TRENDS AND STRATEGIES IN LOGISTICS
AND SUPPLY CHAIN MANAGEMENT

2023

Success factors for the integration of artificial intelligence in supply chains

BVL

infront

KPS

Whitepaper

from Infront on the BVL
Triple Transformation study:
Digitalisation, sustainability and resilience as guidelines for future-proof value chains

Success factors for integrating artificial intelligence into supply chains

Whitepaper from

Dr. Joachim Getto, Partner bei Infront für Supply Chain Management und Logistik

as part of the BVL study

Triple Transformation:
Digitalisation, sustainability, and resilience as guidelines for future-proof value chains

from the series

Trends and Strategies in Logistics and Supply Chain Management

Supply chain concepts – Exhaustive competitive advantage and a new approach to improving performance

A defining element of the supply chain is the endeavour of its decision-making bodies to achieve competitive supply chain performance. Over the past five decades, many supply chain concepts for simplification ("lean"), greater agility, improved sustainability and holistic transparency have been developed and implemented. Each concept contributes to a competitive advantage in terms of increasing supply chain performance throughout its decade. However, after the corresponding tools and methods have been introduced and implemented in a considerable number of competing companies, the impact is generally limited.

Figure 1: Collaboration types and AI share in supply chains (source: Getto, J., 2021, p. 278)

#	Collaboration type	Headmaster	Agent	Share
1	Non-AI-supported subsystem	Human expert	Human expert	88 %
2	Mixed subsystem with a human expert in the management role	Human expert	AI application	6 %
3	Mixed subsystem with AI application in the management role	AI application	AI application	4 %
4	Pure AI subsystem	AI application	AI application	2 %
Total				100 %

The possibilities are exhausted, and new concepts are needed to add methods and tools for the next step in performance improvement. For the coming decades, the concept of a comprehensively AI-supported, self-thinking and learning supply chain should be seen as a performance-enhancing model for the future.

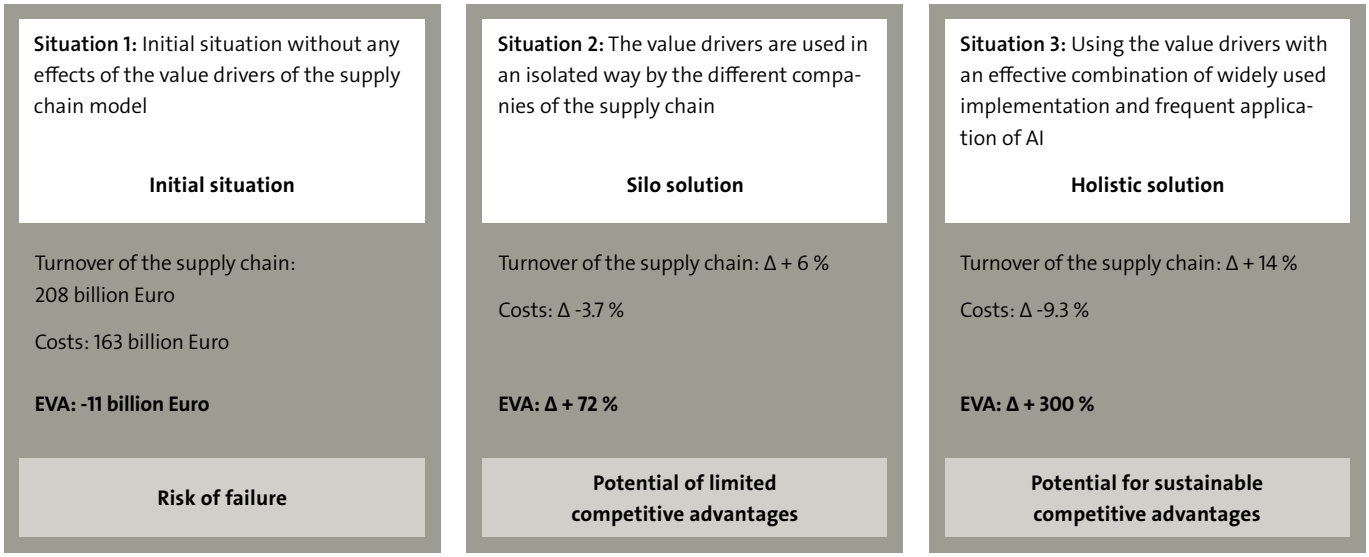
This requires a) a high proportion of AI applications in the interaction between human experts and AI agents and b) the intensive use of these AI applications along the supply chain.

