

SCM and the fifth industrial revolution: How AI impacts the process management flow^{1, 2}

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ABSTRACT

We are almost a decade into the 5th industrial revolution. This revolution is driving digital and green transitions, that places worker well-being at the heart of the production process and productivity. This fifth revolution has had an impact on the management of the entire supply chain from point of manufacturing to consumption. Among other things, this revolution has enabled the use and development of artificial intelligences.

This article reflects on the implication of Artificial Intelligences in the process of managing supply chain flows. It is important to analyze the challenges of the transformation of the 5th revolution in the field of logistics. To do this, after a brief conceptual clarification, we present the different structural changes brought about by artificial intelligence in Supply Chain Management. This is supported by analyses and different case studies. This has allowed us to determine the link between AI and logistics. Subsequently, we have considered the best techniques in the usage of Artificial Intelligence in field of the Supply Chain management. In the medium and long term, AI will take the place of humans in companies. This will gradually eliminate certain jobs. Although we need Artificial Intelligence, we also need human to achieve better results, and in order to maintain its place in the chain, it is important for humans to reinvent and create new jobs.

INTRODUCTION

Problematic

Is it important to look at the relation between the evolution of the SCM and AI? Supply Chain Management is not just logistics. It is the flow from suppliers to customers. The flows are divided

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into three. The information flow, which is the brain behind the physical flow. Then the physical flow which is linked to all movements such as products and transport. The last flow is financial in order to pay and get paid. The fourth industrial revolution, also called 4.0, corresponds to the digitalization and connectivity of tools. The aim is to control and monitor a factory remotely. What is the 5th revolution? It is a new technology. It aims to let a factory manage itself autonomously without being human. This technology is artificial intelligence. Artificial intelligence is a process of imitating human intelligence which is based on dynamic computer algorithms.

The objective of AI is to automate any system by incorporating a dynamic (intelligent) computer algorithm. This algorithm can make the same decisions as a human. This means that the AI will make the best decision based on the incoming information it receives. By integrating this system, we can run a factory without humans. We also have immediate reactivity because the AI retrieves data in real time thanks to factory 4.0. The system is logically evolving. This means that it learns from past actions to better react in the future. The main challenge is to make companies even more efficient. In doing so, AI is a weapon against the competition.

The cause of all possible risk is the removal of any human action or control over an AI. We have 3 levels of risk. High risk with the most serious threats such as data hacking, data modification or taking control of everyday devices (car, plane, ...). Critical risk threats concern human security and integrity. For example, the takeover of military robots or drones for criminal purposes. Scams or Cyber-attacks on vital systems. While the weakest risks are poor judgement or choice of AI, system blockages in the face of a new situation, data exploitation.

Based on current research and based upon real-world experiments, the importance of the supply chain in any organization is acknowledged and the advantage of using ai is also widely known. However, the implementation of both at the same time is not developed. Thus, we can see a gap: **How AI impacts the process management flow?**

STATE OF THE ART

La gestion des flux et l'Intelligence Artificielle

In logistics, flow management is constituted of all the activities between the manufacturing and distribution process of a product. The supply chain is divided into 3 flows: the information flow, the physical flow and the financial flow.

The information flow enables the various activities in the supply chain to be forecast, anticipated and planned. This is to better channel the risks that may affect the system and cause unforeseen additional costs. Artificial Intelligence helps to revitalize the information processing system by identifying the important content from the superfluous. It makes forecasts more reliable. Let's take the case of raw material supply. A good number of companies in search of economies of scale prefer to export from LCCs (Low-Cost Countries) rather than buy locally or in neighboring countries. But this purchase involves consideration of cost and time factors. Are we going to buy low cost with a long lead time or buy a little more expensive with a short lead time? What, when,

how, where to buy? The decisions related to this questioning can be taken with Artificial Intelligence. Artificial Intelligence considers data factors such as need, purchasing power, personal data and customer experiences that feed the algorithms.

