qualitative approach provides a flexible and adaptive framework to understand the implementation of AI in supply chain management more holistically and in-depth [34]. The object of research is an essential element in any scientific study because the main focus is to find answers or solutions to the problems at hand [41]. The object of research can be defined as "a scientific target to obtain data with certain goals and uses about something objective, valid, and reliable regarding certain variables." In this study, the object of research not only functions as a focal point but also as the leading guide in exploring and analyzing various essential aspects related to the topic being studied.

Selecting the proper research object is very important because it will determine the quality of the data obtained, the validity of the findings, and the relevance of the conclusions that can be drawn from the research. In this study's context, the chosen object applies the concept of artificial intelligence (AI) in supply chain management at PT. Pelita Media Nusantara. AI has become one of the most influential technologies in various industries, including supply chain management, due to its ability to improve operational efficiency, reduce costs, and improve service quality. By choosing the application of AI as the object of research, this study seeks to comprehensively evaluate how the technology is applied in various aspects of the company's supply chain, including planning, procurement, production, inventory management, delivery, and after-sales service. Overall, the main objective of this study is to obtain valid and reliable data on the effectiveness and impact of AI implementation in improving supply chain efficiency and performance at PT.

Pelita Media Nusantara. By evaluating the various aspects of AI implementation mentioned above, this study is expected to provide in-depth insight into how this technology can optimize company operations and improve competitiveness in an increasingly competitive market. This study is also likely to contribute significantly to the existing literature, especially in the field of supply chain management supported by AI technology.

In this study, the Supply Chain Management Thinking Framework includes strategies related to three main aspects. Where are the upstream, internal, and downstream supply chains? The upstream supply chain focuses on various company activities involving suppliers, especially in procuring raw materials and supporting materials needed to support company operations. This procurement process is a crucial initial step because the availability of quality and timely raw materials will affect production. Companies must establish good relationships with suppliers, ensuring they can provide materials that meet quality standards and demand within the specified time. Effective procurement of raw materials also helps companies manage costs and maintain operational continuity.

Furthermore. In the context of this research, primary data were collected through in-depth interviews with seven informants with knowledge and experience relevant to the research topic, namely the application of Artificial Intelligence (AI) in supply chain management at PT. Pelita Media Nusantara which includes the following:

Table 1. List of Sources

No	Name	Position	Length of work (Year)
1	Fahmi Jihaduddin, S.Si	Supply Chain Manager	7
2	Putri Nurul Hikmah, S.M	Head of Planning Division.	4
3	Abdul Rozak	Head of Procurement Division	9
4	Ono Johana	Head of Production.	10
5	Dwi Ernawati, S.H	Head of Management Supply	3
6	Esa, S.Par	Head of Delivery Division.	4
7	Abdul Hasib	Head of After-Sales Services	6

Each informant was selected based on their roles and responsibilities that are directly related to critical aspects of the company's supply chain so that the information obtained from them can provide in-depth and specific insights regarding the application of AI in each phase of the supply chain. Interviews were semi-structured, allowing researchers to get rich, in-depth information while focusing on previously formulated vital questions. In addition to primary data, this study uses secondary data from existing sources, such as scientific literature, research reports, and electronic data from the Scopus database. Secondary data is used to support and complement primary data and provide a broader context for the analysis to be carried out. Electronic data from Scopus was selected because of its high quality and credibility as one of the world's leading scientific databases, which provides access to various scientific publications relevant to this research topic. By combining primary data from interviews with informants and secondary data from scientific literature, this study is expected to produce comprehensive and valid findings.

This systematic data collection process allows researchers to get a clear picture of the application of AI in supply chain management at PT. Pelita Media Nusantara, as well as to evaluate the effectiveness and impact of the technology on the company's supply chain performance. The results of interviews with managers will be analyzed to identify patterns, challenges, and opportunities associated with using AI. In contrast, secondary data strengthens the findings and provides a broader perspective. The research stages carried out in this study are systematically arranged to ensure that each step is carried out following the designed methodology. This process starts from planning to concluding to obtain valid and reliable research results. The diagram in Figure 2 below explains each stage of the research process in detail. Figure 2 demonstrates the research flow applied in this study. From research planning, conducting interviews, and collecting secondary data to filtering and analyzing data, each stage is carried out carefully to ensure that the data collected and processed has high relevance to the research objectives. The results of this process are then used to draw conclusions that follow the findings of the data that has been analyzed. The data analysis technique applied in this study is a descriptive-analytical approach, which aims to provide a comprehensive and detailed picture of the data that has been collected. The first step in this process is to read each research material's title, abstract, and conclusion to evaluate its relevance and suitability to the research topic. Based on this initial assessment, research will be included in the database if it is considered relevant or not included if it does not meet the criteria.

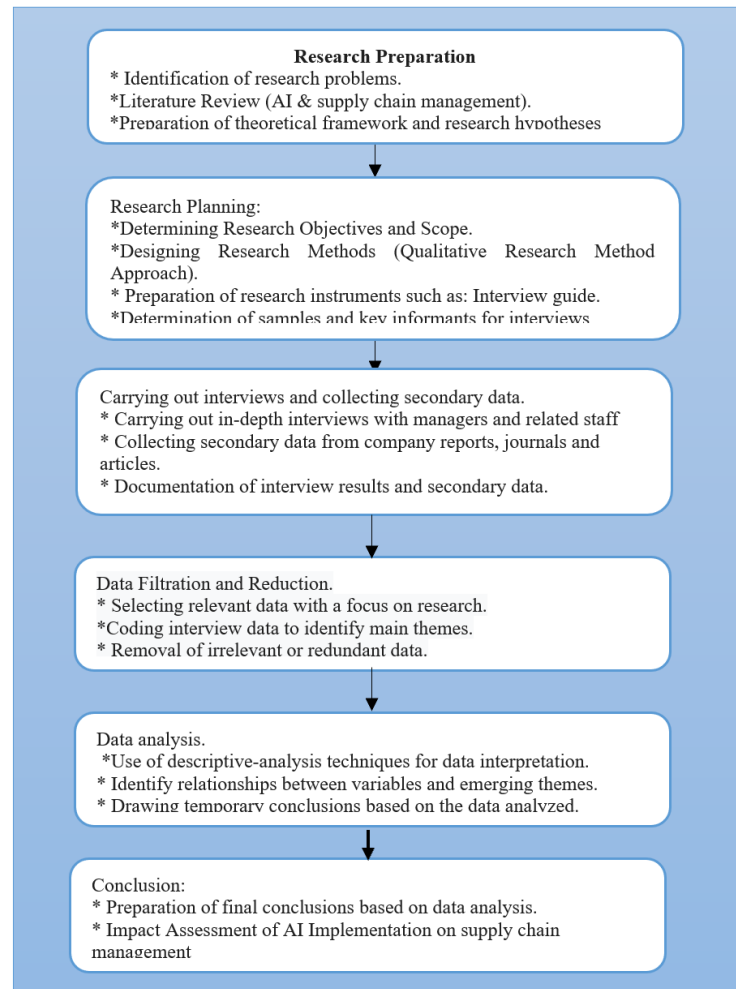


Fig 2. Research Stages

This process ensures that only high-quality and relevant research will be used in further analysis. Once a robust research foundation has been formed, the next step is to thoroughly assess the relevant literature to ensure that all sources used are appropriate and up-to-date. This evaluation includes checking the reference list of the literature found to identify additional sources that may be more relevant or provide further insights.

The researcher will assess the unique contribution of each selected literature, especially those that address supply chain issues, to determine how much they can add value to the study. This process is followed by data filtration of the selected literature to ensure that only the most relevant and high-quality data is used. After filtration, the researcher will apply the deductive method to analyze the data. The deductive method allows the researcher to systematically describe and analyze the data, starting from an overview of the filtered literature database and then narrowing its focus to specifically answer the research problem formulation. With this approach, the researcher can identify relevant patterns, relationships, and findings related to the application of AI in supply chain management and produce an in-depth and evidence-based analysis.

In the data analysis process, after applying the deductive method, the researcher will integrate the findings from the primary and secondary data to gain a deeper understanding of the application of AI in supply chain management. This analysis combines interviews with informants and data from the literature to identify patterns, trends, and relationships between the various variables involved. The researcher will use triangulation techniques to compare and validate findings from multiple data sources to ensure the accuracy and consistency of the analysis results. This approach allows researchers to evaluate the effectiveness of AI implementation holistically, considering different perspectives and contexts. The results of this analysis are expected to provide in-depth and evidence-based insights into how AI affects supply chain performance and efficiency at PT. Pelita Media Nusantara, and provide valuable recommendations for future improvements.

