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Artificial intelligence – the Gamechanger in the automotive industry to counteract material shortage in a crisis

Thomas Solderits¹

ABSTRACT: This paper researches the hypothesis: Artificial intelligence can counteract material shortage, caused by a crisis in the automotive industry. The methodology of the article is a literature review of the state of the art of artificial intelligence and the possible impact of artificial intelligence in a crisis as well as interviews with experts and executives from the automotive industry. The research results show that with the help of artificial intelligence, a crisis can be detected at a very early stage and serve as the basis for early warning systems to counteract the crisis and its consequences.

KEYWORDS: leadership, artificial intelligence (AI), corona crisis, automotive industry

JEL Codes: I15, F60, F61, H12, I12

Introduction

Intel, the American chip-maker, has outlined plans to spend US\$20 billion to build new plants in Arizona. But that is less than the US\$26 billion that Intel spent on share buybacks in 2018 and 2019, money the company could have used to expand capacity – titled the New York Times (Goodman–Chokshi, 2021).

The Journal Automotive Logistics featured the headline “Material shortages are forcing a supply chain rethink in automotive”. Governments are increasing scrutiny across the supply chain and adopted a draft Supply Chain Act to ensure that companies are compliant with ethical legislation, including human rights across global supply chains (Chow, 2021).

The crisis has been going on for 2 years now and material shortages of electronic components as a consequence of the COVID-19 crisis are still causing a serious problem in the automotive industry in many current supply chains. Manufacturers are working on minimizing the risks and

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expanding production to multiple lines and countries. Another consequence of counteracting the shortage of materials on the customer side are larger inventories and multiple source supply. But can suppliers and customers afford this in the long term, or is the cost pressure so high so that once the crisis has subsided, cost savings are the top priority, ahead of risk minimization?

Artificial intelligence (AI) has already arrived in the industry and the possible applications are almost limitless. The automotive industry, its managers and leaders have long understood that AI can not only make decisions accurately and sustainably, but also that "big data" and very fast calculations would not even be possible without AI. But can AI also counteract a crisis and its consequences or are the expectations of this new technology too high?

The methodology of the article is a literature review of the state of the art of artificial intelligence and the possible impact of artificial intelligence in a crisis, as well as interviews with experts and executives from the top ten companies in the automotive industry (Kords, 2022). In the research for this paper it was discovered that making fast and reliable decisions is actually the supreme discipline of AI and there are already numerous existing applications.

The result of this scientific research is unequivocal and the hypothesis is supported: Artificial intelligence can detect a crisis at an early stage and counteract the crisis as well as its consequences like the material shortage in the automotive industry.

Artificial intelligence, current state of the art

AI has been around for less than a century as a technology. In spite of this, it has made significant progress. The quick advancements in this sector have piqued the interest of many technologists throughout the world, and many firms from many industries, as well the automotive industry, are eager to learn more about its possibilities. For a science that has accomplished so much in such a short period of time, it is critical that persons interested in working in Artificial Intelligence examine the field's roots, current breakthroughs, and future growth potential to obtain a better understanding of the area.

Prasad and Choudhary (2021) summarize in their research the significant developments achieved in Artificial Intelligence in numerous disciplines, from its conception to its current condition and future prospects. It includes topics such as the turing machine, the turing test, historical breakthroughs in AI, expert systems, big data, robots, current developments in AI across numerous domains, and future research potential.

Until a few years ago executives and managers in the automotive industry were convinced that the experience and judgment of an expert could not be replaced by any machine in this world, however large, complicated and expensive, but the question “Can a machine judge?” is probably the wrong question.

At the IEDC conference, Daniel Susskind (2018) spoke about “Artificial Intelligence and its impact on leadership” and explained this question by asking two counterquestions. “What do people expect from experts?” When facts are unclear because the available information is insufficient or inaccurate, people do not know what to do and trustingly turn to experts. The experts then judge on the basis of experience in their respective fields. The second question is not whether machines are capable of judging, but whether they can deal with these uncertain facts better than an expert. In most cases, this question is answered with a clear “yes”, because that is the strength of the AI, the handling of large amounts of data in a very short time.

Based on a dermatological example, the researcher explained how a computer can assess a photo of a freckle with even better accuracy as renowned doctors. Because the machine does not know anything about medicine, the process underlying this system does not designed to mimic a human doctor’s choice. Instead, it employs a pattern recognition algorithm to explore a library of thousands of photographs for correlations between the images and the target image. This is a thorough examination of much more instances than any human doctor could reasonably deal with in a lifetime. It does not matter if a human doctor is unable to articulate how a patient is diagnosed; a computer can do it in a different way (Susskind, 2018).

