



Whitepaper

UNLEASHING THE POWER OF AI IN SUPPLY CHAIN

NAVIGATING TOMORROW'S SUPPLY CHAIN THROUGH TRENDS, INSIGHTS AND CASE STUDIES

EXECUTIVE SUMMARY

In today's dynamic logistics landscape, characterized by digitalization and transformative technologies, supply chain professionals confront urgent demands for adaptation. Facing **six disruptive challenges** from market growth to resource shortages and customer expectations, companies risk inefficiencies and service compromises. New entrants and sustainability concerns heighten competition and cost pressures. Meeting technological demands necessitates significant investments. Managers must act swiftly to navigate these complexities and ensure resilient, efficient supply chains. Furthermore, urgency mounts as we delve into **Industry 4.0 technologies'** (I4.0T) managerial implications. I4.0T integrates transformative technologies like **3D Printing, Robotics, Augmented & Virtual Reality, Blockchain, AI, Cloud Computing, & Big Data, Internet of Things, and Simulation & Digital Twins.**

Recognizing AI's pivotal role in unleashing its potential is crucial. Artificial intelligence (AI) encompasses various technologies and applications, aiming to mimic human cognitive abilities. It analyzes data, learns, and acts intelligently, particularly through machine learning.

This paper explores the role of AI in logistics, based on **three use cases of AI in inventory management for Murata, vision technology**

for high-tech clients, and finance fraud detection. Implementing AI in inventory management addresses challenges related to inventory accuracy, ensuring a seamless supply chain. By employing automated image processing and barcode reading, every crate undergoes comprehensive scrutiny, enhancing transparency and accuracy. Real-time inventory monitoring allows for informed decision-making, reducing waste and contributing to cost savings. In the context of outbound picking, AI-integrated cameras revolutionize the process, dynamically detecting and adapting to varied box sizes and labels. This innovation not only streamlines operations but also introduces flexibility for evolving product dynamics. In the realm of finance, AI-driven machine learning proves instrumental in fraud detection for e-commerce clients, safeguarding against evolving threats and minimizing financial losses.

In the future, industry leaders expect that AI revolutionizes logistics and SCM, streamlining processes, enhancing collaboration, and providing precise insights through predictive analytics and real-time tracking. It transforms supply chains into **eco-conscious networks, harmonizing profitability, operational efficiency,** and environmental stewardship, paving the way for sustainable prosperity.



"AI goes beyond a trend, reshaping our daily lives and entire industries."

Karoline Kowalik,
Author and Logistics Engineer at Arvato

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1 TRENDS IN SUPPLY CHAIN - CHALLENGES IN 2024

In 2023's ever-evolving logistics market, characterized by rapid digitalization and transformative technologies, supply chain professionals face a crucial need to adapt. Embracing AI advancements, sustainability practices, and enhanced connectivity becomes imperative to ensure seamless operations and efficiency optimization in an interconnected world post-pandemic. Amidst this, logistics companies grapple with **six disruptive challenges** across Western Europe and North America:



1. MARKET GROWTH

- Global e-commerce sales were rising, especially during the pandemic.
- About 3 billion dollars and this number rose by 73% to 5,2 billion in 2021 and is forecasted to grow to just over 8,148 billion dollars by 2026 (Chevalier, 2022).



2. RESOURCE SHORTAGE

- Facing scarcities in real estate and skilled labor.
- E.g, In 2023, the Netherlands has limited available warehouse space to 800,000 m2, with stricter policies for large distribution center construction (CBRE, 2023).



3. CUSTOMER EXPECTATIONS

- Meeting demands for faster, cost-effective delivery services.
- 47% of consumers would abandon a brand they love after a bad shipping experience (Convey, 2021).



4. NEW ENTRANTS AND COLLABORATION

- Adapting to agile pricing and collaborative structures.
- Logistics start-ups have received more than 12.9\$ billion in funding in 2022 (Gosling, Hausmann, Pena-Alcaraz, & Woelfel, 2023).



