ROLE OF ARTIFICIAL INTELLIGENCE IN SUPPLY CHAIN

Beáta BORODAVKO[1], Prof. Dr. Béla ILLÉS[2] and Dr. Ágota BÁNYAI[3]
[1] *University of Miskolc, Institute of Logistics, 3515 Miskolc-Egyetemváros, Hungary*
E-mail: beata.borodavko@uni-miskolc.hu
[2] *University of Miskolc, Institute of Logistics, 3515 Miskolc-Egyetemváros, Hungary*
E-mail: altilles@uni-miskolc.hu
[3] *University of Miskolc, Institute of Logistics, 3515 Miskolc-Egyetemváros, Hungary*
E-mail: altagota@uni-miskolc.hu

***ABSTRACT**: The last century brought significant changes to the automotive industry and represents a significant economic and technological force in the life of countries connected to the industry. Digitalization, automatization, Internet of Things, Big Data applications are forming the current business models and challenging the companies to adopt to the new ERA. From Industry 4.0 grow out the Logistik 4.0 or Supply Chain 4.0. Logistics 4.0 - much more than having the right products at the right time and in the right place. The different AI use cases and solutions review will present the complexity of the Supply Chain and Logistics*

***KEYWORDS**: Supply Chain Management, Artificial Intelligence, Industry 4.0, supply chain 4.0, Machine Learning, inventory*

1 INTRODUCTION

The concept of digitizing everything is becoming a reality. Automation, artificial intelligence, IoT, machine learning and other advanced technologies can quickly capture and analyze a wealth of data that gives us previously unimaginable amounts and types of information to work from. Our challenge becomes moving to the next phase—changing how we think, train and work using data—to create value from the findings obtained through advanced technologies." Brian Householder, President and Chief Operating Officer, Hitachi Vantara.

Industry 4.0 is defined by connectivity. In an Industry 4.0-capable factory, devices are connected to one another and to human interfaces and provide real-time data from a large number of sensors. People can "connect" to this data at any time.

Today, most automotive manufacturers and suppliers have voluntarily embarked on the journey to Industry 4.0, and that journey will lead them to higher profitability. According to Automotive World, the sensors have been very useful in the supply chain. As an example, Bosch has achieved a 25% increase in production for its automatic brake stabilization (ABS) and electronic stability program by simply introducing smart, interconnected wires.

2 INDUSTRY 4.0 DRIVES THE RISE OF SUPPLY CHAIN 4.0

The rise of digital factories – better known as "Industry 4.0" – is creating a real disruption in the industry and requires companies to rethink the way they design their E2E manufacturing processes and hence their Supply Chain management organization.

The digitization of the Supply Chain will enable companies to align with new customer needs and expectations while responding to the remaining challenges of increased efficiency and decreased costs. McKinsey predicts that Supply Chain 4.0 could not only significantly increase Supply Chain agility but also potentially reduce operational costs by 30%, lost sales by 75% and inventories by as much as 75%.

Supply Chain 4.0, targets to reach improved Supply Chain processes.

Fig 1. Supply Chain 4.0 process segments

Predictable - using enhanced forecasting approaches, e.g., predictive analytics based upon internal and external data to provide much more accurate forecasts of demand and Supply.

Agile - using real time planning as a continuous process in order to be able to react rapidly to changing needs and constraints.

Segmented – customer products become more and more specific or customized, which increases the need for micro-segmentation of the Supply Chain and a more granular product clustering.

Transparent - new generation of Supply Chain systems and technology provides real-time data and end-to-end transparency throughout the holistic Supply Chain process.

Efficient – reducing process inefficiencies by automation and the use of robot software technologies or other automation techniques.

In order to achieve these ambitious goals, companies should embrace and implement new technologies like Artificial Intelligence (AI), Internet of Things (IoT), Cloud Computing, Blockchain technologies, Big Data and advanced data analytics.

In particular, AI is getting an increased focus in organizations over the last years. Gartner's 2019 CIO Survey identified that 92% of respondents have AI on their radar, or have initiated projects that use AI in one way or another.