The report “Artificial intelligence for decision making in the era of Big Data – evolution, challenges and research agenda” identifies the issues related to the usage and effect of reinvigorated AI-based decision-making systems, as well as a series of research recommendations. It covers AI for the so important area in the automotive industry, the decision-

making in general, as well as the specific concerns surrounding the interaction and integration of AI to help or replace human decision-makers. The study proposes twelve research suggestions in terms of conceptual and theoretical development, AI-technology-human interaction, and AI implementation in order to promote research on the use of AI for decision-making in the age of big data. The article in the *International Journal of Information Management*, confirmed the great advantage of AI in the decision making process, especial in the area of big data analysis as in the automotive industry (Duan–Edwards–Dwivedi, 2019).

The effect of COVID-19 on the automotive industry

Without the many Chinese manufacturers of components and semiconductors, the global automotive industry would simply be unthinkable. The Corona crisis not only had an enormous impact on the automotive sector, but on all sectors of the economy – worldwide. Securing a high level of supply chain performance is a demanding endeavor – even in a perfect environment. Balancing competing interests, coordinating raw material supply and information flow, collaborating with partners, and forging and sustaining a trusting relationship are difficult to do in order to satisfy client requirements.

The latest outbreak of COVID-19 permanently changed the entire supply chain and the value added activities of supply chains are becoming increasingly more important. In a situation like this, the inventory and organizational method is crucial to preventing a production stop at the end of the supply chain at the customer.

The reaction to the crisis

The first logical reaction to the impending crisis in the automotive sector were additional orders to secure inventories and avoid material shortages, as the experts expected the crisis to end quickly and believed that the problems were only short-term. However, since many companies tried to secure production by ordering additional material, the manufacturers very quickly reached their capacity limits. In addition to these challenges in production, there was the problem of logistics, as flights were cancelled to counteract the spread of the virus and the materials could not be delivered to the customers, even if the problem of multiple orders could be solved by sophisticated risk systems.

The changes in Asian transportation cost and transportation time increase are listed as follow (Pato–Herczeg, 2020):

- Road freight – cost increase 50% to 300% – transport time depend on infected area.
- Rail freight – cost increase 20% to 100% – transport time increase 50% to 150%.
- Sea freight – cost increase 0% to 50% – transport time increase 0% to 50%.
- Air freight – cost increase 100% to 500% – transport time increase 100% to 600%.

In the future, it will be necessary to review the status of suppliers and consumers, as well as the flexibility of the organization's long-term strategy, in relation to the economic outlook. Precautions must be taken to select optimal stock levels to respond to major fluctuations. Based on past experience, it is difficult to prepare for such large economic shocks. In order to maintain production processes while keeping stock levels as low as possible, proactive planning is required. It is important to build flexible organizational structures in order to be able to react very fast to changes (Pato–Herczeg, 2020).

Wu et al. (2021) publication conducted an empirical analysis of the structure of the global electronic components market and examined supply and demand in the market. The analysis showed that:

- Anti-pandemic measures and reallocation of market resources are the short-term variables unbalancing supply and demand.
- The global shortage of electronic components is expected to continue, which increases the risk of a break in the industrial chain, because it is a long industrial chain that depends on effective cross-border cooperation, but there is no international prevention and control system.

Both publications, the article by Pato and Herczeg (2020) and by Wu et al. (2021) expressly point out that future effects of crises, especially those of material shortages for electronic components in the automotive industry, can only be dealt with by very close cooperation between customers and suppliers – a fast and efficient reaction from the whole supply chain is essential.

Interview about the impact and the reaction in the crisis

In addition to the literature research on the current state of AI and the problems in material logistics caused by the COVID-19 crisis, interviews

with specialists and managers from the affected area in the automotive industry are an essential part of the methodology of this work. In this way, what is “read” in the literature can be confirmed by the “affected” experts and the problems can be described in more detail from them.

The interviews were done from the author, who is working in a manager position in the automotive industry, conducted with executives and managers, affected by the material shortage in this industry branch. Since the crisis was not predictable by anyone (and is still ongoing), several strategies were developed and implemented in the automotive industry. In order to show this process, the interviews are presented in chronological order. The partially contradictory strategies correspond to the crisis and the constantly changing circumstances – this is intentional and should reflect the many changes of directions and updates in the strategies to fight material shortage. The following interviews were done in one of the top 6 companies globally (Kords, 2021) with managers and leaders with at least the responsibility of an area (EU, ASIA or NAFTA). In order to better illustrate the extreme scope of this impact, the original text from the interview was transcribed word for word as far as possible – presented in italics – and only small summaries were transcribed in a compressed form by the author – in standard font.