4. Result and Discussion

In this study, the profile of the research source will be described based on interviews, observations, and results from the documentation. The interview process was carried out in June 2024 with the Supply Chain Manager and the Heads of Divisions in the organizational management structure of PT. Pelita Media Nusantara. The following is the source profile, as seen in Table 2.

Table 2. Interviewee Profile

No	Name	Position	Length of work (Year)
1	Fahmi Jihaduddin, S.Si	Supply Chain Manager	7
2	Putri Nurul Hikmah, S.M	Head of Planning Division.	4
3	Abdul Rozak	Head of Procurement Division	9
4	Ono Johana	Head of Production.	10
5	Dwi Ernawati, S.H	Head of Management Supply	3
6	Esa, S.Par	Head of Delivery Division.	4
7	Abdul Hasib	Head of After-Sales Services	6

Each interviewee has a vital role in the operations of PT. Pelita Media Nusantara. They have experience and an in-depth understanding of the responsibilities of each area in the company's supply chain. Interviews were conducted to obtain in-depth information about the strategies, challenges, and policies implemented in their respective regions and how each area contributes to the efficiency and effectiveness of the company's overall supply chain. With work experience ranging from 3 to 10 years, the interviewees provided a rich perspective on best practices and obstacles faced in the supply chain management process. Company History PT. Pelita Media Nusantara is a company that was established in 2012 and has focused on three main areas, namely Furniture, IT, and Educational Tools.

Since its inception, PT. Pelita Media Nusantara has demonstrated its commitment to providing high-quality products to various institutions throughout Indonesia. With more than a decade of experience, the company continues to grow and adapt to changing market needs. In the Furniture sector, PT. Pelita Media Nusantara offers a wide range of products designed to meet the needs of various institutions, from offices and schools to other public facilities. Furniture products produced by PT. Pelita Media Nusantara is known for its modern, functional, and durable designs. In addition, this company pays attention to the ergonomic aspects of each product made so that it can provide comfort and support the productivity of its users. In the IT field, PT. Pelita Media Nusantara provides various innovative technology solutions to help institutions operate in Indonesia.

The IT products offered include hardware, software, and technical support services. PT. Pelita Media Nusantara collaborates with various leading vendors in the technology industry to ensure that the products they offer are always up-to-date with the latest developments. In addition, this company also provides consulting services to assist clients in designing and implementing IT solutions that suit their needs; meanwhile, in the field of Educational Tools, PT. Pelita Media Nusantara provides various equipment and supplies needed by educational institutions. These products include educational props, laboratory equipment, and multimedia devices supporting the teaching and learning process.

PT. Pelita Media Nusantara understands the importance of technology in the world of education. Therefore, they always strive to present products that can improve the quality of learning in Indonesia. In addition to providing various quality products, PT. Pelita Media Nusantara also has a B2B-based E-Commerce platform that aims to facilitate product buying and selling transactions. This platform is designed to provide convenience for agencies in finding and buying the products they need. With this platform, the purchasing process can be done faster and more efficiently, so agencies can focus more on their main activities.

PT. Pelita Media Nusantara is always committed to continuing to innovate and produce the latest products that are of high quality and at competitive prices. This company realizes that market needs are constantly evolving. Therefore, they always try to follow trends and changes that occur. Innovation is one of the primary keys in PT. Pelita Media Nusantara's business strategy is because they believe that by continuing to be creative, they can provide added value to customers. In addition, PT. Pelita Media Nusantara also pays close attention to the quality of each product they produce. The production process is carried out with strict standards to ensure that every product that leaves the factory is of the best quality. PT. Pelita Media Nusantara also has a quality control team that checks every product before sending it to customers. Thus, customers can feel confident that the products they receive meet their expectations and needs. To improve the quality of products and services, PT. Pelita Media Nusantara is also open to input and criticism from customers. The company believes that by listening to customers, they can find out what needs to be fixed and improved.

Therefore, PT. Pelita Media Nusantara always maintains good communication with customers and is ready to provide the best solution for every problem. Overall, PT. Pelita Media Nusantara is a company that is committed to providing. PT. Pelita Media Nusantara's vision is to become a leading procurement company dedicated to working together and creating a trusted e-commerce platform to provide the best product quality. The mission of PT. Pelita Media Nusantara is to make the best, most reliable, quality, and efficient human resources, provide the best product solutions, build a trusted e-commerce platform that can serve all buyer needs, and strive to introduce the latest products to help achieve customer goals.

The Relationship between Artificial Intelligence and the Concept of Supply Chain Management The manufacturing industry has been the foundation of economic progress in various countries for centuries. Still, in recent decades, technological developments have changed the landscape significantly. Digital transformation has become the center of the industrial revolution, affecting almost every aspect of manufacturing activities. With the development of artificial intelligence (AI) technology, manufacturing companies face great opportunities to improve their operational efficiency. AI can provide intelligent and adaptive solutions to the challenges faced in an increasingly complex and rapidly changing manufacturing environment. AI technology has opened the door for manufacturing companies to increase productivity, improve product quality, reduce production costs, and optimize the supply chain. With the ability to process and analyze large amounts of big data quickly, AI can provide valuable insights for decision-making, allowing companies to identify previously undetected patterns, detect anomalies, and predict future events. In many cases, the implementation of AI has resulted in significant improvements in various aspects of operations, from inventory management, production planning, and machine maintenance to product quality. Computer-based demand planning is nothing new. It is based on a series of designed algorithms that take various data sets such as shipping data, product life cycle data, ordering patterns, and production data. Over some time to make predictions about business phenomena that will occur in the future, related to various aspects such as demand and supply, commodity

price fluctuations, and potential profits or losses in a certain budget period. In contrast, AI-enabled systems know the best combination of algorithms and data sets to consider accurate predictions. More importantly,

AI helps businesses to get almost 100% accurate projections and forecasts of customer demand, optimize their R&D, therefore increasing production with lower costs and higher quality, assist them in promotions (identifying target customers and demographics, determining prices, designing the right messages, etc.) and provide a better experience to customers. Artificial intelligence (AI) in manufacturing companies can improve operational efficiency in several ways. First, AI allows companies to optimize the supply chain by predicting demand, managing inventory, and planning production more accurately [42]. In addition, AI can improve product quality by automatically detecting defects during the production process [43]. The ability of AI to analyze big data also allows companies to perform predictive maintenance on factory equipment, reducing unexpected production downtime [44]. In addition, the application of AI in manufacturing companies can also improve energy efficiency by optimizing resource usage and reducing production waste [45]. AI can also automate production processes, increase productivity, and reduce labor costs [46]. Using AI technology, manufacturing companies can improve product delivery timeliness, reduce lead times, and increase customer satisfaction [47].

In addition to operational benefits, the implementation of AI can also help manufacturing companies identify new opportunities, optimize marketing strategies, and respond quickly to market changes [48]. By leveraging AI's data analysis and prediction capabilities, companies can make more intelligent and timely decisions to increase their competitiveness in the market [49]. By integrating AI in manufacturing processes, companies can achieve higher operational efficiency, faster product innovation, and better adaptation to changing business environments. Artificial Intelligence (AI) has become an essential technology in various fields due to its ability to mimic human intelligence [50]. The application of AI has significantly impacted organizational creativity, company performance, and consumer behavior [51]. In marketing, the use of AI in social media has positively influenced consumer purchase intentions [52]. In addition, AI has been utilized in developing chatbots, which serve as interactive tools in the digital era [53]. Integrating AI in systems such as chatbots and virtual assistants shows how computers can be trained to perform tasks similar to human capabilities [53]. In addition, AI has become an essential instrument in improving the performance of professionals, such as accountants, by helping to understand, predict, and support their work processes [54].

The implementation of AI in various sectors, such as banking, health, and agriculture, has been recognized for its efficiency and effectiveness [55]. For example, AI-based risk management in banking has been raised due to its potential to simplify processes and improve decision-making [56]. In addition, AI has been applied in various scenarios, such as classifying plant diseases, diagnosing animal diseases, and even optimizing electric car battery measurements [57]. AI algorithms have been proposed as a solution to combat the spread of misinformation and distinguish between fake and real news [58]. In addition, AI has been integrated into gaming environments to enhance user experience, especially in non-player character interactions [59]. Improving operational efficiency in manufacturing companies is a strategic step that can provide a competitive advantage. Operational efficiency can be measured as the effectiveness of using all company assets to generate revenue [60]. In this context, the application of Enterprise Architecture can be an effective solution. Enterprise Architecture aims to plan information technology that supports company operations efficiently and effectively so that companies can compete well in the Industry 4.0 era [61].

In addition, case studies relevant to improving operational efficiency in manufacturing companies also highlight the influence of operational efficiency on the company's financial performance [62]. By improving operational efficiency, companies can optimize the use of resources and increase profitability. In addition, the synergy between environmental information disclosure and technological innovation can also positively impact manufacturing companies' financial performance [63]. The operational activities of manufacturing companies impact the company's internal environment and surroundings, so it is essential to consider environmental aspects to improve operational efficiency. In implementing technology, such as artificial intelligence (AI), the role of this technology in improving operational efficiency cannot be ignored. AI can optimize production processes, supply chain planning, and equipment maintenance, thereby helping improve overall operational efficiency [64].