However, AI applications currently support only 12% of all supply chain processes (see Figure 1).

Supply chain model as a decision-making aid for assessing value contributions through AI along the supply chain

In our day-to-day work, we find that many companies still react with uncertainty when it comes to the use of AI. The specific effects on the company's own business model and the value-creating processes cannot be assessed clearly and holistically. There is often a lack of references and the necessary competencies to assess the topic with regard to one's own company.

Figure 2: Different scenarios of the model calculation, source: Getto, J., 2021, p 311



Source: Annual Report 2019 of BASF, Continental, BMW

For this reason, we have incorporated our project experience with AI-based supply chains and our research results from various scientific papers and extensive literature analyses into a supply chain model.

Using the example of an original equipment manufacturer (OEM) supply chain in the automotive industry with tier 1 and tier 2 entities (see Figure 2), we have calculated the initial situation (situation 1) with two future scenarios (situation 2: silo solution and situation 3: holistic solution) in terms of sales, costs and economic value added (EVA) potential.

Situation 1 (initial situation) represents the percentage distribution of the collaboration types from Figure 1. In **Situation 2** (silo solution), managers focus on increasing the effectiveness of supply chains through isolated AI applications in their own area of responsibility. Situation 2 is characterised by separate optimisation within the individual supply chain entities. A shared culture along the entire supply chain develops only to a limited extent. The supply chain's ability to learn is limited. **Situation 3** (holistic solution) is characterised by a high proportion of collaboration types 2, 3 and 4 from Figure 1 and represents the vision of a holistically controlled supply chain through autonomous planning and a physical material flow that is as autonomous as possible.

The detailed model calculation in Getto, J. (2021): Analysis and evaluation of the impact of artificial intelligence on value creation in the supply chain. PhD thesis, University of Gloucestershire, shows that only those who transform the performance of their supply chain into a holistic solution with the concept of an AI-based, self-thinking and learning supply chain will be sustainably competitive.

Success factors for a sustainable competitive advantage

Four critical success factors emerge from the findings of the model calculation (Figure 3).

Figure 3: Success factors for a sustainable competitive advantage

Success factor	Designation
Success factor 1	Rationality and pattern recognition of AI
Success factor 2	Interaction between human experts and AI experts
Success factor 3	AI's ability to learn – The common culture of the supply chain
Success factor 4	Protection from competitors

Success factor 1: Rationality and pattern recognition of AI

AI is the technical agent that can better model uncertainty through expected values of variables or functions of variables and always decides on the optimally rational result among all possible actions.

Algorithms can control and, if necessary, redirect the flow of goods in a targeted and efficient manner. In contrast, employees would need days to analyse all the data. Moreover, especially in stressful situations such as delays, errors can creep in. The artificial intelligence, however, can process data immediately and without emotion and quickly make the right, rational decision.

The ability of AI to process large amounts of data faster and more precisely than human experts enables the supply chain to reliably identify relevant patterns for demand planning over a longer time horizon, among other things. Whereas in the past, the demand-driven supply chain could only reliably determine demand over a relatively short time horizon, AI will enable a secure, primarily forecast-driven supply chain in the future..

Success factor 2: Interaction between human experts and AI experts

It is a frequently voiced concern that AI could replace humans. However, it is often forgotten that AI-supported skills already complement human skills and compensate for many human weaknesses - in other words, they support people in their daily work. The technological approaches of the AI are different from the thought structures of humans: Human agents in supply chains combine and unite their abilities (known as "sensor fusion") to create a uniform and consistent image. The interplay of hormones and chemical processes controls their emotional and social intelligence. AI-supported agents have some catching up to do in this area, meaning that the advantages of human decision-making influences cannot be dispensed with in the short- to medium-term.

While the supply chain of the 21st century was still of a socio-ecological character, shifting towards a socio-technological character is inevitable. In future, the supply chain will be predominantly data-driven. The extent of the AI's value contribution also depends on how much the implicit, data-based expertise gathered by the AI application enriches the overall knowledge along the supply chain. And it depends on the extent to which it is incorporated into the standards and rules and utilised by human experts..