5. SUSTAINABILITY

- Tackling economic, environmental, and social sustainability pressures (CSRD).
- 73% of Generation Z consumers, born between the mid-90s and early 21st century, think a sustainable purchase is more important than the brand itself (Hardcastle, 2022).



6. TECHNOLOGY & INNOVATION

- Grappling with digital culture adoption, automation, and data analytics integration.
- Industry 4.0 technologies (I4T), include blockchain, augmented reality, robotics process automation, autonomous logistics, and big data analytics.

Table 1: Challenges in supply chain. Table based on Tipping & Kauschke (2016) and updated by the author.

ChatGPT 3.5 ▾



You

What challenges were supply chains facing in 2023?



ChatGPT

While I can't provide a direct answer due to the limitations of my knowledge base, which is current up to January 2022, I can predict that in 2023, supply chains faced several significant challenges that influenced their operations and dynamics.

The ongoing repercussions of the COVID-19 pandemic continued to disrupt global supply chains, emphasizing the critical need for resilience and adaptability. Additionally, geopolitical shifts and trade policy changes, such as the implementation of new trade tariffs and agreements, altered the global trade landscape, necessitating companies to reassess their global sourcing strategies and distribution networks.

The increasing focus on sustainability and environmental consciousness further influenced supply chain practices, prompting organizations to integrate eco-friendly practices and reduce their carbon footprint. Technological advancements, including the proliferation of blockchain and the Internet of Things (IoT), revolutionized supply chain management, enabling enhanced transparency, traceability, and efficiency.

Moreover, the rise of regional protectionism and trade disputes affected global supply chain flows, compelling businesses to diversify their supplier base and adopt agile procurement strategies to mitigate potential disruptions. The combination of these events underscores the need for supply chain resilience, flexibility, and innovation to navigate the evolving global business landscape.

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Source: ChatGPT by OpenAI



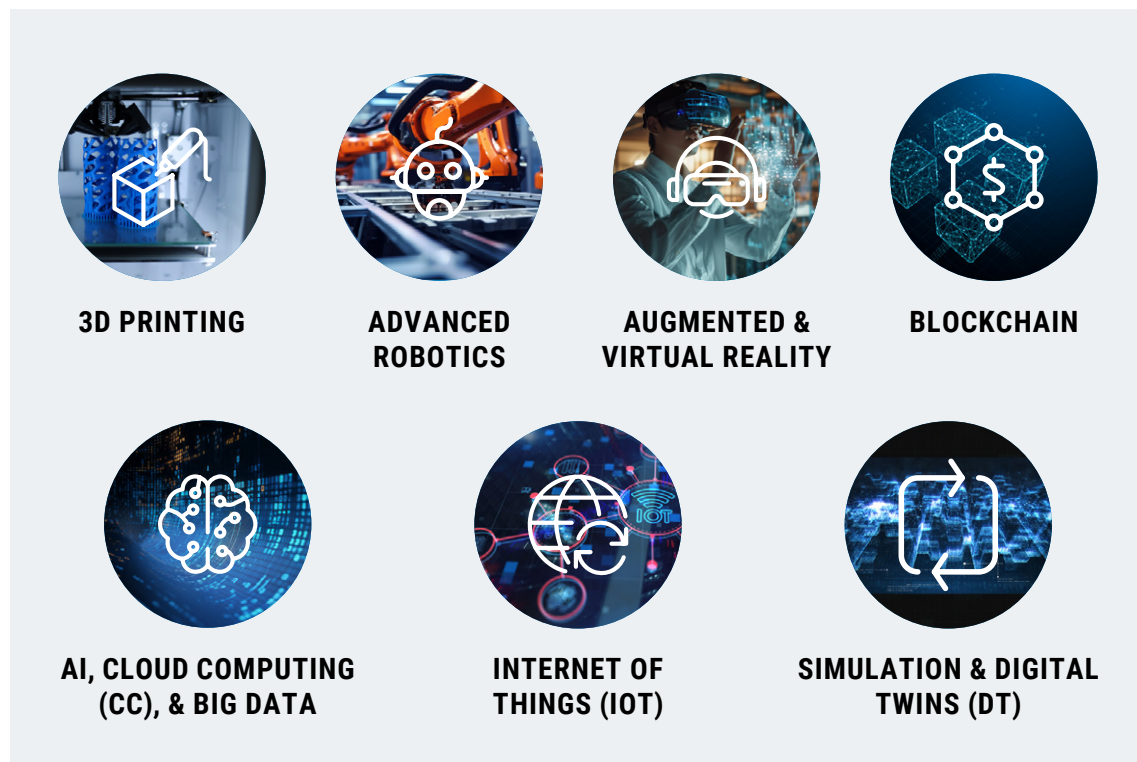
2 THE NEW WAVE: INDUSTRY 4.0 TECHNOLOGY AND AI