However, it is important to consider ethical aspects when applying AI technology so that its use is based on applicable principles [65]. AI has been used effectively in projections and forecasting. Given that, in principle, companies constantly strive to ensure a balance between supply and demand, better supply chain projections are needed. AI's ability to process, analyze (automatically), and predict data allows AI to provide accurate and reliable demand forecasts, which will enable businesses to optimize their sources in terms of purchasing and order processing, thereby reducing costs associated with AI can also spot trends and patterns that help design better retail and manufacturing strategies. In addition, AI can also play a significant role in manufacturing due to better asset and process optimization, creating the best teams, i.e., humans and robots, improved quality and reliability, i.e., error-free, and prevention of downtime for maintenance. The automation process has seen significant advancements due to AI technology. Robotics, one of the advanced branches of AI, has taken a central role in manufacturing [66]. Technological advancements in object recognition and semantic segmentation have changed robots' behavior, especially in how they recognize the properties of materials and objects they interact with. New robots equipped with AI-enhanced cameras are being trained to recognize empty shelf space. This dramatically increases speed over conventional object-picking methods [67]. Furthermore, in terms of marketing and sales productivity, digital content has become commonplace in this era, and businesses are using multiple channels to reach their customers. According to a recent Gartner survey, approximately 25 percent of marketing budgets are now dedicated to digital channels, and nearly 80 percent of marketing organizations are spending capital on technology—typically hardware and software—[68].

AI-powered activities include digital ad buying (programmatic buying), website operations and optimization, search engine optimization, A/B testing, outbound email marketing, lead filtering and scoring, and many other marketing tasks [68]. AI applications can analyze millions of data on consumer behavior, such as the frequency of the best, what interests them most, and the best time and day of the week to contact users. Several AI-based applications such as Boomtrain, Phrases, and Persado have demonstrated their value. Phrases claim that its generated emails outperform human-generated emails by over 95%. AI platforms analyze information, including interests, demographics, and other aspects, to learn and predict the best audience for their brand. Adext (an AI platform) can automate ad handling and optimization across platforms, including Google AdWords and Facebook. AI has revolutionized Internet search and search engine optimization (SEO) [69]. About pricing in recent years, AI has also enabled pricing solutions to track purchasing trends and determine more competitive product prices [70]. AI-based pricing software has been used in various sectors, including consumer goods, fashion, hospitality, and transportation [71]. In the future, businesses will evolve from absolute pricing, which is static pricing, to dynamic pricing, which will offer different prices to customers based on external factors and their purchasing habits. Dynamic pricing is based on aggregated price data available from multiple sources, namely across the web, from competitors, and prices available in other regions.

Dynamic pricing algorithms consider factors such as competitor prices, consumer behavior, location, time, and season to determine how much a buyer is willing to pay for a product or service. Many machine learning programs have been designed to collect and analyze data from multiple sources, such as loyalty cards and zip codes, to predict how much customers are willing to pay and how responsive they are to special offers. Most importantly, once these patterns are revealed, they can adjust and determine the best price for new products that suit the customer [72].

Although dynamic pricing is still in its infancy, it is predicted to grow exponentially. Furthermore, AI technology can also make every customer feel special and welcome. For example, a typical supermarket shopper puts a bunch of bananas in her cart, and a camera or sensor can relay that information to an AI application that will have a good idea of what the shopper likes based on previous purchases. The application can then, via a video screen in the cart, suggest that bananas would be delicious paired with chocolate fondue, which the shopper has a history of enjoying, and remind the shopper where to find the proper ingredients [73]. A runner can also download an app from an athletic shoe company to monitor her exercise routine and recommend footwear that matches her routine and preferred running routes. Amazon has built a retail store in Seattle that allows shoppers to grab food off the shelf and walk straight out of the store without stopping at a cashier to pay [74]. Overall, AI enables retail and manufacturing businesses to make smarter decisions with more accurate, real-time predictions, improve supply management, determine impactful thematic promotions, and optimize assortment and pricing. AI also makes operations more efficient, as robotics and process optimization increase productivity and reduce manual labor costs. Advances in enhanced vision are only made possible by more powerful computers, new algorithmic models, and extensive training datasets [75].

AI has enabled retailers to increase the number of customers and the average amount they spend by creating a personalized and convenient shopping experience. Retailers now know more about what their shoppers want - even before the shoppers themselves [69]. AI estimates from data patterns and volumes, i.e., previous transactions, weather forecasts, social media trends, shopping patterns, online viewing history, facial expression analysis, seasonal shopping patterns, etc. [76]. Similarly, a European retailer increased earnings before interest and taxes (EBIT) by 1 to 2 percent using machine learning algorithms to anticipate fruit and vegetable sales. Based on these forecasts, the company automatically ordered more products to maximize turnover and minimize waste. A German company, Otto, cut excess stock by 20 percent and reduced returns on more than two million items annually, using deep learning to analyze billions of transactions and predict what customers will buy before placing an order [77].

AI technology helps retailers predict future store performance as they expand their physical footprint. This is because retailers can optimize their storage space and locations using AI. Another critical aspect of the retail industry is merchandising. AI helps in merchandising, with the opportunity to increase the efficiency of product assortments. Using geospatial and statistical modeling, they predict and minimize inventory. Amazon has embedded AI at the heart of its operations. At the retailer's Seattle warehouse, machine learning algorithms direct thousands of products through a maze of conveyor belts and deliver them to humans just in time to fill shopping bags. Another robot carries the bags to a delivery van whose driver is guided by an AI application that selects the best route based on weather and traffic conditions [76]. Thus, AI is closely related to supply chain management through various mechanisms that support operational efficiency and effectiveness.

AI helps companies in every stage of the supply chain, from planning to after-sales service. The following is a more detailed explanation of AI design in improving efficiency in each supply chain process. (1) Planning is More Accurate Demand Prediction. AI uses machine learning algorithms to analyze historical sales data, market trends, weather changes, and other external data to predict demand more accurately. This helps companies organize more timely production and procurement, reducing the risk of overstocking or understocking. Scheduling Optimization is AI can generate optimal production schedules by considering various variables such as raw material availability, production capacity, and labor requirements. In this way, AI can help reduce bottlenecks and improve overall production efficiency. (2) Procurement is Procurement Process Automation: With AI, procurement processes such as supplier selection, price bidding, and contract management can be automated. AI can compare supplier prices and performance in real time and predict future price trends, leading to better purchasing decisions. Supplier Performance Analysis: AI can analyze historical supplier data, such as delivery timeliness and quality of goods supplied, to provide a more accurate assessment of supplier performance.

This allows companies to build stronger relationships with high-performing suppliers and mitigate supply chain risks with low-performing suppliers. (3) Manufacturing is predictive maintenance, which means that AI can analyze data from sensors installed on machines to detect patterns that indicate potential failures. With this, companies can perform maintenance before the machine breaks down, reducing downtime and reducing repair costs. Real-Time Defect Detection: Companies can detect product defects on production lines in real time using AI-powered machine vision. In this way, products that do not meet quality standards can be immediately identified and addressed, thereby reducing production waste and improving the quality of the final product. (4) Inventory Management is Inventory Level Optimization is; AI can analyze demand patterns, seasonal trends, and lead times to determine optimal inventory levels. In this way, companies can balance overstock and understock, reducing storage costs and improving operational efficiency. Real-Time Inventory Tracking: By leveraging IoT sensors connected to AI, companies can track inventory in real time. This allows companies to quickly adjust inventory, minimize shortages and overstock, and improve response to market demand. (5) Logistics and Distribution, namely Input, Traffic data, weather, customer location, Activity or Task, namely Delivery route optimization, real-time delivery tracking; Output, namely On-time delivery, reduced transportation costs, Control: Monitoring of delivery routes and times, transportation management and Stakeholders, namely Logistics team, customers, transportation service providers. (6) After-Sales Service, namely Input, Customer feedback, customer questions or complaints; Activity or Task, namely Chatbot and virtual assistant for customer support, customer feedback analysis; Output: Quick response to customers, increasing customer satisfaction, Control, namely Monitoring chatbot performance, analyzing complaint trends for product or service improvement and Stakeholders, Customer service team, customers, product management.

