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## ***Editorial Words***

*Dear esteemed readers,*

It is my great pleasure to welcome you to the latest edition of ASEJ, the academic journal that brings you the latest research in the fields of law, economics, logistics, finance, psychology, criminology, computer science, and security. This issue features a diverse range of articles from leading experts in these fields, showcasing their latest research and insights into current trends and challenges.

As we continue to face unprecedented challenges and rapidly evolving technological advancements, it is more important than ever to stay up-to-date with the latest research and trends in these fields. This issue of ASEJ offers valuable insights and perspectives that are essential for anyone seeking to stay at the forefront of their respective disciplines.

We would like to take this opportunity to express our sincere gratitude to the authors for their hard work and contributions to the advancement of knowledge. We would also like to acknowledge the invaluable support of the Bielsko-Biala School of Finance and Law for their continued commitment to publishing this journal, which serves as a platform for the exchange of the latest knowledge and insights.

Virtual reality (VR) technology has been advancing at a rapid pace, and with its growth come a range of challenges in various fields, including economics, law, security, and computer science. In the realm of economics, one challenge is determining how to integrate VR technology into existing business models. VR has the potential to revolutionize the way companies conduct business, but it also requires significant investment and infrastructure to do so. Additionally, there are concerns about how VR will impact the job market, as it could potentially eliminate the need for certain types of jobs while creating new ones in the VR industry.

In this issue, we also explore the growing significance of virtual reality in law, economics, finance, and security. As VR technology continues to evolve, it presents both opportunities and challenges in these fields. For example, in economics, VR has the potential to revolutionize the way businesses operate, but it also requires significant investment and infrastructure. In law, the use of VR raises important questions around data protection, privacy, and intellectual property rights. In finance, VR can be used to enhance customer experiences and provide new insights into investment opportunities. In security, VR presents new risks and challenges, such as ensuring the safety of users and protecting sensitive data from cyber threats.

We hope that this issue of ASEJ will prove insightful and informative for our readers, and we look forward to your feedback and contributions in future editions.

Sincerely,

*Dr Muhammad Jammal*  
*Editor of the ASEJ, Issue 4, Volume 26, 2022*

# Digital transformation in the automotive supply chain: trends and cases

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**Abstract**— Logistics system efficiency has a major impact on the level of the country's economy, thus the area deserves special attention. The New Reality of the Next Decade (VUCA) characterizes the modern market by the following features: volatility, uncertainty, complexity and ambiguity. Besides, the trends already formed in such conditions are specifically exacerbated and emphasized. Two main ones among those for the global logistics area include digital and sustainable supply chain. The automotive industry has a leading role in the world economy, so it has a direct impact on its development. The article considers current state and up-to-date digital solutions targeted at the industry. These topics are going to be covered by the main directions of digital transformation overview, in-depth explanation of their importance for the success along with some practical examples presentation for the cases of automotive industry digital transformation

**Keywords**— Supply Chain Management, Digital technologies, Digital Logistics, Automotive industry, Automotive supply chain.

## I. INTRODUCTION AND ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS.

There is a radical phase of transformation happening for the whole economic world. The digitalization of all industries is considered as a driving force behind these changes. Thus digitalization may be referred to as one of the main factors in the growth of the world economy in the coming years. DHL Innovation Center (2021) identified 5 main logistics trends where digitalization is ranked among the firsts. The key digital trends include:

- data becoming the main source of competitiveness;
- Internet of things (IoT) development;
- digital transformations of both individual businesses and entire sectors;
- sharing economy;

- IT systems physical infrastructure virtualization;
- Artificial intelligence;
- Digital counterparts;
- Real-Time Supply Chain Visibility;
- Warehouse Robotics;
- Digital platforms.