The physical flow is everything related to the movement of products. This includes processing, handling and storage. In a production plant, after manufacturing the finished products are put in stock and/or on delivery bays waiting for trucks for distribution to the different channels (short or long). In the case of Amazon, the pallets are coded. When the trucks come to unload the goods at the warehouse, normally it is the forklift drivers with the help of handling equipment who do the unloading and put the goods in the warehouse. Then robots pass under the pallet and scan it. Depending on the code read and the information stored in the system, the robot automatically knows where the pallet should be stored. AI thus saves time and money through good space management, data synchronization and the virtual absence of accidents. It improves customer satisfaction by optimizing reception, delivery and return times. We are witnessing the integration of human skills into AI, allowing it to make decisions like a human and without human intervention. It analyses the information it receives in its environment which allows it to automate and manage robots.

The cash-flow is everything related to cost along the supply chain. We see that AI enables process optimization through the analysis of tasks done by algorithms that allow the company to make savings, ensure customer safety in the purchasing process and make a predictive analysis of the market. AI is creating a new form of economy with the development of marketplaces that are progressively killing small businesses.

From the analysis of the 3 flows, we retain that good data collection allows to anticipate, optimize, and evaluate the risks inherent to the supply chain, both on physical and financial aspects.

THE 5TH INDUSTRIAL REVOLUTION

An industrial revolution is a major change in the way industry operates and processes. Each revolution is the result of the development of a new technique or technology. The first industrial revolution took place in 1765 with mechanical production. This production was made possible by the steam engine. The second revolution took place around 1870 thanks to the appearance of electricity and oil. The second revolution allowed for mass production. In 1969, the third revolution allowed the automation of production with the internet. It was supported by computer technologies. While the fourth revolution is the digitalization of production tools and systems. This revolution started in the 2000s.

Siemens

AI is at the heart of the concerns of researchers and industry. The company Siemens is interested in AI in industry. Since it wants to make actions of our added values into autonomous action, such as transport, quality and flow optimization. Siemens wants to integrate AI into their self-guided transport trucks as well as into quality control machines. Thanks to this AI, the systems automatically adapt, evolve and adjust to be more effective and efficient. Indirectly, this efficiency allows us to reduce our electricity consumption and we know the importance of human action on

global warming. Moreover, the Roland Berger firm has carried out a study on the financial importance of AI on industrial processes. By 2035, the digital networking of intelligent systems and process chains could generate some 420 billion euros of additional growth in Western Europe alone. AI could be worth more than \$15.7 trillions to the global industry by 2030.

Louis Vuitton

We also have Louis Vuitton working with AI on supply chain planning and agility. As Anne Borde, supply chain director, says, "In a VUCA world, you must be agile, by going for the shortest lead time. For example, without AI, it took 17 days to get sufficient data on a new product. But now, Louis Vuitton can do this in just 3 days thanks to AI. Thanks to digitalization, AI can develop exponentially. It can be used to analyze multiple criteria simultaneously. This makes it possible to determine sales with precision. In addition, Louis Vuitton is also working with researchers from the ENS and INRIA to develop machine learning. AI is also used to automate simple tasks and to allow humans to intervene only in the event of drifts or incidents. As Bruno Guilbot, who is head of data & artificial intelligence, says, "The success of such a project depends on the fact that we manage to link artificial intelligence and human expertise.

Automotive

Car manufacturers are interested in this new, still-blue market, which is autonomous vehicles that communicate with their environment. Hence the importance of having the 4th revolution in place so that AI can be exploited to its full potential, and this is not yet the case. This new mobility will revolutionize transport. It will start with multimodal transport and above all without hiccups or friction. Multimodal transport is transport that successively uses two or more modes of transport. There will therefore be an interface as an interlocutor. The AI will be able to analyze its environment in order to optimize its driving, its consumption but also to practice predictive maintenance. For example, the oil change to be done every 20,000 km or the change of brakes. The point that is as important as the others is the personalization of each vehicle with its passenger and not just its driver. An analysis of the passenger's tastes, choices and personality will enhance the user's experience. This is useful on long journeys. Then there is the development of car-sharing. This car-sharing will make transport routes more fluid and optimized. In some cases, they are limited. It should be noted that private vehicles are used on average 7% of the time over a year. This gain is therefore significant. This sharing will lead to an improvement in safety because it will no longer be passive but active with sensors and communications between network users. Accidents would be reduced by 65% thanks to this intelligent sharing.