Thus, integrating AI in supply chain management improves operational efficiency and effectiveness and changes the way companies interact with data and make strategic decisions. AI enables companies to respond to market dynamics more quickly and accurately while minimizing the risks associated with supply chain uncertainty. Companies can create a more resilient, responsive, and customer-oriented supply chain by utilizing AI in every stage of the business process, from planning to after-sales service. It's about improving short-term performance and building a solid foundation for long-term success amidst increasingly fierce global competition. The Practice of Using Artificial Intelligence in Improving the Efficiency of the Company's Supply Chain at PT. Pelita Media Nusantara is the Use of Artificial Intelligence (AI) at PT. Pelita Media Nusantara aligns with the company's vision to become a leading procurement company committed to cooperation and creates a trusted e-commerce platform that provides the best product quality. To achieve the mission of creating the

best human resources, providing quality product solutions, building a reliable e-commerce platform, and introducing the latest products to support customer goals, AI technology is a vital tool.

AI enables PT. Pelita Media Nusantara to improve operational efficiency, optimize supply chain management, and reduce the risk of human error. At PT. Pelita Media Nusantara, based on information provided by Mr. Fahmi Jihaduddin as, the company's supply chain manager, PT. Pelita Media Nusantara has used several artificial intelligence (AI)-based platforms to assist the company in its various supply chain activities. He stated: "We have seen highly efficient and well-organized supply chains that maximize value for all parties involved. However, in addition to opportunities, we also see current challenges, such as disruption and increasing costs in the supply chain, and new challenges that need to be addressed in the next wave of optimization. With the tremendous increase in computing power, the availability of cheap sensor technology, and advances in Internet communications, many technological breakthroughs impact our daily lives." While many of these technologies are aimed at meeting the needs of end-users, many more technologies provide benefits in the context of logistics and supply chain management. In this regard, Mr. Fahmi Jihaduddin explained: "We see new warehouse technologies being used that fundamentally change the principles of traditional man-to-goods design, truck routes can be optimized in real-time based on traffic conditions, and the latest pickup and delivery requests, as well as order and invoice data, are exchanged without contact between supply chain partners, thus avoiding lengthy and error-prone data entry. Using blockchain technology in these processes will provide added value through authentication and verification". Overcoming the safe and controlled product distribution process by reducing the risk of travel obstacles caused by human error from drivers, PT. Pelita Media Nusantara has implemented various Company Operating Standards (SOPs). The SOP focuses on ensuring drivers' safety and accuracy in delivering products to end-users.



Fig 3. Cutting Edge Sensor

The SOP focuses on ensuring drivers' safety and accuracy when delivering products to end-users. In this case, PT. Pelita Media Nusantara uses GPS sensor technology in vehicles that allow management to control vehicle speed not to exceed the maximum speed limit and adjust driver rest times to achieve punctuality in the delivery process. Although technology is not the answer to all problems, if many technologies come together, they can enable significant productivity improvements and innovative disruptions, such as the idea of a physical Internet or the promise of a warehouse without lights. Although technology seems beneficial for the supply chain in the future, it is worth mentioning that Internet security and the potential loss of human capabilities/experiences can be possible risk factors in the transition process towards more autonomous and intelligent logistics and supply chains. The application of the technology below is one of the sectors where AI has been most successfully applied at PT. Pelita Media Nusantara. Cutting Edge Sensors installed in the company's logistics vehicles allow vehicles to accelerate or brake automatically and simultaneously. Thus, the driver's responsibility for the risk of the trip is reduced. In this regard, Mr. Fahmi Jihaduddin explained: "The AI-based system on Cutting Edge Sensor used in the company's logistics transportation has significantly improved road safety, and various problems that occur in the delivery process due to human error (such as speeding, distractions, and drunk driving).

Next, PT. Pelita Media Nusantara also uses a big data analytics platform in the form of Radio Frequency Identification (RFID) to analyze point-of-sale data, which can help determine special prices and services for each customer group while analyzing inventory and shipping data can minimize waiting times and increase product availability, and ultimately increase sales. RFID can help small markets improve the decision-making process in logistics functions. In addition, RFID can help businesses identify inefficiencies, optimize processes, and make data-driven decisions that lead to better results. From tracking inventory levels to predicting demand, data analytics using RFID can provide valuable insights into the supply chain that can help businesses optimize company operations. IDs are attached to products and points of sale to automatically collect data on location, movement, and inventory status. This data is then collected in an extensive data system that uses cloud computing technology for large-scale data storage and processing. In its application, the use of AI big data analytics can be described as explained by Mr. Fahmi Jihaduddin, who stated: "There are four things that cover the use of AI in business development analysis activities and more accurate strategy formulation, including predictive analysis, real-time analysis, supply chain visibility, and risk management." Predictive analysis uses data, statistical algorithms, and machine learning techniques to identify possible future outcomes based on historical data. In supply chain optimization, predictive analytics can forecast demand, identify potential bottlenecks, and optimize inventory levels. In this case, PT. Pelita Media Nusantara uses predictive analytics to predict demand for certain products and adjust their inventory levels to avoid running out of stock. This algorithm can identify hidden trends and patterns in the data to provide accurate predictions about future product demand.

Technologies such as Python and R and machine learning platforms such as TensorFlow and Scikit-Learn are often used to develop this predictive model. Real-time analytics involves analyzing data generated in real-time. In supply chain optimization, real-time analytics can track inventory levels, monitor equipment performance, and identify potential issues before they become significant problems. In this case, PT. Pelita Media Nusantara can use real-time analytics to monitor the performance of the company's delivery vehicles and identify potential maintenance issues before they cause damage. The company uses streaming data technologies such as Apache Kafka and Apache Spark for real-time analytics. These technologies enable data collected from RFID sensors and other systems to be analyzed instantly. With real-time analytics, PT. Pelita Media Nusantara can continuously monitor inventory levels, detect anomalies, and take

quick action if any issues are detected. Supply chain visibility refers to tracking products and materials as they move through the supply chain. Using data analytics to improve supply chain visibility, businesses can identify potential bottlenecks, optimize inventory levels, and improve delivery times. In this case, PT. Pelita Media Nusantara uses data analytics to track the movement of goods through their supply chain and identify potential delays in transit. In terms of supply chain visibility, PT. Pelita Media Nusantara uses Internet of Things (IoT) technology to integrate various sensors and devices along the supply chain. The data collected by these IoT devices is sent to a big data analytics platform, which is analyzed to provide a comprehensive picture of the movement of products and raw materials. Geographic Information System (GIS) technology is also used to track the geographic location of goods and provide better visibility. Data analytics can be used to identify potential risks in the supply chain and develop strategies to mitigate those risks. In this case, PT. Pelita Media Nusantara uses data analytics to track supplier performance and identify potential issues before they impact the supply chain. The company developed an AI-based analytics dashboard for risk management that provides reports and visualizations on supply chain performance, potential risks, and recommended actions.

The dashboard uses technologies like Tableau or Power BI, allowing users to understand data and make data-driven decisions quickly. Machine learning algorithms are also used to identify risk patterns and provide early warnings of potential issues in the supply chain. In addition, data analytics plays a critical role in improving supply chain resilience by providing actionable insights and predictive capabilities by leveraging data analytics, PT. Pelita Media Nusantara can gain a deeper understanding of its supply chain, identify areas for improvement, and proactively mitigate risks. Here is how PT uses data analytics. Pelita Media Nusantara to improve supply chain resilience: (1) Demand forecasting and planning: By analyzing historical sales data, market trends, and external factors, the company can develop accurate demand forecasts. This helps optimize inventory levels, improve production planning, and reduce the risk of stockouts or excess inventory during disruptions. (2) Risk assessment and mitigation: Data analytics can assess supply chain risks and prioritize mitigation efforts. Companies can identify potential risks by analyzing historical disruptions, supplier performance data, and market intelligence and develop strategies to mitigate their impact. (3) Supply chain optimization: Data analytics can identify inefficiencies and bottlenecks in the supply chain. By analyzing transportation routes, inventory levels, and lead times, companies can identify areas for improvement and optimize their supply chain for greater resilience and cost-effectiveness. (4) Predictive analytics for disruptions: By analyzing historical disruptions and external data sources such as weather patterns or geopolitical events, predictive analytics can provide insights into potential disruptions. This enables companies to develop contingency plans, allocate resources, and proactively respond to disruptions. Data analytics provides companies with actionable insights that enable data-driven decision-making and improve supply chain resilience. This empowers companies to identify opportunities for improvement, optimize operations, and proactively mitigate risks.