Digital technologies enhance companies with a direct increase in productivity, as well as a chain of indirect benefits of digitalization including time saving, creating new demand for new products and services, improved quality and value, etc. Digital technology is characterized as a critical catalyst for change in recent years and one of the most destructive trends in logistics. Digitization is the logistics industry evolution. The digital transformation entails a paradigm shift, corporate culture along with work approaches change, as well as a formation of the company's life cycle.

An issue of a digital transformation in the automotive supply chain has received the scientists' attention in recent years. Digital transformation is considered a technological change (Bajgar et. all 2019). The research (Krykavskyy, Pokhylchenko, Hayvanovych, 2019) presents a conceptual transformation for supply chain influenced by digital transformation. Current trends and requirements of SCM are outlined, digital transformation impact on the strategic and operational levels of the classical management model is characterized, and Ukrainian enterprises readiness for implementing digital transformation into their activities is compared with similar abroad companies. Digital transformation of supply chain management enables companies to become competitive, use their resources more efficiently, make each stage of the supply chain more transparent, efficient and closer to customer needs (Özkanlısoy, Akkartal, 2021). OECD (2019) outlines the impact of digital transformation in different segments – corresponding similarities and differences. Industries under



consideration: agro-industry, automotive and retail. OECF proposed to identify specific indicators needed to assess the impact of digitalization on the economy and society. In particular, the effect of digitalization under different rates of digital technologies implementation in this supply chain, for different segments, different company sizes in different countries is analyzed (OECF, 2019). Researchers consider investment issues in their publication (Kern, Wolff 2019), give investment examples made by car manufacturers and suppliers to maintain the efficiency and further development of automation for their production and supply chain processes. The research (Russo 2019) for automotive industry of China, Germany, Italy and Japan will help to identify key challenges for digital transformation for European countries, which will include a closely interconnected supply chains both within Europe and beyond. The paper (Ramanathan 2021) aims at characterizing the digital supply chain (DSC) technologies role for the automotive supply chain reliability (SCR) for improving the supply chain performance (SC-Perf.) for companies operating in the automotive industry. This study also compares the results of SC-Perf-related targets before and after blocking caused by COVID-19 pandemic outbreak.

The digital transformation in the automotive supply chain problem proves to be relevant but requires more detailed recommendations.

## II. THE AUTOMOTIVE SUPPLY CHAIN

Currently, the supply chain for motor vehicles is in decline. Although supply chain problems affect virtually every type of product, supply or raw material worldwide, the global automotive supply chain is one of the most affected. Supply chains for cars are one of the most complex supply chains in the world; each vehicle contains more than 20,000 parts from thousands of different suppliers located throughout the world. Organizing individual parts movement around the world is a difficult task for the automotive industry. Almost 78 million motor vehicles were produced worldwide in 2020. Given this figure alone, we will get a decrease of about 15 percent compared to last year.

The automotive supply chain is struggling with chips shortage since 2019. This challenge has made it impossible for producers to keep up with consumer demand. As manufacturers continue to look for materials and parts such as semiconductor chips, many automotive assembly lines have experienced a series of shutdowns through the course of the past year. Production is projected to fall to its lowest level since 1982. Automakers worldwide will lose more than \$ 210 billion in revenue this year due to these supply chain problems.

In a period between January 2020 and January 2022, prices for used cars increased by more than 40% emphasizing the pandemic effect on the market of used cars. The constant shortage of new vehicles is one of the important factors in increasing demand.

It is worth mentioning that in February-March 2022, global

automakers will stop Russian plants and sales due to sanctions imposed on Russia after its invasion of Ukraine. After the pandemic and global shortage of chips, the Russian-Ukrainian war caused the third supply chain crisis in the automotive industry. Fighting in Ukraine has led to small but very important industrial suppliers and factories closure far from the conflict zone, as sanctions and blocked trade routes hamper the cars and spare parts supply to and from Russia. Renault SA, which owns AvtoVAZ, which produces Lada, and Volkswagen, which owns brands such as Audi, Skoda and Porsche, have stopped working in Russia. International automakers such as Toyota Motor Corp., Ford Motor Co., Hyundai Motor Co. Ltd. suspended their activities in Russia. This was produced another blow to the entire supply chain within automotive sector, following the global semiconductor crisis and the coronavirus pandemic.