Adding artificial intelligence to Supply Chains is delivering tangible benefits for companies putting it in place. Recent research of McKinsey finds 61% of executives report decreased costs and 53% report increased revenues as a direct result of introducing AI into their Supply Chains.

3 CATEGORIES OF AI SOLUTIONS AND TECHNIQUES

As common the use of AI is today, understanding AI and AI terminology can be a challenge as terminology is used interchangeably or even incorrectly. Defining what AI stands for is more than ever important in order to better understand and objectify the hype.

AI can be defined as a discipline that applies advanced analysis and logic-based techniques, autonomous learning, to interpret events, support and automate decisions and take actions.

Depending on the techniques used, multiple sub-fields can be identified under the umbrella of the AI field. The different subfields are now than buzz word in the industries and organizations as real use cases in numerous corporations and industries can be found. The most common used subfields are the following:

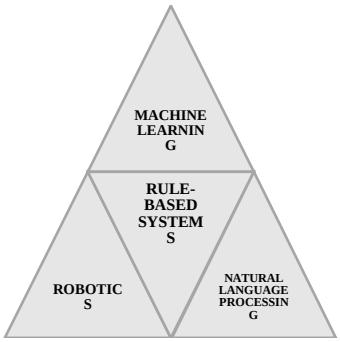

Fig. 2 AI solution´s categories

3.1 Machine learning

Machine learning is used in applications or solutions to learn from data and improve their accuracy and efficiency over time without being programmed to do so. Machine learning uses algorithms that are trained to find data patterns in significant amounts of data in order to facilitate decision making or predict outcomes. The better the algorithms and the more trained they are, the more accurate decisions can be made.

3.2 Rule-based systems

Rule-based systems are used to extend the implicit and explicit know-how and knowledge humans. These techniques translate knowledge in a structured manner into human-made rules to store, sort and manipulate data. They use triggers to initiate action and interaction between systems. Rule based systems mimic human intelligence but contrary to machine learning they won't correct or enhance algorithms on its own, and a system will not 'learn' from its mistakes.

3.3 Robotics

Robotics have emerged over the last years as a very interesting subfield of artificial intelligence. Robotics Process Automation (RPA) determines the design, implementation, operating, and usage of software robots for executing tasks that might be labor intensive for humans or difficult to repeat steadily with quality. RPA doesn't make people redundant but act as virtual assistants to whom simple and repeatable tasks can be offloaded and hence free up time for more value added activities.

3.4 Language Processing

Language Processing is the part of computer science and AI and help communicating between computer and human by use of natural language. The system will be able to process human language and a computer to read and understand data by mimicking human natural language.

4 CONCRETE CASES WHERE ARTIFICIAL INTELLIGENCE COULD BE VALUE TO SUPPLY CHAIN 4.0

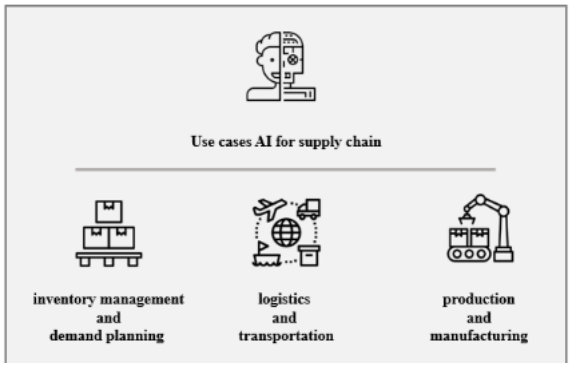

Fig. 3 AI use cases for supply chain

4.1 AI use cases in inventory management and demand planning

Accurate inventory management is a crucial foundation of Supply Chain Management as it has a direct impact on the cash flow and profit margin of a company. Efficient inventory management will prevent over-or-understock. Inventory management is one of the most typical machine learning use cases in Supply Chain Management. The ability of AI to handle, analyze and interpret large data sets of real time data will contribute in efficiently forecasting supply and demand.

Efficient inventory management has also a significant impact on customer satisfaction. Inadequate stock management can lead to product shortages and increased delivery times, which will negatively impact client relationships. AI can help optimize stock management and managing client demands adequately.