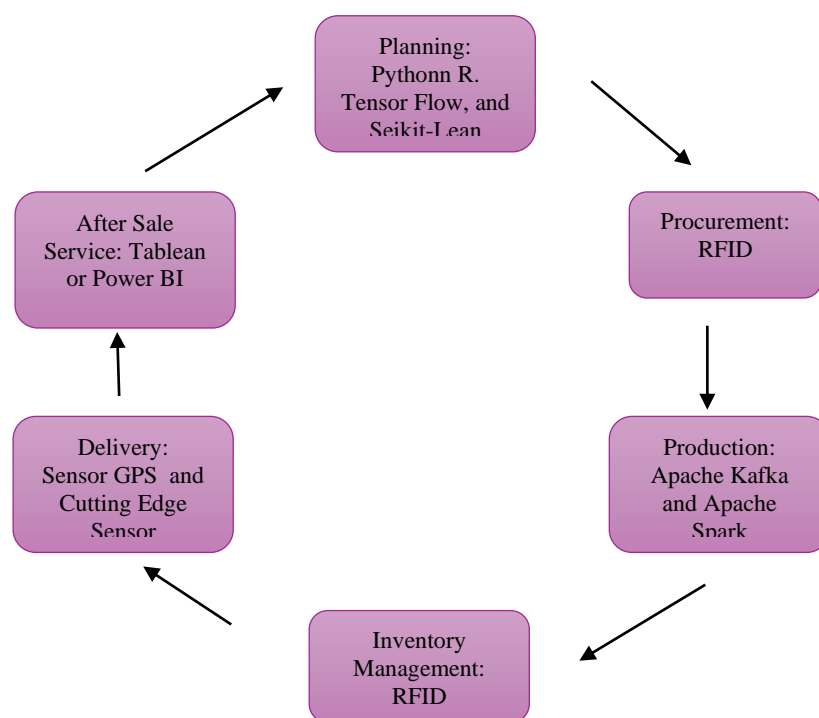


Fig 4. PT Supply Chain. Pelita Media Nusantara

In this context, Mr. Fahmi Jihaduddin explained: “By analyzing customer data, market trends, and external factors, the company identified changes in consumer preferences and potential disruptions caused by labor strikes at key suppliers. With these insights, companies can adjust production plans, diversify their supplier base, and quickly respond to disruptions without significantly impacting operations.” Therefore, PT uses big data and analytics. Pelita Media Nusantara has enabled companies to make data-driven decisions and optimize their supply chain operations for maximum efficiency and profitability.

Data analytics can be a game-changer for startups in today’s competitive landscape. By leveraging data analytics, startups can gain valuable insights into their operations, optimize supply chain processes, and drive innovation. Based on the above information regarding the analysis and AI used at PT. Pelita Media Nusantara, it can be concluded that AI is based on the supply chain process. A more detailed explanation of the role of each application in each supply chain process is as follows: (1) Planning: Python and R: Companies use Python and R to process historical sales data and external data such as market trends, seasonal changes, or marketing campaigns. For example, Python scripts can be used to import sales data from a database, merge it with external data, and then clean and prepare the data for further analysis, and TensorFlow and Scikit-Learn: TensorFlow is used to build neural network-based machine learning models that can

forecast complex demand patterns. Scikit-Learn, with various algorithms such as Random Forest or Support Vector Machines (SVM), allows companies to select the best prediction model based on accuracy and performance. Once the model is built and validated, companies can make monthly or weekly predictions, thereby adjusting production and raw material procurement with greater precision. (2) Procurement: RFID (Radio Frequency Identification): At the procurement stage, companies attach RFID tags to each product or raw material received at the warehouse. When the goods arrive, the RFID tags are automatically read by an RFID reader placed at the warehouse entrance. Data collected from RFID, such as the number of items, type of items, and storage location, are automatically updated in the company's inventory management system. This technology reduces manual errors in stock tracking and speeds up the process of receiving and shipping goods. In addition, RFID data is used to monitor the speed of stock replenishment from suppliers, allowing companies to negotiate or find new suppliers if delivery times are not in line with requirements. (3) Manufacturing is Apache Kafka: Apache Kafka streams real-time data from sensors installed on production machines to a central analytics system. For example, temperature and pressure sensors on a packaging machine continuously send data to Kafka. This data is then forwarded to an Apache Spark-based analytics system, and Apache Spark: Apache Spark processes the data received from Kafka in seconds. Spark performs analyses by detecting abnormal patterns in machine operation, such as sudden increases in temperature, that could indicate a potential problem. If an anomaly is detected, the system automatically sends a notification to the maintenance team to conduct an inspection to avoid more serious machine damage. This ensures that production runs smoothly without significant disruption. (3) Inventory Management: Big Data Analytics: Data collected from various points in the supply chain—such as sales data from POS, receiving data from warehouses, and shipping data from RFID—is aggregated and analyzed using big data platforms such as Hadoop or Spark. These analytics enable companies to detect trends such as declining demand for a particular product or increasing seasonal demand. Based on this analysis, companies can reorganize inventory by moving stock from overstocked to understocked warehouses or deciding when to run promotions to reduce excess stock. Cloud Computing: Data generated from inventory analytics is stored in the cloud, such as Amazon Web Services (AWS) or Google Cloud. Cloud storage enables management teams to provide real-time access to data spread across multiple locations. For example, an inventory manager at the head office can monitor stock across branches and make necessary adjustments without being physically present. Cloud computing also allows integration with other systems, such as ERP, providing greater visibility and better control over the supply chain. (4) Logistics and Distribution GPS Sensors: Each delivery truck has GPS sensors that track the vehicle's position in real-time. This location data is uploaded to the company's transportation management system (TMS), which can then be analyzed to monitor the route traveled, average speed, and travel time. For example, suppose there is a delay on the road due to an accident or congestion. In that case, the system can automatically calculate a faster alternative route and notify the driver via the truck's onboard navigation device. and Cutting Edge Sensors: These sensors analyze driver behavior, such as acceleration, braking, and rest periods. Suppose the sensors detect that the driver is starting to show signs of fatigue (for example, increased frequency of hard braking or decreased reaction time). In that case, the AI system can alert the driver to take a break or automatically adjust the route to find the nearest rest stop. This improves safety, optimizes fuel efficiency, and reduces vehicle wear and tear. (5) After-Sales Service: AI-Based Analytics Dashboard: Tableau or Power BI is used to create dashboards that integrate data from multiple sources in the supply chain, including sales, shipping, and customer service. For example, these dashboards can show trends in customer complaints related to late deliveries or damaged products. The AI behind these dashboards can analyze historical data to identify patterns that may indicate future risks, such as suppliers who frequently ship raw materials late or certain products that customers frequently return. Based on this analysis, companies can take proactive actions, such as changing suppliers or improving quality control on certain production lines. This not only helps improve customer satisfaction but also minimizes potential losses. Adopting analytics and AI technologies at every stage of the supply chain (PT. Pelita Media Nusantara has succeeded in increasing operational efficiency, reducing costs, and increasing product availability.

This technology allows the company to make more accurate predictions, optimize inventory, monitor real-time production performance, and manage shipments more efficiently. In addition, better risk management through analytical dashboards helps make more informed decisions. This increases customer satisfaction and the company's competitive advantage in the market. Furthermore, besides the role of AI in each supply chain process, it is beneficial, but there are also challenges in its implementation, as explained by the Heads of Divisions at PT. Pelita Media Nusantara, namely as follows: (1) Planning Division: Since the implementation of AI technology in the planning process, Putri Nurul Hikmah, as Head of Planning, has felt a significant positive impact in increasing the efficiency and accuracy of the company's strategy. By using machine learning algorithms such as TensorFlow and Scikit-Learn, her team can now perform predictive analysis that is much more accurate than conventional methods. Previously, product demand planning relied heavily on historical data and intuition, which often did not consider dynamic variables such as changes in market trends or economic fluctuations. However, with AI, companies can analyze data in real-time and predict product demand with high accuracy, thus avoiding costly overstocks or stockouts. The most significant difference felt after implementing AI is the ability to make decisions faster and based on richer data. This speeds up the planning process and allows teams to be more proactive in responding to market changes. However, the challenge is the high dependence on the data quality used. The quality of predictions is highly dependent on the accuracy and completeness of the input data. Incomplete or biased data can result in incorrect predictions, potentially disrupting the supply chain and harming the company. To overcome this challenge, Putri Nurul Hikmah has ensured that the data used in the planning process comes from a reliable and well-integrated system. She also initiated a training program for her team to improve their data management skills and understanding of AI. In addition, the data cleansing process is carried out periodically to eliminate anomalies or inconsistencies affecting the analysis results.