As we explore the managerial implications of Industry 4.0, it is imperative to recognize its unique characteristics, benefits, and the pivotal role AI plays in unleashing its full potential. This chapter sets the stage for a comprehensive understanding of Industry 4.0's managerial relevance, laying the groundwork for subsequent discussions on strategic adoption and organizational adaptation.

2.1 WHAT IS INDUSTRY 4.0: THE NEW ERA OF INDUSTRIALIZATION

The term "Industry 4.0" (I4.0) made its debut in 2011 at the Hannover Fair, as coined by the German government (Zhou, Liu, & Zhou, 2015). This signals the Fourth Industrial Revolution, marked by a profound emphasis on **digitization, network communication, automation technologies, and advanced analytics**.

At its core, Industry 4.0 seamlessly integrates transformative technologies (Efthymiou & Ponis, 2021) such as:



Distinguishing itself from its predecessor, Industry 3.0, Industry 4.0 exhibits the capacity to handle **diverse products and situations individually, make autonomous decisions, collaborate** seamlessly with human counterparts, and provide end-to-end **interconnectivity** and **transparency** throughout the entire value chain, as opposed to isolated processes (Torn & Vaneker, 2019). This amalgamation empowers decision-makers with real-time insights and enables agile responses to dynamic real-world scenarios (Lasi, Fettke, Kemper, Feld, & Hoffmann, 2014).

2.2 WHAT IS AI: DEFINITION AND APPLICATIONS

One of the key technologies of Industry 4.0 is **artificial intelligence (AI)**. AI is a widely used term for a variety of technologies and use cases. While there is no one definition of AI, some describe AI as a discipline that “brings together sciences, theories and techniques (including mathematical logic, statistics, probabilities, computational neurobiology and computer science) and whose goal is to achieve the imitation by a machine of the cognitive abilities of a human being” (Council of Europe, 2023) or that “applies advanced analysis and logic-based techniques, including machine learning, to interpret events, support and automate decisions, and take actions” (Gartner, 2023).

Despite the lack of definition, there are certain **characteristics** of an AI system, according to research by Gbadegeshin & al. (2021):

MAKES USE OF DATA	NEEDS TO BE TRAINED
LEARNS	ANALYSES CRITICALLY
ACTS INTELLIGENTLY	CAN MIMIC HUMANS
AUTOMATES	ACTS INDEPENDENTLY

AI can be categorized into **narrow/weak** and **general/strong AI**. Current use of AI is limited to narrow (weak) applications focused on specific tasks, like text-to-speech. There is no current application of general (strong) AI as a self-aware AI has not yet been developed (Kampakis, n.d.). Both applications are trained with big datasets, often through **machine learning (ML)**. ML is a branch of AI that focuses on systems learning and improving independently with neural networks over time. A system can be taught with supervised (labelled, categorized, clean) and unsupervised (unlabelled, chaotic) data.

In conjunction with AI, there are many other buzzwords: recommender systems, sentiment analysis (text mining), natural-language processing (speech processing), image & video recognition (vision) and general process automation.