## III. DIGITAL TRANSFORMATION IN THE AUTOMOTIVE SUPPLY CHAIN: TRENDS

The automotive supply chain demonstrates its adaptability in crisis times. There is a trend in the automotive market, which is called C.A.S.E. (Connectivity, autonomy, sharing/subscription and electrification), which continues its development due to digital technologies introduction. Top 10 trends in the automotive industry (Research Blog, 2022):

1. Autonomous Vehicles (AVs)
2. Vehicle Connectivity
3. Electrification
4. Shared Mobility
5. Artificial Intelligence
6. Big Data & Analytics
7. Human-Machine Interfaces
8. Blockchain
9. 3D Printing
10. Internet of Things

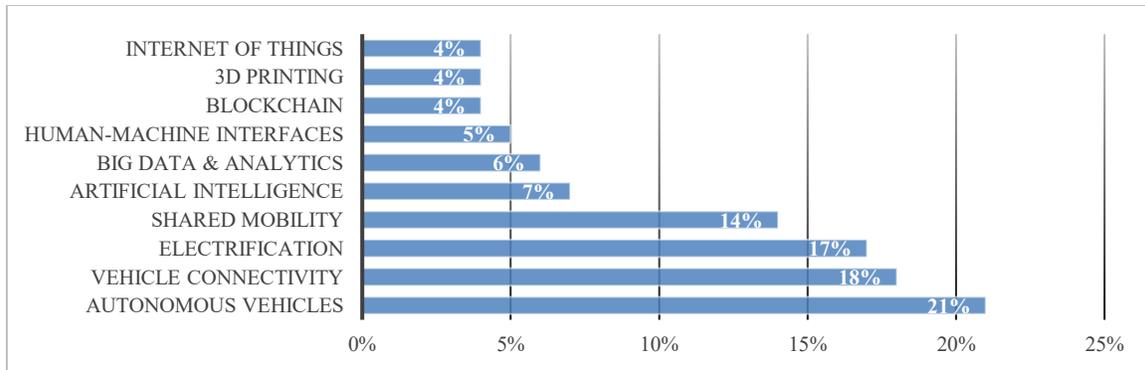
Figure 1 depicts the impact of these technologies on the automotive company.

**Autonomous Vehicles.** This technology is developed progressively, but testing and improving algorithms is a big problem in this process. Safety standardization is also a barrier, as regulatory components lag behind technological innovations, and thus delay the launch of self-driving cars. Functions of low level autonomy (such as active safety systems) are being actively used in the automotive industry, but high level autonomy (such as cars that can operate without human intervention or supervision) are still years away.

**Vehicle Connectivity.** As 5G capabilities are slowly evolving and 6G research is already underway, vehicle connectivity has been touted as a defining automotive trend for many years. Studies forecast 90% of all new vehicles in the United States will have built-in connectivity by 2023.

**Electrification.** Companies like Tesla have proven that electric cars can gradually replace conventional fuel vehicles in the coming decades.

FIGURE 1. IMPACT OF TOP-10 AUTOMOTIVE INDUSTRY TRENDS IN 2022



Source: author's grouped based on Research Blog, Top 10 Automotive Industry Trends & Innovations in 2022

Factors contributing to electric vehicles growth: reducing the gap between the initial cost of electric vehicles and traditional vehicles with internal combustion engines, lower battery prices, increasing fuel costs. Electric cars are going to exceed the number of traditional vehicles by 2030 according to experts.

**Shared Mobility.** New business models have emerged that focus on shared mobility as an alternative to traditional vehicle ownership. This ensures mobility as a service, so such solutions improve the mobility of the city or business. This trend results in a reduction in fleet waiting times and a reduction in pollution caused by petrol or diesel vehicles.