Success factor 3: AI's ability to learn – the common culture of the supply chain

The increasing complexity and large volume of information in the supply chain make it impossible for software programme developers to code the solutions needed for optimal decision-making with their (development) language possibilities in the form of programming language.

Artificial neural networks, with their ability to process data and generate knowledge in a self-learning manner, can cope with this complexity. This type of AI can already be found in applications such as natural language processing, which is used in voice assistants (chatbots), among other things. Computer systems that use and learn from existing knowledge can also be found in computer-based vision, in adaptive robots, in simulation applications, in cloud systems and in the creation of virtual reality, which is used, for example, in order picking and loading.

A shared culture is essential for the learning ability of humans and AI, as it reduces the time required for communication and cooperation between the players to exchange and integrate information. Such a shared culture is created when all stakeholders can build on common guidelines, data and experiences and absorb, share, and expand knowledge. Such a common culture is fostered when knowledge is shared with multiple artificial intelligences and is brought together by a central cloud.

While AI applications can analyse large amounts of data and make recommendations for action, humans with their emotional intelligence are still decisive in drawing the right conclusions from the data, developing strategies, and initiating measures. While AI already supplements existing knowledge today, it will play a more important role in the future.

Success factor 4: Protection from competitors

AI creates knowledge. Two factors are crucial for turning this into a strategic competitive advantage: First, the creation of this knowledge must not be comprehensible to competitors. Secondly, this knowledge only offers an advantage if it is used throughout the entire supply chain.

Over the past decade, AI expert systems such as IBM Watson, ImageNet or Google with their artificial neural networks (ANN) for image recognition or natural language processing (NLP) have begun to continuously build up a knowledge repository and develop complex self-learning capabilities. The sheer volume of processed data that has grown over time has given them a competitive advantage. If these AI-supported expert systems are integrated into the so-called intelligence architecture of a supply chain, this complexity advantage is difficult for competitors to catch up with, as the interfaces between AI and the other parts of the intelligence architecture are more difficult to imitate than stand-alone AI solutions.

The more frequently AI applications are used, the more likely they are to become part of the supply chain and elude systematic and direct control and influence by companies. In combination with the self-learning ability of AI, the supply chain becomes a complex, adaptive system that can hardly be imitated. In this case, complexity and the ability to adapt mean a strategic competitive advantage. Such a competitive advantage is sustainable if other supply chains give up duplicating this strategy. To secure this advantage, the supply chain must avoid that the knowledge about the connection between the resources and the benefits becomes understandable and transparent.

The transparency of knowledge is created through codification. Knowledge codification is the conversion of tacit, implicit knowledge into explicit knowledge. However, the more open and observable the knowledge is, the easier it can be learnt by competitors, and the less valuable it is, as there is a risk that it will be stolen and imitated. Agents must, therefore, apply implicit knowledge to manage the supply chain and carry out activities. The self-learning ability of AI creates such implicit knowledge, because AI applications learn without codified programming, set up rules and adapt them to process their algorithms without human input. They can execute processes implicitly. AI-inherent implicit knowledge is hidden from the outside observer. The knowledge distribution along the supply chain is based on compatible cooperation routines such as forms, rules, procedures, conventions, strategies, and technologies. This common schema, also known as inter-organisational culture, contains and distributes implicit knowledge across all entities in the supply chain. An AI-supported platform processes and converts data into information and makes the information available as shared supply chain knowledge for all authorised agents in the supply chain.

AI applications or human experts access this stock of knowledge. Still, they can only express to a limited extent how they process their individual but interlinked activities and how the knowledge is created. This is why the network of individual knowledge and the general knowledge as part of the shared culture of the supply chain are inextricably linked by the knowledge repository of the decentralised AI applications and the central AI-supported platform; and they are only partially transparent and protected accordingly.

Knowledge protected from competitors is only valuable if it enables a supply chain to design or implement strategies that improve their efficiency and effectiveness by exploiting opportunities or neutralising threats in the supply chain environment. According to this view, even two supply chains that have access to the same internal and external knowledge can achieve different competitive positions. This happens when one supply chain has superior intelligence that enables specific insights as a basis for targeted competitive measures that the other company lacks.