4.2 AI use cases in logistics and transportation

Combined with IoT, AI can help track goods through the end-to-end logistics process. It can help Supply Chain professionals track the location of goods as well as create visibility on the conditions in which they were handled. The use of sensor-technology can provide insights on important factors like temperature or humidity during transportation.

By tracking weather and traffic conditions, AI can be used to give real-time route-optimization recommendations and in this way decrease transportation times and costs.

Autonomous cars have the potential to transform logistics and decrease the dependency on humans. Companies like Tesla, Google and Mercedes Benz are investing heavily in the concept of autonomous vehicles for years. Autonomous trucks could be the next big thing for the transportation sector although it might take a while to mature. According to BCG estimations, only around 10 % of light trucks will drive autonomously by 2030.

4.3 AI use cases in production and manufacturing

AI can be used to identify product quality issues in the early stages of the production process. By the use of computer vision a product can be compared to an ideal mock-up piece and assess the required level of quality before it reaches the client. Audi - for example - uses machine learning to recognize and mark the finest cracks in sheet metal parts—automatically, reliably and in a matter of seconds. With this project, Audi is revolutionizing the testing process in production through AI.

Another use case of AI in manufacturing is predictive maintenance of equipment based upon real-time data rather than a predefined maintenance calendar. By improving asset maintenance, Supply Chain professionals can significantly decrease maintenance costs. General Motors – for example - decided to add AI technology to their assembly chains in order to detect component failures and hence maintenance needs upfront.

5 CASE STUDY FOR INVENTORY GENERAL RECOMMENDATIONS

In this part of the article will be presented a real business case from the industry about Use Case – Inventory Adjustments Root Cause Analysis

5.1 Company Overview

The company is an international automobile supplier. This company has over 10.000 employees around the world and revenue of over $4 billion over its 6 business units.

5.2 Business Problem

The company detected overstated inventory:

1. Machine picks 2 components instead of 1

➔ System backflushes 1 component and inventory is wrong by 2 – 1 = 1

2. Operator reports return qty = 1200 instead of 120

➔ Inventory is wrong by 1200 -120 = 1080

Cycle Counts are performed to identify inventory inaccuracies leading to adjustments to correct errors.

➔ Business Impact:

- Time consuming process
- No root cause analysis to solve underlying problems

5.3 Business challenge

They were looking for a tool and automatized system solution for accurate inventory management which would enable support of their existing tool chain, and customized cloud environment.

The company researched a number of options, looking for system-integrated solutions that could support their existing stock management, communicate and process data coming from their infrastructure application, as well as support a diversity of existing dashboards.

5.4 Business solution

Adopting machine learning and connecting with real data analyses brings an optimized solution for the accurate inventory track.

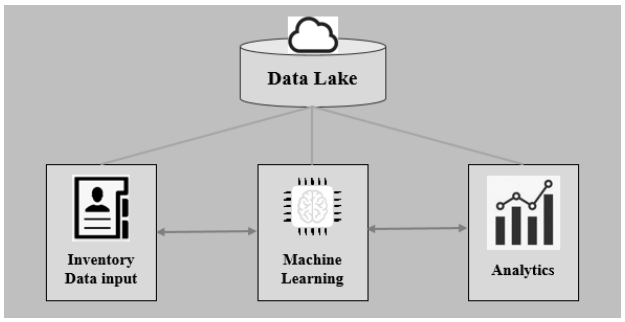

Fig. 4 Implementing machine learning in the inventory alert system using Big Data analyses

Different data and input information is needed for the accurate analyses

Data needed:

- Cycle Count information
- Inventory Adjustment Transactions
- Unplanned Receipts
- Negative Planned Receipts
- Unplanned Adjustments
- Bill of Materials
- Scrap Reports

Outcome:

- Identification of items with high rates of adjustments
- Patterns of inventory adjustments
- List of Potential Root Causes w/ confidence levels

Business benefits:

- Improved Inventory Accuracy
- Reduction in over-stocks & shortages
- Lower volume of Cycle Counts & Adjustments (labor savings)

6 KEY CHALLENGES WHEN THINKING ABOUT AI IMPLEMENTATION

Although the AI topic is reaching the CEO's and CIO's strategic agenda, the effective implementation and efficient use of AI technologies are still facing significant hurdles and challenges in most organizations.