**Artificial Intelligence.** This technology has a significant role in the automotive value chain. AI is now being implemented in the automotive industry to improve the creation process, supply chains, production and after-sales service. Besides, AI is being implemented in driver assistance and driver risk assessment systems, transforming the transport sector. After-sales services, such as forecasting and insurance, are also being transformed through the use of AI.

**Big Data & Analytics.** This technology allows you to make different decisions throughout the life cycle of the car. Data collected from vehicles allow to forecast maintenance and notify the relevant authorities in case of accidents. Customer data is used to increase sales, optimize supply chains and improve product design for new vehicles.

**Human-Machine Interfaces.** This trend allows drivers and passengers to interact with their vehicles in a much more natural way: with touch screens and buttons in the car, rotary controllers, scroll and gesture functions and even speech recognition technology. These functions ensure safer driving without distractions, as well as make job involving car usage much more pleasant experience. Such personalized features create synergies between driver and vehicle and increase trust in the car brand.

**Blockchain.** This technology is already used by several car companies to exchange data, including to test their supply chain. Self-driving cars can access critical traffic data with increased accuracy through blockchain in the future. Blockchain can also simplify the task of paying for driving, such as tolls or repairs and insurance.

**3D Printing.** This technology is used for rapid prototyping, as well as for the production of tools and, in some cases, final

parts. The range of automotive 3D printing capabilities continues to expand and is used by companies to improve their production processes.

**Internet of Things.** Mainly this technology provides a secure connection between vehicles, as well as vehicles and infrastructure components. Technology improves road safety, solves road congestion and reduces pollution and energy costs through better fleet management.

From year to year, the trend of increasing digitalization will continue to have a decisive impact on the mobility industry. Advanced technologies described above become more accessible and prove that their use in vehicles can increase both safety and comfort.

#### IV. DIGITAL TRANSFORMATION IN THE AUTOMOTIVE SUPPLY CHAIN: CASES

Processes analysis for the companies that successfully implement digital technologies in their activities requires special attention. ARC Research Center highlights the top 25 industrial companies that succeed in integrating digital technologies into all areas of business resulting in a radical change for the way they work. Leaders of digital transformation represent various industries (Fig. 2).

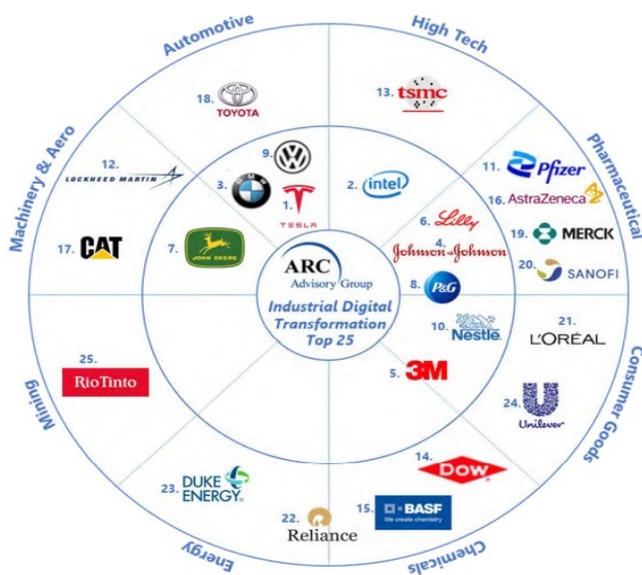
The automotive industry is represented by four companies: Tesla, BMW, Volkswagen, and Toyota Motor. These companies are demonstrating considerable progress in implementing technologies to achieve business results. There is no universal strategy or action plan, but these companies are demonstrating full use of their digital resources and capabilities. The table (Table 1) presents the set of indicators companies were evaluated against and the rating was created over.