January 2020

Interview with the Head of purchasing Europe: *“We are aware of the crisis in China and have already counteracted this with increased call-off numbers for electrical components. Furthermore, we have secured contracts with the suppliers that guarantee us the ability to deliver”*. At that time, the suppliers still confirmed the requested quantities of the call-offs.

March 2020

Interview with the Head of Hardware Europe: *“The strategic purchasing department contacted us that they shift to second source in Europe and NAFTA as some components from China are not available. We have a sustainable second source strategy, which means, during the development process we already validate critical components from several suppliers for of the product. So now we have the ability to change the supplier in short notice to keep the production running”*.

April 2020

Interview with the Head of purchasing Europe: *“We have problems to get to the second source because the majority of the production of*

electronic components in China is affected by the crisis and other companies in the automotive sector are also increasing call-offs. On top of this problem, many flights are blocked and urgent deliveries will soon no longer be able to meet the orders”.

October 2020

Interview with the Head of Hardware Europe: *“We have already had line stop in the production and nearly all customers needed to ramp-down their call-offs. In our department, we start the first re-designs of our products (mainly high runners) in order to release suppliers for new components, which are available on the market. This process is very time consuming and financially expensive”.* The situation was no longer sustainable and the entire industry sector had to adapt. This means that some products with electronic components were produced with the second source parts, but for some products it was even necessary to choose new manufacturers and suppliers, re-design the hardware, adapt the software (especial for micro controllers and other semiconductor elements) and to validate the products with these components.

February 2022

Interview with the Head of Equipment and Manufacturing global: *“We are still in a very turbulent time; Nothing is as certain as uncertainty! We have already had to postpone ongoing development projects to respond to the shortage of materials to re-design current products to get deliveries to the automobile manufacturers back in to bring the agreed call numbers. New developments such as high performance computers, where the autonomous driving logarithm is calculated, are affected and will be delayed”.*

Interview with a global acting Project Director: *“We calculate per product with costs in the range of up to € 300,000 for standard components and up to € 600,000 for the re-design of micro controllers.”*

As noted prior to the interviews, the survey was conducted in one of the largest global suppliers in the automotive industry, which means that the cuts in small companies are even greater and some companies already are, or will go bankrupt.

Crisis management using artificial intelligence

The German Federal Ministry of the Interior defines a crisis: “In the public perception, the concept of crisis is closely linked to the concept of catastrophe. According to the relevant laws of the federal states, a catastrophe is usually defined using two conceptual elements: First, there is an event that endangers or damages the life or health of numerous people or animals, the environment, significant property or the vital supplies of the population. Secondly, the defence against and combating this event requires uniform management by the competent (disaster control) authority. Catastrophes and major damage events are therefore also crises in the sense of the guideline” (German Federal Ministry of the Interior defines, 2014).

The following two subchapters are divided into how artificial intelligence can already support before a crisis – in the sense of situational awareness – as well as possible crisis management when the crisis has already arrived.

The possibility of AI-support in pre-crisis

“Situational awareness” is a critical disaster response process that gives tactical information to first responders during and after disasters. Technology may assist in obtaining the essential situational awareness, which can then be utilized to make practical, life-saving decisions in the event of a catastrophe. Following an earthquake or flood, for example, these considerations can involve evacuating the most dangerous areas or assessing tactical options for deploying crucial resources like medication, food, water and another necessary expedients. Scientists are concentrating their efforts on enhancing how computers can assist and optimize situation awareness systems utilizing artificial intelligence, which can also support in case of material shortage in the automotive industry by early warning.

Mayank Kejriwal (2019) is a major researcher of the University of Southern California on the project THOR (Text-enabled Humanitarian Operations in Real-time) project. The LORELEI (Low Resource Languages for Emergent Incidents) aims to build capabilities for low resource languages that are less generally spoken; human language technology is often built for widely spoken languages like English.