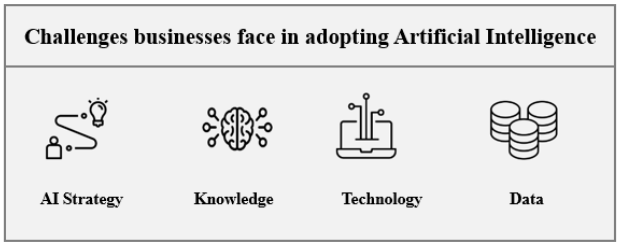

Fig.5 Key challenges by AI implementation

6.1 AI Strategy

Companies spend a significant amount of effort and investments in defining AI strategies or choosing platforms before having a clear vision on the business problems they want to solve. Organizations should start from the issue, define clear business uses cases upfront and assess what added value AI Technology can bring. Support of all layer spread across the organization will be needed to have a wide adopting of AI.

6.2 Technical and business knowledge

Bringing new technologies within the organization, will result in the need for attracting different or additional talent pools to implement, run and maintain AI solutions. Resources that can combine deep technical as well as business knowledge are for many business areas still scares. Specific AI training paths in order to build the missing skills might be the only available option.

6.3 Technology

Also on the technology side a number of challenges can be stated. AI – and specifically machine and deep learning techniques, require a high number of calculations to be made in very short time frames. The need for larger and modern infrastructure to assure AI platform performance result in increased pricing and investments. These could be a burden in the general adoption of AI technology especially in small to midsize companies.

AI will not replace existing legacy systems but needs to be seamlessly integrated with them. The older or heavier legacy systems are — the more effort and potentially costs it will require to

implement an AI solution within the exiting IT ecosystem.

6.4 Data

One of the most common AI challenges that businesses face is the availability of real-time, coherent and holistic data. The availability of data sets is essential to train, implement and run AI Solutions and achieve the desired outcomes. More stringent data protection regulations (like the General Data Protection Regulation (GDPR) in Europe) might add additional challenges on the storage and use of personal data.

7 SUMMARY

The paper has given an overview about the important AI solutions in the industry. It has focused on the Industry 4.0 impacts in the supply chain and logistics. It has been reviewed which benefits and challenges of AI implementation has in the field of supply chain. Different use cases are showing the importance and the key role of AI and machine learning for more effective operation. In connection with these, we have described some of the important techniques, data types that need to be collected. It can be stated that production system operation problems can be significantly improved by using more data application.

8 ACKNOWLEDGEMENTS

Any acknowledgements would be written in this section.

9 REFERENCES

The Internet Of Things Delivers Value Throughout The Supply Chain; Paul Miller and Michele Pelino/Forrester February 23, 2021

Research Overview: Artificial Intelligence- A Guide To Navigating Our AI Technology Research Portfolio; Srividya Sridharan /Forrester May 20, 2020

Building a cognitive digital supply network- Augmenting automation in an AI world; Adam Mussomeli, Mark Neier, Bryan Takayama, Brenna Sniderman and Jonathan Holdowsky / Deloitte Insights

The Future of Commercial Vehicles How New Technologies Are Transforming the Industry; Andreas Jentzsch, Joel Janda, Gang Xu, Peter Wiedenhoff, and Andreas Girisch/Boston Consulting Group October 17, 2019

3 ways AI can help solve inventory management challenges; Chloe Chang /IBM March 4, 2020

Supply Chain 4.0 – the next-generation digital supply chain; Chloe Chang /McKinsey & Company October 27, 2016

https://kodiakrating.medium.com/6-applications-of-artificial-intelligence-for-your-supply-chain-b82e1e7400c8

Artificial Intelligence (AI) in Supply Chain Planning: The future is here and now; Mark Balte/ European Business Review January 10, 2020

20 Things To Know About Artificial Intelligence For Supply Chain Management; Steve Banker / Forbes January 1, 2019

Ways AI is Impacting the Supply Chain; Lucy Benton / Beyond Supply Chain September 27, 2018

Artificial intelligence in supply chain management: theory and applications; Hokey

Min / International Journal of Logistics Research and Applications March 24, 2009