What makes these companies true leaders in digital transformation? The answer to that question may be given by considering in detail experience for each of them.

Founded in 2003, Tesla aimed to create something new in the field of automotive engineering with several digital strategies. Tesla's mission is to ignite interest in electric vehicles. We are already seeing progress in 2022, but it is happening so fast that it surpasses the current capacity of the supply chains. This is a company demonstrating confidence in the effectiveness of

digitalization since the beginning of its existence and quickly adapts to new business challenges. Their business model assumes value in the first stage of creation. This means that when Tesla is going to optimize its internal processes, they try to build the best version from the beginning instead of starting and improving the process on version 3 or 4. This approach is fundamental in identifying key performance indicators. Tesla stated a record net profit of 1.62 billion US dollars in the third quarter of 2021 against 331 million for the same period last year. This figure is the result of improved sales in the company's electric cars, which increased by 30.5%. The company noted at the same time, that the shortage of chips in the world remains a challenge for Tesla. The company has invested heavily in Digital Twins technology to provide the best service and reliability for car owners. Tesla creates the digital twin of every car it sells. Sensors from thousands of cars continuously transmit data to the simulation of each car in the factory, where artificial intelligence interprets the data and determines whether the car is working properly or needs maintenance. Tesla software integration is so thorough that problems can be fixed with software updates for many maintenance problems, such as adjusting the hydraulics to compensate for door slams. Through the combination of artificial intelligence and the Internet of Things, Tesla can constantly learn in the real world and optimize each of its cars individually in real time. This data-driven software development process provides a more efficient allocation of resources and a much better user experience for the vehicle owner.

FIGURE 2.TOP-25 INDUSTRIAL DIGITAL TRANSFORMATION



Source: ARC Industrial Digital Transformation Top 25

ReportBMW's digital strategy is a holistic approach. Cars are going to be autonomous soon, and BMW products are increasingly becoming digital services. There are programs providing possibility to integrate various products, such as a smart home. Also, production lines and plants are becoming more digital as big data is used to increase production accuracy.

BMW has more than doubled its revenue before the 2021 pandemic to 16 billion euros (\$ 17.67 billion). Higher prices and strong sales of high-end cars have increased revenue despite supply chain constraints. The automaker having a record 2.52 million cars sold last year despite a semiconductor shortage, reported a profit of 10.3 percent for the year, the highest since 2017. However, interest income and taxes (EBIT) in its automotive segment fell 4.2% in the fourth quarter as global chip shortages, which BMW has so far outperformed its competitors, led to a 14% drop in shipments. The new sales and marketing strategy envisages that BMW will build on the contactless sales processes developed in 2019 during the pandemic. The digital system allows the company to target customers with great precision. BMW customers can buy customized cars and deliver them home entirely online. However, the company claims its dealer network will still play an important role in sales and service. BMW has also expanded the range of car features available as a digital after-sales update. Features such as driver assistance systems, lighting and sound packages and even suspension settings can be adjusted with digital upgrades. Customers will also have the opportunity to share their personal data with the BMW Group to optimize their experience. This will provide capabilities of using a mobile phone as a car key and integrating Amazon Alexa with client's car.

Volkswagen is guided by the strategy "NEW AUTO - Mobility for Future Generations" in its activities, which aims at radical changes in cars by 2030: the focus will be on electric drive, connection and autonomous driving. Volkswagen invests around €27 billion in digitalization of products and corporations by 2025, creates new digital jobs and improves working methods through IT solutions. They use a vision computer to increase the efficiency of production at their plants, which allows them to obtain information from optical data at the plant and with the help of artificial intelligence to evaluate, analyze and thus reduce energy costs. A standard platform for communication between plants, suppliers and logisticians has been introduced in Europe. The system has eliminated some of the manual work in the logistics network; supply chain staff and logistics service providers no longer have to rely on emails, faxes or phone calls to confirm readiness or shipment status. Also, some plants in the network use a "list of critical parts", which provides a real-time indication of how long the plant can continue to operate, using the stock of components that it has in place. If an incoming shipment is delayed, logistics personnel can use the list to see if the delay could affect production. Volkswagen can also use its detailed logistics data at a more strategic level, namely to optimize routes and cross-dock designs to improve vehicle utilization. Volkswagen is becoming a tech group and will continue to offer its customers everything they need starting from hardware along with software and services. Volkswagen Group continues to expand its competence in digital transformation and develop software mainly for digital ecosystems and internal corporate processes.