RECOMMENDER SYSTEMS	"Others ordered too" appears often on e-commerce platforms and recommend items which are often bought together.
SENTIMENT ANALYSIS (TEXT MINING)	Is it a form of text mining (analysis). Texts are screened and clustered into themes and afterwards labelled into positive and negatives.
NATURAL-LANGUAGE-PROCESSING (SPEECH PROCESSING)	NLP used languages rules to understand, interpret, or generate written or spoken human text.
COMPUTER VISION	Images, videos or sensors are used to mimic vision and provide e.g. a robot with an understanding of its surrounding.
ROBOT PROCESS AUTOMATION	This is a form of process automation, but instead of pre-programmed processes, the system can decide and act on its own.

Table 2: Key words of AI



DID YOU KNOW

AI in daily life: Phone virtual assistant (Siri, Alexa; Spotify); robot cleaning devices (Roomba); self-driving cars; chatbots; recommendation systems in e-commerce; NPC in games; language translation (DeepL); phone bots (e.g. Telekom hotline).

ChatGPT 3.5 ↑

A You
How would you describe AI in a few simple words?

ChatGPT
Artificial Intelligence (AI) is a branch of computer science that empowers machines to imitate human intelligence and perform tasks that typically require human cognition. It encompasses various technologies like machine learning, natural language processing, and computer vision. AI enables systems to process and interpret complex data, make autonomous decisions, and adapt to changing environments, thereby enhancing operational efficiency and decision-making processes within organizations.

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2.3 IMPACT OF AI

AI is a complex and multi-faceted topic that we face in our daily lives – from our smartphones to news consumption and workplace interactions – its sheer potential impact is endless. Every potential positive impact comes with its caution.

PEOPLE'S PERSPECTIVE	ON THE ONE SIDE...	... ON THE OTHER SIDE.
Risky task	Takes risks instead of humans (e.g. defusing a bomb)	Abuse e.g. military or war-related usage
Decision-maker	Increased responsiveness and flexibility through real-time monitoring e.g. medical response	(Data) Bias could lead to stereotypes and exclusion
Environmentalist	Combat climate change through mitigation (e.g. measurement, reductions, and removal)	Power consumption and CO ² emissions from data centers
Private usage	Support students with learning, e.g. customized learning plans and feedback	Deep fake creating false news and wrong information
Businesses	Reducing environmental impact (waste) and errors through data prediction (consumer behavior)	Ownership and ethics of AI-generated content is questionable

Table 3: The positive and negative side of AI. Content based on: (Didier, et al., 2015) (McKinsey & Company, 2021); (Maher, Meinecke, Gromier, Garcia-Novelli, & Fortmann, 2022); (Jariwala & Lee, 2023); (Rege, 2023); (Stahl & Eke, 2024),

The research surrounding the role of AI is extensive, engaging researchers and practitioners in discussions about its potential positive impact. **This paper explores various case studies of AI and its potential contributions to addressing challenges frequent in supply chain management.** Let us explore how AI can strategically support companies in overcoming the aforementioned obstacles.

3 WHAT'S THE ROLE OF AI IN SUPPLY CHAIN?

We conducted interviews with practitioners to explore the question:

"How does AI can strategically help us overcome supply chain challenges"?

EXAMPLES FROM PRACTICE

AI IN INVENTORY MANAGEMENT AT MURATA

AI IN ROBOTICS IN HIGH-TECH

AI MACHINE LEARNING IN FINANCE - FRAUD DETECTION IN E-COMMERCE

3.1 AI AT MURATA – AN INVENTORY CHALLENGE



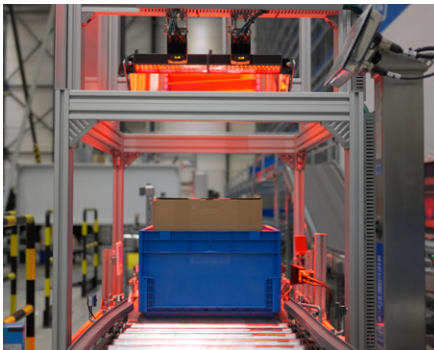
Accurate inventory management is a cornerstone of successful supply chain operations, directly influencing customer satisfaction, brand reputation, and overall business performance. This use case shows how Arvato & Murata use AI in inventory management.