Thus, Putri ensures that the predictions generated by the AI system are always accurate and reliable to support the company's strategic decisions. (2) Procurement: The head of Procurement, Abdul Rozak, has seen a significant change in procurement operations after implementing AI, especially with RFID technology integrated with advanced analytics systems. Before AI, the procurement process often took a long time and was prone to human error, such as errors in stock recording or delays in procuring goods. However, with the implementation of AI, the procurement system has become more automated and efficient. For example, by using RFID, goods entering and leaving the warehouse can be tracked in real-time, so that inventory data is always up-to-date and accurate. In addition, AI can analyze previous procurement patterns to predict future needs so that companies can place orders more efficiently and on time. A significant difference felt after implementing AI is increased transparency and speed in the procurement process. The system can automatically send notifications when stock is approaching the minimum threshold so that the procurement team can immediately take action without waiting for manual reports. However, the main challenge faced is integrating AI technology with supplier systems, which may not be as good as the technology used by PT. Pelita Media Nusantara. Some suppliers still use manual or semi-digital systems,

which can hinder the process of automation and data analysis. Abdul Rozak has taken proactive steps to overcome this challenge by establishing closer communication with suppliers. He works with suppliers to integrate their systems with the company's AI platform and provides training and technical support to ensure that they can adapt to this new technology. In addition, Abdul also negotiates agreements with suppliers to improve more transparent and efficient cooperation so that the procurement process can run smoothly without significant obstacles. This approach improves internal efficiency and strengthens long-term relationships with suppliers. (3) Production Sector: Ono Johana, as Head of the Production Sector, has felt the great benefits of implementing AI technology in the production sector, especially in monitoring machine performance and real-time decision-making. Before using AI, machine monitoring was done manually or with a system limited in detecting potential problems. This often caused delays in responding to machine failures, which could result in production stoppages and enormous losses for the company. However, with the implementation of AI technology and real-time analysis using platforms such as Apache Kafka and Apache Spark, the company can now continuously monitor every aspect of machine operations. Data from sensors installed on the machine is collected and analyzed in seconds so the production team can immediately determine if anomalies or potential damage need to be addressed.

The main difference felt after implementing AI is the increase in speed and accuracy in problem detection, which allows the production team to perform preventive machine maintenance rather than reactively. This not only reduces machine downtime but also extends the life of the equipment and reduces maintenance costs. However, the challenge faced by Ono Johana is the resistance from the operational team, which is used to manual systems. Some team members find it challenging to adapt to new technology and are worried about relying too much on AI. Ono Johana initiated a comprehensive training program to address these challenges and increase the production team's understanding of the benefits and workings of AI. He also held open discussion sessions to listen to the team's concerns and explain how AI can help them work more efficiently without reducing their essential role in production. In addition, Ono also ensured adequate technical support to help the team overcome any technical obstacles they might face while adapting to the new technology. This approach reduced resistance and increased the production team's confidence in using AI daily. (4) Inventory Management: Head of Inventory Management, Dwi Ernawati, has seen the tremendous impact of implementing big data analytics and cloud computing in inventory management.

Previously, inventory management at PT. Pelita Media Nusantara was carried out reasonably traditionally, often leading to inefficiencies such as excess or shortage of stock. However, with the implementation of AI, the company can now integrate data from various sources, such as sales data, goods receipts, and shipments, to provide a more holistic and real-time picture of inventory conditions. Big data analytics allows Dwi and her team to conduct in-depth analysis of demand patterns, market trends, and stock changes, which were previously difficult to do manually. The most significant difference after implementing AI is the ability to make more precise and data-driven decisions. The AI system provides better visibility into the supply chain, allowing for more efficient inventory management and reduced storage costs. However, the main challenge faced by Dwi Ernawati is the need to continuously update and maintain the cloud system to keep it secure and effective. Storing large amounts of data in the cloud also poses challenges regarding data management and security, especially with the increasing cyber risks. To overcome these challenges, Dwi Ernawati works closely with the IT team to ensure that the cloud system is always up-to-date with the latest security protocols. She also ensures that data stored in the cloud is encrypted and can only be accessed by authorized personnel. In addition, Dwi implements an efficient data management strategy, including regular data cleansing and access monitoring to prevent potential data leaks. Dwi also continues to update her team's cloud management and big data analysis skills through ongoing training so that they can make the most of these technologies to support better decision-making in inventory management. (5) Shipping: Esa, as the Head of Shipping, has seen significant improvements in the efficiency and safety of shipping operations since implementing AI technology in her field. Previously, shipping goods at PT. Pelita Media Nusantara often experienced delays, suboptimal route use, and driver safety issues. However, with the implementation of AI, Esa can utilize GPS sensor technology and AI sensors installed on vehicles to monitor vehicle conditions and driver behavior in real-time. This technology helps track the truck's position precisely and analyzes driving patterns such as speed, acceleration, and braking, which can impact fuel efficiency and safety.

The main difference after the implementation of AI is the ability to optimize routes in real time based on constantly updated traffic data, reducing travel time and operational costs. In addition, drivers can now be instructed to take alternative routes in case of congestion or bad weather conditions, which was previously difficult without real-time data analysis. However, the challenge Esa faces is the resistance from drivers to the tighter monitoring system through AI sensors. Some drivers feel they are losing their privacy and are more stressed by this intensive monitoring. To overcome this challenge, Esa introduced a performance-based incentive system measured by AI, where drivers who demonstrate compliance with safety and efficiency protocols will be rewarded or given bonuses. This aims to motivate drivers to see AI as a tool that helps them improve their performance rather than as a mere surveillance tool. Esa also conducts training sessions for drivers to understand better this technology's benefits in protecting their safety on the road. This collaborative approach has succeeded in reducing resistance and increasing driver acceptance of AI in delivery operations. (6) After-Sales Service Area: Abdul Hasib has seen how AI technology has significantly changed how companies interact with customers and handle post-sales issues. Before the implementation of AI, the after-sales service process relied heavily on manual methods to collect customer feedback and identify issues. This often led to delays in responding to and handling customer complaints, negatively impacting customer satisfaction.

However, with the implementation of AI, companies can now leverage AI-based analytical dashboards such as Tableau or Power BI to analyze. Thus, the implementation of AI technology in various operational areas of PT. Pelita Media Nusantara has significantly changed how the company runs its business. Every head of the field, from planning to after-sales service, has felt the benefits of AI's enhanced efficiency, accuracy, and decision-making capabilities. Although internal resistance and the need for new skills have emerged, proactive measures such as training, technology integration, and effective communication have successfully overcome these obstacles. As a result, PT. Pelita Media Nusantara has improved performance and service quality and strengthened its position in the market with continuous innovation driven by technology.

To understand the concrete impact of the implementation of AI in PT. Pelita Media Nusantara, it is essential to see how the company's performance has evolved before and after implementing this technology. The following data compares the company's performance in recent years, covering aspects such as operational efficiency, customer satisfaction, cost reduction, and revenue growth. We can measure how far AI has helped PT by looking at this data. Pelita Media Nusantara in achieving its business goals and positioning the company as a leader in the furniture industry. In the table above, we can see a significant increase in the efficiency of PT's supply chain. Pelita Media Nusantara after the implementation of Artificial Intelligence (AI) technology. Before the implementation of AI in 2018, supply chain efficiency was at 60.23%. After the implementation of AI, this efficiency increased to 90.75% in 2022 and reached 95.89% in 2023. This

increase reflects significant improvements in the company's supply chain management, enabling more effective and responsive operations to market needs. On-time delivery times also showed impressive enhancements. In 2018, the on-time delivery rate was only 70.46%. With the help of AI, this figure rose to 89.78% in 2022 and reached 94.21% in 2023. In addition, the driver accident rate has decreased drastically. Before the implementation of AI, the driver accident rate was at 7.76%. However, in 2022, this figure drops to 2.43% and further to 1.45% in 2023. This decrease shows that AI technology, such as sensors and monitoring systems, has significantly improved driver safety and reduced the risk of accidents. AI has also managed to reduce the data error rate significantly. In 2018, the data error rate was 8.77%. After the implementation of AI, this figure decreased to 2.15% in 2022 and reached 1.23% in 2023. In addition, supply chain visibility increased from 50.50% in 2018 to 85.45% in 2022 and 90.68% in 2023. This increased visibility allows companies to track and manage inventory better, as well as identify and resolve issues before they become major obstacles in the operational process. The implementation of AI also has a positive impact on the accuracy of demand forecasts and risk management. In 2018, demand forecast accuracy was only 60.25%. With the implementation of AI, this figure increases to 90.75% in 2022 and then to 95.47% in 2023. This increase in accuracy allows companies to plan production and distribution better, avoiding excess or shortage of stock. Risk management has also significantly increased, with the risk management score rising from 4 in 2018 to 8 in 2022 and 9 in 2023. This shows that companies are better prepared to face and manage risks that may occur in their supply chain. Finally, the implementation of AI has also had a positive impact on customer satisfaction. In 2018, the customer satisfaction rate was at 70.23%. After the implementation of AI, this figure increased to 90.65% in 2022 and reached 97.57% in 2023. This increase in customer satisfaction reflects improvements in various aspects of the company's operations, including more precise delivery times, increased safety, and reduced data errors. This overall analysis shows that the implementation of AI has significantly and positively impacted efficiency, safety, and customer satisfaction at PT Pelita Media Nusantara. Thus, implementing Artificial Intelligence (AI) technology at PT Pelita Media Nusantara has significantly improved the efficiency and effectiveness of the company's supply chain. With the integration of AI, the company improved on-time delivery, reduced driver accidents, and minimized data errors. In addition, better supply chain visibility and higher demand prediction accuracy have enabled better planning and risk management. This transformation reflects the great potential of AI in optimizing logistics and supply chain management, giving PT Pelita Media Nusantara a significant competitive advantage in an increasingly complex and dynamic market.