Health

The field of health is also part of this new technology. The work of medicine is complex and at the same time complicated. AI aims to simplify the work of the medical profession. Whether it is about detection, structuring and protecting data. Because yes, patient data is sensitive due to medical secrecy and identity forgery. In the hospital, AI has two approaches. The first is logic-based (symbolic) while the second is data-based (digital). Symbolic AI is based on learning to

reproduce. That is, being able to reproduce the cognitive mechanisms of an "expert". Its reasoning is based on the body of medical knowledge in each field and a formalization of reasoning. Following this, it produces a diagnosis to help in the decision. So-called digital intelligence is pragmatic, it relies on data. It needs a large quantity of data to find a regularity and extract it. These AIs are deep learning algorithms. The system works like a brain with neurons that exchange with each other. The system learns like a human. By dint of repetition, trial and error, it will then determine on its own what to do. It is therefore said to be autonomous. For example, an AI that is capable of spotting melanoma in photographs or detecting diabetic retinopathy. For melanoma, the AI needs 50,000 images to learn to reliably detect a melanoma. For retinopathy, it needs about 128,000 pictures.

REVIEW

AI cannot work alone. It must have a source of tools that provide it with incoming data. Because without it, AI cannot make decisions. Car manufacturers will no longer sell a product in the fifth revolution. But they will sell a service, which is to get the customer from point A to point B. Many other areas of business will see their business plans change. The cause of all the possible risk is the removal of any human action or control over an AI. We have 3 levels of risk. High risk with the most serious threats such as data hacking, data modification or taking control of everyday devices (car, plane, ...). Critical risk threats concern human security and integrity. For example, the takeover of military robots or drones for criminal purposes. Scams or cyber-attacks on vital systems. While the weakest risks are poor judgement or choice of AI, system lockups when faced with a new situation, data exploitation.

The other dangerous point is the malfunction or bug of the AI. This can generate big problems in the flows and on the safety of the users or the environment. Secondly, the AI can be hacked by hackers to take control of the system. The biggest fear is the appearance of free will and that the AI decides to do what it wants outside its algorithm. In both cases, the risk is that humanity will become dependent on these intelligences.

SUMMARY

It is therefore imperative to complete the fourth revolution in the environment before implementing AI. Because without the digitization of data and the communication of it, AI is useless. The intelligence will communicate with humans the information we have requested to meet our needs. But also, so that the algorithm can function 100% in its environment and receive the right incoming data.

The processes will become dependent because artificial intelligence brings so many advantages. This is a danger, so passive and/or active security must be put in place in case of loss of control over AI.

The fourth revolution is on its way, but it is disparate across industries. That is why the fifth revolution has been initiated in the advanced sectors to meet needs and improve systems. But we must be careful not to implement AI before the systems are digitized.

As seen in our various articles, each field of activity or service has a very specific need. Therefore, each AI will have a different function and algorithm. As a result, 3 types have been created: artificial intelligence (mobile application), machine learning (Automobile) and deep learning (health).

From all the above we can conclude that a certain symbiotic relationship is being played out between Artificial Intelligence and the Supply Chain. Thanks to digital innovation, AI allows the synchronization of flow management. Nevertheless, the application of AI throughout the chain can pose many problems that should not be overlooked. First, we can list the respect of the privacy of people (both staff and customers) and companies, not to mention the issues of vulnerability of the system. It should also be noted that in the event of a system failure, the entire chain will be paralyzed. The other important aspect is the ecology, as we are witnessing a squandering of natural resources. This is justified by the spectacular development of industries and the development of high-tech solutions based on rare materials.

CASE STUDY

The future of sales forecasting and demand planning in the SCM domain by integrating artificial intelligence.

In the SCM domain, we are always linked to the customer's constraint, which makes our attachment to sales forecasting to meet the customer's need in a better time while optimizing our storage costs and resources.

This need led us to study the future of sales forecasting using artificial intelligence to better align demand with forecasting projections while anticipating resource shortages or constraints.

Machine Learning is a field of artificial intelligence research, based on mathematical and statistical methods, that allows computers to learn from data, i.e., without having to explicitly program each task, it can improve its task solving performance. More broadly, it involves the design, analysis, optimization, development, and implementation of such methods.

Machine Learning develops forecasting and planning of business operations in SCM.

German Drugstore Chain Müller selects RELEX to manage Forecasting and replenishment:

German drugstore chain Müller will work with RELEX Solutions, a unified retail planning solution provider, to use RELEX forecasting and replenishment software to optimize inventory management in all its stores. The RELEX system will ensure that the right products are provided in the right quantities at the right time, so that the retailer's customers are satisfied. Müller is a German drugstore chain founded by Erwin Müller in 1953, who is still the head of the company.