THE CHALLENGE: INVENTORY ACCURACY

The inability to achieve a 100% quality Key Performance Indicator (KPI) in inventory accuracy (e.g. due to lost boxes or scan errors) poses multifaceted challenges:

STOCKOUTS AND CUSTOMER FRUSTRATION	SHIPPING ERRORS AND ADDITIONAL COSTS	LOST INVENTORY AND DECISION-MAKING IMPACT
<ul style="list-style-type: none"> Meeting demands for faster, cost-effective delivery services becomes challenging. Customer frustration due to unfulfilled orders can erode trust and damage brand reputation. 	<ul style="list-style-type: none"> Inaccuracies in inventory data can result in shipping errors, incorrect deliveries, and additional costs for returns and exchanges. 	<ul style="list-style-type: none"> Increases costs for replacing goods. Compromised decision-making due to incorrect demand and production forecasts affecting budgeting and strategic planning.

THE SOLUTION: AI INVENTORY CHECK



The integration of AI technologies, specifically automated image processing and barcode reading, offers a comprehensive solution to inventory accuracy challenges.

Every crate of the shuttle system passes multiple scan and picture points. Using image recognition, the content of every crate gets captured, and feedback is sent to SAP. The AI checks based on the pictures if the boxes it sees is matching with the SAP content. Either the content is verified or the crate needs to be checked manually.

THE BENEFITS: TRANSPARENCY AND ACCURACY

REAL-TIME INVENTORY MONITORING	TRANSPARENCY AND DECISION-MAKING	AUTOMATED ERROR DETECTION AND NOTIFICATION	COST SAVINGS
<p>Continuous and accurate snapshot of inventory levels through image verification increases transparency.</p>	<p>More accurate decisions regarding replenishment and production can be made to minimise waste.</p>	<p>Through continuous inventory checks, errors in stock keeping can be detected much faster (in case of manual operations it can be done only during picking or accidentally).</p>	<p>Fewer lost boxes and streamlined error detection contribute to cost savings.</p>

3.2 AI VISION IN HIGH-TECH – A ROBOTICS SOLUTION

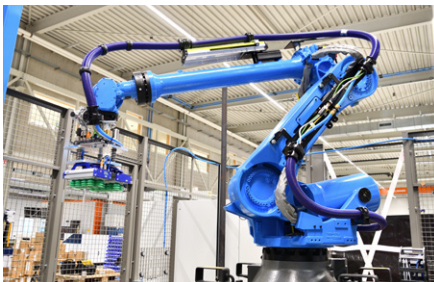
As robotics, with AI integrated cameras, becomes a cornerstone in supply chain management, this chapter explores the challenges and transformative impact of AI vision. A compelling use case illustrates how AI is revolutionizing the outbound picking process for Artavo's high-tech clients: Our three superhero robots ("Stark", "Hercules", & "Groot").

THE CHALLENGE: DIFFERENT BOX SIZES AND LABELS

After the wide-aisle picking process, the challenge arises in placing the picked boxes on the conveyor with their labels oriented in a specific manner for optimal scanner readability and shipping label application. Complicating matters, the varied types of boxes and random stack patterns necessitate a solution that can dynamically detect and adapt to the situation in real-time. Adding to the complexity, the evolving nature of products introduces constant changes in SKUs and box dimensions, requiring a flexible and adaptive approach to address these dynamic challenges.

NO READS AT SCAN POINT	HAND-EYE COORDINATION PROBLEMS	FUTURE READINESS
If the box is not correctly oriented, barcodes cannot be scanned and orders not confirmed.	Small boxes and big boxes have to be handled differently (grabbed differently, movements need to slow down) to avoid damages.	A robot should not be reprogrammed with every new SKU introduction as effort and cost will outweigh the benefits.