The situation awareness system THOR is based on open-source technology. During a crisis, Twitter, Facebook and other text messengers provide a fast source of data, and multidisciplinary AI research is developing

a platform for information, which can be adapted to different areas – also for the automotive industry – to identify and address critical situations utilizing this data. Due to the availability of public data and its real-time use, that data serves as a significant avenue for crisis informatics, in the private sector, as well it is possible to adapt in all areas of industry branch. Many people with phones may send messages about their present situation during a humanitarian crisis, reporting on topics that are of urgent relevance to their well-being. Even if they carry a relevant hashtag (a keyword or topic label), some messages may be useless because the body of the message lacks data directly related to the event; other tweets may be pertinent but have strange spellings or utilize idioms. The quick deployment of assistance necessitates the identification and sorting of the 'corpus' or body of data in real-time. Clearly, humans would be unable to do this activity without major assistance, and here is where AI-technology advancements come in. Algorithms extract key signals or data pertaining to places and person names, which may subsequently be used to route resources to victims and rescuers. The method guarantees that limited cognitive and physical resources on the ground are used to their full potential to control risk and hazard. Importantly, these communications may be categorized by urgency, allowing assistance to be directed to the places that are most in need (Kejriwal, 2019).

The THOR AI can support natural disasters such as floods, fires, storms, but also mass shootings and major accidents, with the use of time-sensitive social media data and can support crisis management by helping victims and signaling the presence of risks. After further development, the THOR system is also able to detect abnormalities in long-term changes, such as the beginning of possible epidemics like COVID-19 crisis and can support in that way to find strategies to counteract material shortage in the automotive industry. With that system there would be an early warning system, not only for the automotive industry, but for all areas affected by the crisis – in the private, as well the working world.

Crisis management in the crisis

Smart cities support the integration of traditional urban infrastructure with information technology to improve the city's quality of life and provide long-term urban services. It requires collaboration between the public and commercial sectors, as well as collecting and analyzing large amounts of data – the perfect job for the AI. In addition, smart cities (also based on

artificial intelligence) need systems to manage crisis scenarios in health-care. Authorities need to pay better attention to individuals in times of health crises in order to provide competent services. On social networks, sentiment analysis can provide useful information about public opinion about government actions. Against this background, this study by Hilal et al. (2021) present a novel AI-based tool for crisis management in health-care in smart cities. This research has created a novel approach to identifying people's emotions during healthcare crises. Pre-processing, feature extraction and classification are part of this approach. The methods used to pre-process the Twitter data are noise removal, tokenization, normalization and stemming. After pre-processing, the input tweets are fed into the model for feature extraction and using Twitter data to validate the relevant sentiment class labels and score the results against a variety of metrics. The experimental results showed that this approach outperformed current state-of-the-art techniques and can be further improved in the future by integrating feature selection and outlier detection approaches (Hilal et al., 2021).

Just with simple and small adaptations, this system could support also the automotive supplier industry during a crisis by using the same model. In general, this example in healthcare shows that AI can be used to connect the information from different network together – even it seems there is no value add in the first view, like the health care sector and the automotive sector.

Result and Interpretation

With the work of Kejriwal (2019) and his THOR project, it is possible to recognize a crisis at very early stage, to counteract material shortage in the automotive industry. The interviews from the affected automotive industry in chapter 4.2. once again confirm how important a quick response and sophisticated logistics strategy is.

With the approach of Hilal et al. (2021), authorities can use sentiment analysis to better care for individuals in times of health crises in order to be able to provide competent services and thus get the crisis under control or end it as quickly as possible. This further supports the scientific results of Pato and Herczeg (2020) to counteract the effect of the delay in delivery and the increase in material prices in the automotive industry in the

COVID-19 pandemic, as well as the work of Wu et al. (2021) to minimize the risk of disruption in the automotive supply chain.

With these references, the hypothesis is supported: Artificial intelligence can counteract material shortage, caused by a crisis in the automotive industry.

Conclusion

Artificial intelligence can counteract material shortages caused by a crisis, in two areas:

- to recognize a crisis at an early stage in order not to let it arise in the first place or to keep the effects of a crisis in the automotive industry to a minimum;
- in a crisis, to provide people with better and competent services in the automotive industry and thus get the crisis under control and end it as quickly as possible.

The AI algorithm from the early warning system THOR has been optimized for natural disasters (e.g. earthquakes, floods or fires). The researchers can also optimize the system for epidemics such as the corona crisis in a very short time to recognize Corona clusters in the early stages and show ways of counteracting them to support material shortage in the automotive industry.

There is such a complex world that future crises and their effects cannot be foreseen at this time. Who would have thought that a speculatively bloated real estate market (real estate bubble) in the USA would result in a global economic crisis? Also nobody could foresee the consequences of a virus that broke out in Wuhan in 2019 and shook the whole world in terms of health and economy ... and is still ongoing with consequences that will last for years.

The advantages of AI is exactly this adaptability and big data handling in real time, so researchers all over the world are confident to counteract future crises with this technology. It is up to governments to unlock the enormous potential of artificial intelligence and adapt data protection regulations so that this enormously important data can also be used for such systems.

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