Müller has approximately 190,000 products covering all aspects of daily necessities and provides its customers with the largest pharmacy variety in Germany. Müller is always looking for a smart solution that can reduce inventory while ensuring high availability of products in all its 864 stores. After a trial phase that lasted for several months, Müller chose RELEX Solutions, which is known for its system flexibility and intelligence.

The configurable RELEX solution is based on artificial intelligence and machine learning technology and will provide automated, easy-to-configure demand forecasting for every retailer's store located in Germany, Austria, Switzerland, Croatia, Hungary, Slovenia and Spain. RELEX will provide daily order recommendations including holidays and promotions. The software will process data for approximately 35 million SKUs and provide retailers with fine-grained control based on individual SKUs, store types, and workday demand levels. Müller will initially implement RELEX in one store, and then gradually roll out the system to the rest of its stores.

Christian Remy, Chief Financial Officer of Müller, said: "As a retailer with a very diverse category, we need an intelligent system to support us in optimizing our processes and inventory while remaining flexible and easy to adapt." The results were very satisfactory. In addition, the strong support we received from the team allowed us to further cooperate with RELEX."

According to the example of the collaboration between Müller drugstore and RELEX solution, the need for AI in the logistics sector has become important due to the increasing competition and the requirement of customers to optimize their internal and external costs while respecting the environment and human beings.

Therefore, route planning can be executed and supported by route optimization technology. Route planning is done with the help of powerful optimization algorithms that allow to calculate efficient routes in terms of time, kilometers, or more generally operational delivery costs. The calculation of these routes must consider the constraints of quality of service (delivery time, etc.), working hours, vehicle capacity, etc.

This is a difficult problem because the number of possible solutions is almost infinite. In real situations, the age of the universe is not sufficient to test all possible routes. These algorithms can run in seconds or minutes.

The operating result is usually between 10% and 40%.

Machinery malfunction

The manufacturing industry has many aspects that AI can intervene in the optimization of the supply chain. The first example that comes to mind is the robot-driven assembly lines, but there's much more utility for AI in the manufacturing industry that meets the eye, such as intelligent systems that can predict the malfunctioning of machinery, thus making itself inevitable for the manufacturing industry in the future.

The monitoring of machinery is an essential task in today's production processes. This task is often performed by an operator or by a manufacturing executing system (MES) assisted by an operator. The problem with these methods is that they always rely on the operator, for the data entry, the validation of data, in addition to the fact that the only way to predict machinery failures is by having an operator who spent years and years beside that machine, which is something fewer companies get to have these days. All in all, the human intervention in data entry has always known a certain error degree, therefore, a new approach for fault detection and diagnosis in machinery is proposed through AI.

This approach can be alienated in three steps as mentioned in the paper about An Explainable Artificial Intelligence Approach for Unsupervised Fault Detection and Diagnosis in Rotating Machinery:

- Feature extraction: the vibration features in real time and frequency domains are extracted.
- Fault detection: the presence of fault is verified in an unsupervised manner based on anomaly detection algorithms. The modularity of the methodology allows different algorithms to be implemented
- Fault diagnosis: Shapley Additive Explanations (SHAP), a technique to interpret black-box models, is used. Through the feature importance ranking obtained by the model explain ability, the fault diagnosis is performed. Two tools for diagnosis are proposed, namely: unsupervised classification and root cause analysis. The effectiveness of the proposed approach is shown on three datasets containing different mechanical faults in rotating machinery. The study also presents a comparison between models used in machine learning explain ability: SHAP and Local Depth-based Feature Importance for the Isolation Forest

Through these steps we can get ahead of the problem and solve it before anything unpredictable can occur.

Many researchers are now relying on AI to better understand the sound patterns of troubled machines. Thanks to AI, they are enabling faster and easier problem detection, which can be helpful for many parts of the supply chain, such as the maintenance, the production, and the management.

CONCLUSION

All in all, there is a lot of potential for artificial intelligence in the supply chain industry. Even if the domain is already very advanced due to the industry 4.0, artificial intelligence offers solutions for problems that involves too many variables, something that couldn't been done by the advanced technologies that we already had in the field.

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