5. Conclusion

1. Artificial Intelligence (AI) is deeply connected to the concept of supply chain management because AI can significantly improve efficiency and effectiveness at every stage of the supply chain. In planning, AI leverages predictive algorithms to forecast demand and plan resources more accurately, reducing waste and increasing accuracy. AI helps select the best suppliers by analyzing performance and pricing data in procurement. In production, AI optimizes manufacturing processes through automation and predictive maintenance, which reduces downtime and increases productivity. In inventory management, AI uses data analytics to manage stock more efficiently, reducing overstock and understock. In logistics and distribution, AI improves delivery routes and optimizes fleet usage, reducing costs and delivery times. Finally, in after-sales service, AI improves responsiveness to customer demand through feedback data analysis and artificial intelligence in chatbots. By leveraging AI, companies can create a more intelligent, integrated, and responsive supply chain to market dynamics.
2. The practice of using artificial intelligence (AI) at PT. Pelita Media Nusantara has succeeded in significantly increasing the efficiency of the company's supply chain. AI is used to automate the process of monitoring and analyzing data in the supply chain, enabling faster and more accurate identification of potential problems and decision-making. With the implementation of AI, companies can predict demand better, optimize inventory management, and reduce the risk of overstock or stockout. In addition, AI helps coordinate logistics and distribution to make the delivery process more efficient and timely. This technology also plays a role in reducing operational costs through the automation of routine tasks and reducing human error. Overall, the implementation of AI at PT. Pelita Media Nusantara has increased productivity, cost savings, and customer satisfaction, ultimately strengthening the company's competitive position in the market. This success shows that integrating AI in the supply chain is relevant and essential in an increasingly digital and automated business era, allowing companies to adapt quickly to market changes and customer needs.
3. Further research and development in AI is essential to maintain this momentum and explore untapped potential. Continuing to innovate in AI technology will enable discoveries and improvements in industrial applications, paving the way for greater efficiency, more innovative solutions, and limitless creativity.
4. Encourage collaboration between the public and private sectors, academia, and other stakeholders to advance the use of AI in the industry. Through strong partnerships, we can address common challenges, share knowledge and resources, and create an environment conducive to growth and innovation.

References

- [1] Putro, H. P. (2023a). Building Digital Communication Effectiveness in Organizations. 1, 0–6.
- [2] Min, H. (2010). Artificial intelligence in supply chain management: theory and applications. *International Journal*
- [3] Raza et al. (2020). Effectiveness of information and communication technologies as information source among farmers in Pakistan. *Pakistan Journal of Agricultural Sciences*, 57(1).
- [4] Herbert Simon, A. Herbert. 2004. *Administrative Behavior, Administrative Behavior: A Study on Decision Making Processes in Administrative Organizations*, Third Edition, Print Fourth. Jakarta: ST Translation. Dianjung, Earth of Letters.
- [5] Manyika, J. (2022). Getting AI right: Introductory notes on AI & society. *Daedalus*, 151(2), 5-27.
- [6] Silberg, J., & Manyika, J. (2019). Notes from the AI frontier: Tackling bias in AI (and in humans). *McKinsey Global Institute*, 1(6), 1-31.
- [7] Gartner, L. P., & Hiatt, J. L., 2012, *Atlas Berwarna Histologi, Edisi ke-5, Tangerang Selatan, Binarupa Aksara*, 374-375
- [8] McCarthy, J., Minsky, M. L., Rochester, N., & Shannon, C. E. (2006). A proposal for the dartmouth summer research project on artificial intelligence, august 31, 1955. *AI magazine*, 27(4), 12-12.
- [9] Legg, S., & Hutter, M. (2007). Universal intelligence: A definition of machine intelligence. *Minds and machines*, 17, 391-444.

- [10] Russell Stuart dan Norvig (1995), Prentice Hall series in artificial intelligence, researchgate.net
- [11] Gunansekar dan dkk., . (2017). Big data and predictive analytics for supply chain and organizational performance. *Journal of Business Research*, 70, 308-317.
- [12] Gholami, M., & Honarvar, M. (2015). Developing a mathematical model for vendor managed inventory considering deterioration and amelioration items in a three-level supply chain. *Advances in Industrial Engineering*, 49(2), 237-256.
- [13] Mohsen, B. M. (2023). Impact of artificial intelligence on supply chain management performance. *Journal of Service Science and Management*, 16(1), 44-58.
- [14] Pujawan, at al., (2009). Supply chain management for Disaster Relief Operations: principles and case studies. *International journal of logistics systems and management*, 5(6), 679-692.
- [15] Darajat, A., Ekowati, D., & Usman, I. (2020). How supply chain regulates the innovations study of diffusion in public service organizations? Recommendations of reform. *International Journal of Supply Chain Management*, 9(4), 363-370.
- [16] Rolf et al., . (2023). A review on reinforcement learning algorithms and applications in supply chain management. *International Journal of Production Research*, 61(20), 7151-7179.
- [17] Nasution, A. P. (2017). Supply Chain Management and Indonesia's Readiness for Global Trade. *Ecobisma (Journal of Economics, Business and Management)*, 4(1), 1-10.
- [18] Singh at al., Si. (2022). Application of AI in SCM or Supply Chain 4.0. *Artificial Intelligence in Industrial Applications: Approaches to Solve the Intrinsic Industrial Optimization Problems*, 51-66.
- [19] Halal, Stefanuk & Zhozhikashvili. Anonymous, "Halal Label for Medicine, Is It Necessary? (Online), <https://lifestyle.kompas.com/read/.2010/03/31/16204391/label.halal.untuk.obat.perlukah>, accessed, 2 July 2018.
- [20] (Eiter et al., Marc Wilkins et al., University of New South Wales, Sydney, Australia, Beranda proteomics methylation PTMs genomics next-generation sequencing bioinformatics
- [21] Becker at al., 2000. *The World of the Cell*. Ed 4. The Benjamin Publishing Company.
- [22] Atkinson & Bench-Capon, (2013), Overview of Trevor Bench-Capon's Research, <https://webspacescience.uu.nl/~prakk101/pubs/TBCoverview.pdf>
- [23] Halpern, (2015), A Modification of the Halpern-Pearl Definition of Causality, <https://arxiv.org/abs/1505.00162>
- [24] J Cheng, M. J. Druzdzel 2000, AISBN, An Adaptive Importance Sampling Algorithm for Evidential Reasoning in Large Bayesian Networks, <https://arxiv.org/abs/1106.0253>
- [25] Cheng] T. Cheng and Z. Li, A., 2006, multiscale approach for spatio-temporal outlier detection, *Transactions in GIS*, vol. 10, no. 2, pp. 253263, mar 2006.
- [26] Zainal Arifin, Hallal, Faculty of Engineering, Yogyakarta State University, Verified email at uny.ac.id, Halal, https://scholar.google.co.id/citations?user=WLF_71AAAAAJ&hl=en&oi=sra
- [27] Stefanuk & A. V. Zhozhikashvili's research while affiliated with The Institute for Information Transmission Problems and other Places, <https://www.researchgate.net/scientific-contributions/A-V-Zhozhikashvili-2034584452>
- [28] Ambite & Knoblock, (2011), computer science, AI, planning by writing, *Journal Of Artificial Intelligence Research*, Volume 15, pages 207-261, 2001; <https://doi.org/10.1613/jair.754>
- [29] Balazinski et al., (1995), Improvement of Tool Life through Variable Feed Milling of Inconel 600
- [30] Eiter et al., Reference Ontologies — Application Ontologies: Either/Or or Both/And? Christopher Menzel Texas A&M University cmenzel@tamu.edu, <https://blog.wordvice.com/reference-citation-et-al/>
- [31] Altekar, R. V. (2023). *Supply chain management: Concepts and cases*. PHI Learning Pvt. Ltd. [32] Alzoubi et al., (2022). Fuzzy assisted human resource management for supply chain management issues. *Annals of Operations Research*.
- [32] Sombultawe et al., (2022). COVID-19 and supply chain management: a review with bibliometric. *Sustainability*, 14(6), 3538.
- [33] Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). Thousand Oaks, CA: SAGE Publications.
- [34] Neuman, W. L. (2013). *Social Research Methods: Qualitative and Quantitative Approaches* (7th ed.). Boston: Pearson.
- [35] Denzin dan Lincoln, (2011), The Sage handbook of qualitative research https://scholar.google.co.id/scholar?hl=id&as_sdt=0%2C5&as_vis=1&q=Denzin+dan+Lincoln+%282011+and+references&btnG=
- [36] Merriam & Tisdell, (2015), Buku Qualitative research: A guide to design and implementation, https://scholar.google.co.id/scholar?hl=id&as_sdt=0%2C5&as_vis=1&q=Merriam+%26+Tisdell%2C+%282015%29%2C+and+reference&btnG=
- [37] Yin, (1995), Fuzzy model-reference adaptive control https://scholar.google.co.id/scholar?hl=id&as_sdt=0%2C5&as_vis=1&q=Yin+and+references&btnG=
- [38] Silverman, (2013), A Higher Efficiency of Converting Gas to Stars Pushes Galaxies at $z \sim 1.6$ Well Above the Star-forming Main Sequence Patton, (2015), *Management, Organizational Communication, Documentation and Interviews* <https://doi.org/10.18592/moe.v6i2.5563>; <https://jurnal.uin-antasari.ac.id/index.php/moe/article/view/5563>
- [39] Sugiyono (2012). *Quantitative Qualitative Research Methods And R&D*. Bandung: Alfabeta Sugiyono (2014). *Research methods Quantitative, Qualitative, and Combination (Mixed Methods)*. Bandung: Alfabeta
- [40] Arinez dkk., (2020), Analisis Bibliometrik pada Penerapan Artificial Intelligence di Smart Manufacturing <https://prosiding.stis.ac.id/index.php/semnasoffstat/article/view/1120>
- [41] Tran, (2022), Effect of aging and neurodegeneration on contextual processing, <https://doi.org/10.1002/alz.049472> <https://alz-journals.onlinelibrary.wiley.com/doi/full/10.1002/alz.049472>
- [42] Plathottam, (2023), A review of artificial intelligence applications in manufacturing operations <https://doi.org/10.1002/amp2.10159>, <https://aiche.onlinelibrary.wiley.com/doi/full/10.1002/amp2.10159>
- [43] Daniati, et al, (2020). Efforts to Increase Motivation for Student Learning Results by Implementing the E-Learning Learning Model Based on Google Classroom during the Covid 19 Pandemic, *Educational Journal: Vol 6. No.3*.
- [44] Königstorfer & Thalmann, (2020), Applications of Artificial Intelligence in commercial banks – A research agenda for behavioral finance, <https://ideas.repec.org/a/eee/beexfi/v27y2020ics2214635019302503.html>
- [45] Tran, (2021), World Bank Verified email at worldbank.org, The innovation imperative for developing East Asia, X Cirera, AD Mason, F De Nicola, S , Kuriakose, TT Tran, World Bank Publications