THE SOLUTION: AI CAMERAS FOR BOX & LABEL DETECTION



Each robot has two AI cameras which take pictures of the pallets, each box, and each label. The top AI camera detects the pallets pattern, box dimensions, and labels. After the robot determines the optimal picking order, detects SKU and dangerous labels, the boxes are held in front of an AI side camera. This camera checks the box height and any further labels. With all the information, the robot calculates if any turns or specific orientations of the box during placement are needed.

THE BENEFITS: INTELLIGENT PROCESSES PROVIDING FLEXIBILITY

DYNAMIC DETECTION	A NEW COLLEAGUE	PROCESS FLOW
The AI cameras can adapt to any situation (pallet and boxes) and orientate boxes according to downstream process flows (also in the future).	Robots replace repetitive and heavy work for our employees.	Queuing pallet loading, the robot operates independently, managing peak volumes and accelerating the process.

3.3 AI MACHINE LEARNING IN FINANCE – FRAUD DETECTION IN E-COMMERCE

This chapter delves into the pivotal role of AI in machine learning, showcasing its significance in enhancing fraud detection capabilities - a critical imperative for modern businesses seeking robust security measures and safeguarding financial integrity. This solution is in place for several e-commerce clients at Arvato.

THE CHALLENGE: CREDIT CARD FRAUDS COSTING HUNDREDS OF THOUSANDS OF EUROS

Amid the escalating challenge of fraud in e-commerce, the cost of combating fraud stands at nearly 2.5 times more than the actual losses. As fraud continually evolves, becoming both more sophisticated and cost-intensive, the implementation of AI emerges as a strategic imperative for businesses seeking effective and efficient solutions in the realm of fraud detection (Maiwald).

Typically, orders require manual checks, and review rules must be consistently updated. The complexity of order reviewing, particularly when combining multiple rule sets, makes it a labor-intensive task, resulting in high costs. Failing to detect fraud poses the risk of financial losses.

THE SOLUTION: SUPERVISED MACHINE LEARNING MODEL IN AZURE AND PYTHON

The financial department has introduced a supervised machine learning model based on Microsoft Azure and python to analyse orders and detect fraud patterns at several clients.

Its goal is to reduce the number of manual reviews and fraud-related write-offs. Rules are based on individual customer’s profile, transaction history, and device information, as well as checking against blocklists, a user’s true geographic location, and detect proxy servers which are known to be a fraud risk.

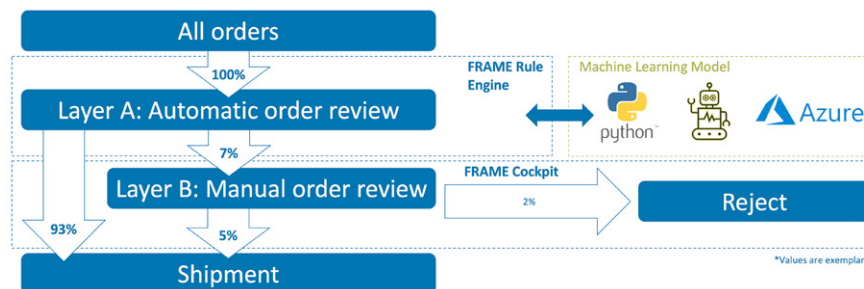


Figure 1: How the machine learning fraud detection works

THE BENEFITS: INCREASED FRAUD PREVENTION IN REAL-TIME

While monetary savings are based on a client’s situation, several use cases reported these benefits:

LESS WRITE-OFF	REDUCED OPERATIONAL COSTS	BRAND PROTECTION
Fraud rate and financial losses (including loss of goods and cost of capital) decreased.	by minimizing manual order reviews.	from reputational damage.

4 CONCLUSION: HOW AI IS SHAPING THE WORLD

Industry 4.0 technology, which emphasizes digitization, network communication, automation technologies, and advanced analytics, is expected to fundamentally impact our daily lives and many industries alike. The logistics market face six disruptive challenges (Market Growth, Resource Shortage, Customer Expectations, New Entrants and Collaboration, Sustainability, and Technology & Innovation).



1. MARKET GROWTH

Implementing AI in inventory management and outbound picking enables scaling operations efficiently to meet the increasing sales volume.