Application example: bad part detection in the holistic collaboration scenario

Based on the bad part detection, scenario 3 of the supply chain model - the holistic collaboration – can be demonstrated well: The detection of bad parts in the production line of a manufacturer or in the delivery of a supplier by AI-supported computer-based vision helps reduce errors. However, this alone does not create knowledge. But if the self-learning algorithms constantly analyse hundreds of bad parts and identify a pattern that reveals the cause of these bad parts, then new knowledge is created.

On the one hand, AI applications learn from constantly analysing the bad parts and updating their inherent knowledge memory. On the other hand, the human experts learn from the results of the AI applications. The more complementary information is processed by the agents involved - i.e. by both humans and AI - the better the results of the pattern recognition. This is because the newly created shared knowledge circulates between the human experts and AI agents involved. Widely disseminated and fully integrated information that is exchanged across all subsystems in the supply chain improves the provision of complementary information for researching the root cause of errors of any kind.

In this collaboration, the AI application with computer vision capability makes the results of the pattern of the AI-supported platform available and the knowledge available to the respective subsystems in the production as well as in the research & development organisations and suppliers and recommends options for actions.

At the moment of the AI platform recommending measures to humans based on its prescriptive analysis capability, this process is codified. This means that the resulting adaptations are incorporated into the shared culture as norms and rules by humans as codified knowledge.

Conclusion and outlook

The decisive feature of supply chains that are competitive in the long term is not the AI-supported forecasting capability, as is often assumed. Instead, it is the fully implemented application of AI along the entire supply chain through a high degree of process autonomy paired with integrated but decentralised coordination of the supply chain partners. This is why the future organisational structure recommended by the authors along the entire supply chain enables a high degree of controlled freedom for adaptive agents that form cross-company clusters at the interfaces of the supply chain units.

The combination of knowledge creation and knowledge distribution with fully implemented and widely used AI-supported forecasting and autonomous supply chain planning is the only viable future concept to achieve sufficient added value through the inevitable data-centred approach throughout the supply chain.

The implicit knowledge and the high number of AI applications ensure that the connection between the origin and the advantages of this knowledge remains opaque.

What we also see: There is still a great deal of uncertainty when it comes to dealing with AI. Many framework conditions have not been defined, and there is still little prior knowledge and application skills are not available across the board.

In addition, the specific impact on the company itself is not clear. Creating a target image that clearly identifies use cases on the one hand and considers the effects on your own processes and value creation on the other hand can help here. Moreover, the foundations for being able to introduce such models at all are identified and existing gaps are made transparent. Building on this, companies can then optimise their processes in a targeted manner and gradually implement AI correctly in everyday life.

References

BASF (2020): BASF Report 2019, https://report.basf.com/2019/en/

Continental (2020): Transformation - Annual Report Continental AG 2019,
https://www.continental.com/en/investors/events/financial-calendar/details/annual-report-2019-available-only-in-a-digital-format/

BMW (2020): Power of Choice - Annual Report BMW Group 2019 (EN),
https://www.bmwgroup.com/content/dam/grpw/websites/bmwgroup_com/ir/downloads/en/2020/gb/BMW-GB19_en_Finanzbericht.pdf

Brown, T. (2020): Impact of AI in Supply Chain Management. Artificial Intelligence.
https://itchronicles.com/artificial-intelligence/ai-in-supply-chain-management/

Getto, J. (2021): Analysis and evaluation of the impact of artificial intelligence on value creation in the supply chain.
PhD thesis, University of Gloucestershire

Leonard, M. (2020): So, only 12% of supply chain pros use AI? Apparently. BRIEF.
https://www.supplychaindive.com/news/artificial-intelligence-machine-learning-supply-chain-mhi-report-automation/574745/

Dr. Joachim Getto is a partner at Infront for supply chain management and logistics.

He combines applied business management thinking with a sound technological background and is responsible for research activities on the contribution of artificial intelligence to value creation in supply chains. Companies from the chemical, pharmaceutical, retail and logistics industries rely on his extensive experience and strategic vision.

Joachim is the author of numerous studies and specialist articles on the transformation of supply chains, is a frequent speaker at conferences and lecturer at universities.

Bundesvereinigung Logistik e.V.
Schlachte 31
28195 Bremen, Germany

www.bvl.de