- [46] Hassani, A. N., (2013), Survey Study of Lead Exposure among Lead Workers in Erbil, Iraq Journal Pharmacy Vol. 13 No. 1, 51–58
- [47] Wang, at al.,(2016). Big data analytics in logistics and supply chain management: Certain investigations for research and applications. *International Journal of Production Economics*, 176, 98-110. ISSN: 0925-5273, eISSN: 1873-757
- [48] Pradani, et.al. 2021. “Analisis Kinerja Keuangan Terhadap Nilai Perusahaan Wholesale”. *Jurnal Ilmu Manajemen* Vol.10, No. 1:10-19.
- [49] Mikalef, P., & Gupta, M. (2021). Artificial intelligence capability: Conceptualization, measurement calibration, and empirical study on its impact on organizational creativity and firm performance. *Information and Management*, 58(3), 103434. <https://doi.org/10.1016/j.im.2021.103434>.
- [50] Kusuma, J. W., at al., (2023). DIMENSIONS OF LEARNING MEDIA (Theory and Application of Learning Media in the Era of Revolution Industry 4.0 Towards the Era of Society 5.0). Sonpedia Publishing Indonesia.
- [51] Almustaqim, A., Toscani, A. N. (2022). Chatbot System Design as a Virtual Assistant at PT. Everbright Jambi.\
- [52] Peterson, J. C., & Kurniawan, Y. (2023). The Influence of the Application of Big Data, the Application of Cloud Computing, and the Application of Artificial Intelligence Intelligence on the Performance of the Accountant Profession in Facing the Era of Industrial Revolution 4.0 at PT. Tinsel Swara Productions. *Journal of Students' Research in Computer Science*, 4(1), 93–104. <https://doi.org/10.31599/jsrscs.v4i1.2054>
- [53] Laksono, A. W., & Suryadi, A. (2020). The Influence of Brand Image, Brand Trust, and Product Quality on Brand Loyalty For Geprek Benu Customers in Malang City. *Holistic Journal of Management Research*, 1(1), 9– 12. <https://journal.ubb.ac.id/index.php/holistic/article/download/1804/1205>
- [54] Permatasari, D., at.al. (2019). Financial Distress Analysis using the Zmijewski Method, *Journal of Management and Business*, Volume 1, p. 74–87.
- [55] Oktaviana at. Al., (2021). Analysis of the Effect of Economic Growth, Regency Minimum Wage and Unemployment on Poverty in Madiun Regency. East Java Veteran UPN Thesis.
- [56] Chairunnisa et al., (2021) The Influence of Incentives, Communication and Organizational Culture on Performance at PT Sinar Graha Indonusa. *News Journal*. Vol. 14.No. 1. ISSN 1829-7463.
- [57] Milik et al., (2014), ‘On translation of LD, IL and SFC given according to IEC-61131 for hardware synthesis of reconfigurable logic, *IFAC Proceedings Volumes (IFAC-PapersOnline)*, 19(1), pp. 4477–4483.
- [58] Novianty et al., (2022), Identification of pork contamination in meatball using genetic marker mitochondrial DNA cytochrome b gene by duplex-PCR. *IOP Conf Ser Mater Sci Eng*. 2017;193(1).
- [59] Ridwan, HR, 2016, State Administrative Law, RajaGrafindo Persada, Jakarta
- [60] Tania & Abdi, (2023) assistance with accounting bookkeeping practices using the Randu pos & accounting application for furniture SMEs Nasywa in South Jakarta, January 2024 Edition Vol. 5 No. 2 Published by Indonesian Idelingual Association, <https://idebahan.or.id/about/article/download>
- [61] Lumangkun, A. G. and Leon, F. M. (2022). Can environmental information disclosure and technological innovation be synergistic? impact on the financial performance of manufacturing companies? *Journal of Research and Development of Science and Humanities*, 5(3), 406-415. <https://doi.org/10.23887/jppsh.v5i3.41142>
- [62] Aishwarya et al., (2022)Aishwarya, “Introduction to Recurrent Neural Network, <https://www.geeksforgeeks.org/introduction-to-recurrent-neural-network/> (accessed Jul. 01, 2022).
- [63] Boddington, Dominic. 2002. Student perceptions of rewards and sanctions. *The Journal of Pedagogy, Culture & Society*, 10:2, 239-256. Routledge: London
- Bughin et al., (2017). Artificial intelligence: The nextdigital frontier? McKinsey Global Institute.
- [64] Martin C et al. (2017). Technology and Innovation for the Future of Production: Accelerating Value Creation. WEF. Mathur, P. (2019). Key Technological Advancements in Retail. In: *Machine Learning Applications Using Python*.
- [65] Sterne, J. (2018). From programming to statistics to machine learning for marketing. *Applied Marketing Analytics*, 3(4), 298 305(8).
- [66] Deb, S.K., Jain, R., & Deb, V. (2018). Artificial Intelligence —Creating Automated Insights for Customer Relationship Management. 8th International Conference on Cloud Computing, Data Science & Engineering (Confluence).
- [67] Paolanti et al., (2018). *J Intell Robot Syst*, 91, 165. <https://doi.org/10.1007/s10846-017-0674-7>
- [68] Seligman, J. (2018). Artificial intelligence and machine learning and marketing management.
- [69] Kietzmann et al., (2018), Artificial Intelligence in Advertising: How Marketers Can Leverage Artificial Intelligence Along the Consumer Journey.10.2501/JAR-2018- 035.
- [70] Mortimer et al., (2018)Mortimer, G., & Milford, M. (2018) When AI meets your shopping experience it knows what you buy – and what you ought to buy. *The Conversation*.
- [71] Metz, R. (2018). Amazon’s cashier-less Seattle grocery store is opening to the public. MIT tech review.
- [72] Wen et al., (2018), AI Swarm Robotics Control and Communications: Imminent Challenges for Next Generation
- [73] Fildes et al., (2018), Retail forecasting: research and practice. Working Paper. Lancaster, 15, 10.
- [74] Burgess A., (2018). AI in Action. In: *The Executive Guide to Artificial Intelligence*. Palgrave Macmillan, Cham.