2. RESOURCE SHORTAGE

By streamlining operations and reducing manual labor through AI-driven processes, the impact of resource shortages (limited warehouse space and skilled labor) can be mitigated.



3. CUSTOMER EXPECTATIONS

AI-powered inventory management ensures faster and more accurate delivery services, meeting customer expectations for timely and efficient logistics operations.



4. NEW ENTRANTS & COLLABORATION

AI supports collaboration through transparency and real-time data sharing, fostering partnerships within the industry but also more agile and responsive ecosystem, capitalize on emerging opportunities.



5. SUSTAINABILITY

AI-driven processes contribute to sustainability efforts by optimizing resource utilization, minimizing waste, and reducing environmental impact through more efficient logistics operations.



6. TECHNOLOGY & INNOVATION

Integrating AI empowers companies with a competitive edge, fostering innovation and adaptability, enhancing their competitiveness and ability to adapt to evolving market trends and technological advancements.

4.1 FUTURE OUTLOOK: WHAT DO WE EXPECT FROM AI?

"Our experience and customer engagement strongly suggest that AI technologies are transforming our industry's future. Through predictive analytics, they provide precise demand forecasts and planning accuracy. Real-time tracking ensures transparency, leading to minimized waste and more precise allocation of resources. By employing and implementing AI, we see supply chains evolving into eco-conscious networks, harmonizing profitability, operational efficiency, and environmental stewardship, ultimately paving the way for sustainable prosperity."

Andreas Barth,
President Tech

"In the logistics realm, we expect AI to streamline processes and enhance planning efficiency by integrating knowledge and experience from various operations and solutions. Through text mining, data analysis, and machine learning, we convert mountains of data into actionable insights. Say farewell to sluggish planning and clunky presentations. We're talking about faster processes, smarter questions, and turning weeks into hours. The future isn't a distant dream - it's within reach. Let's make cool things happen, not just in theory, but in practice."

Bernhard Lembeck,
Vice President Future Warehouse

"In the world of SCM, AI is our guiding light, enhancing collaboration between account managers and clients. With predictive analytics and dynamic optimization, we shape a supply chain that works smarter, not harder. Let's journey together, turning challenges into triumphs, and paving the way for a resilient future."

Andrea Mahon,
Vice President Global Account Management

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You

What does AI expect from AI?



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In logistics, AI's future promises streamlined operations, cost reductions, and enhanced efficiency. Predictive analytics will optimize inventory management and route planning, while automation liberates human resources for strategic endeavors. Machine learning algorithms continually refine processes, anticipating and mitigating disruptions. Autonomous vehicles and drones revolutionize last-mile delivery, expediting fulfilment and reducing environmental impact. Embracing AI technologies empowers managers to navigate dynamic markets with agility, fostering sustainable growth and competitive advantage.

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5 ACKNOWLEDGEMENT

ABOUT THE AUTHOR

Karoline Kowalik is a Logistics Engineer and PhD researcher at Arvato and Maastricht University. Her work mainly focuses on Industry 4.0 technologies such as robotics, AGVs, ASRS, and also sustainability. Her research focuses on the interplay and evaluation of innovation, sustainability, circular economy, and sustainable decision-making.



See further publications:

[Circular Economy in Logistics – Circular Service Design for Logistics Provider: An Arvato Case Study](#)

[Innovation & Sustainability – The Effect of Industry 4.0 Technology on Economic, Ecological & Social Sustainability in Logistics](#)

ABOUT ARVATO

Arvato is an innovative and leading international service provider in the field of supply chain management and e-commerce. By combining deep industry expertise with the right technologies, Arvato develops innovative supply chain management and e-commerce solutions for its clients. Arvato focuses on Consumer Products, Tech, Healthcare, Automotive and Publisher industries and has adapted its organizational structure to the needs of its global clients and their industries. More than 17,000 employees work together at over 100 locations on one platform and with the latest technologies. This enables Arvato to provide its clients with the best possible support for their growth objectives.

For more information, please visit www.arvato.com.

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