"Quality in all aspects" is Toyota's guiding principle. They often refer to the Japanese concept of doing business, which means being the perfect host, anticipating and respecting the

needs of visitors to make their communication with Toyota easy and enjoyable. Toyota began developing a set of core digital standards in 2015 to provide recommendations for quality maintenance. Supply chain management processes have been transferred to the cloud to increase efficiency. The company staff uses Dynamics 365 Finance and Operations, Dynamics 365 Sales i Dynamics 365 Marketing. Currently there is a SharePoint Online portal, which stores the necessary information in access for dealers instead of exchanging

information via e-mail. With Power BI, Power Apps, and Power Automate, reports are generated automatically - what took 2-3 days previously can now be done with a single click. The modern driver aspires to become the owner of the car which would meet requirements of a new smart-lifestyle and advanced quality levels. Toyota introduces self-charging gasoline-electric hybrids that correspond to modern efficiency, reliability, and progressiveness standards.

TABLE I. INDICATOR OF TOP AUTOMOTIVE COMPANY IN DIGITAL TRANSFORMATION

Rank	Company	Profitability as % of Revenue	Year over Year Revenue Growth	Return on Assets (ROA)	Profit per Employee(\$USD)	Community View	ARC Analysts View	ESG Score	Digital Transformation Index	Score
1	Tesla	2.2%	28.3%	3.8%	9.752	1231	485	57	44	689
3	BMW	4.1%	-6.7%	2.5%	36.577	1051	573	85	44	656
8	Volkswagen	4.1%	-13.4%	2.8%	15.358	411	547	88	44	541
18	Toyota Motor	7.0%	0.0%	4.9%	53.578	554	261	78	44	494

Source: Author's grouped based on ARC Industrial Digital Transformation Top 25 Report.

## V. CONCLUSION

The crisis has made us realize there is a lack of "through" visibility in most of supply chains, and therefore digitalization is becoming of even greater importance in such difficult times. It is essential to change the traditional approach the automotive supply chain has been practicing for many years. It is clear that the crisis has revealed critical sores in the supply chains; it has also shown the need to change the old process and rely on better solutions, digitalization in particular, to gain a competitive advantage in the automotive industry. Basic recommendations for improving supply chains:

- supply chain stability – analyze current situation, identify areas where stability is critical;
- create a reserve fund - invest in risk modeling, write a detailed plan and set up regular testing;
- develop a strategy for different cases - invest in research and development to find alternatives for critical raw materials, as well as identify and fill gaps in supply chains;
- create a recovery fund - this will provide you with a faster way out of any crisis.

Automotive industry digital transformation leaders' analysis has indicated digitalization results to be a competitive advantage even in the most difficult global times. Software is the key to digital transformation. There is a correlation between technology investment and key performance indicators for industrial companies. Digital transformation demonstrates increasingly better results from year to year. Another major digital transformation factor is the pressure from citizens, stakeholders and governments to address climate, environment and circular economy issues resulting in a need to become more resilient and change significantly. Bold digital strategies can also drive a company's growth. Some companies nowadays are digital from the beginning and can grow rapidly to stay ahead of existing competitors.

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- Corporate Finance
- Accountancy
- Accounting and Finance in Public Sector Institutions
- Corporate Accounting and Controlling
- Audit
- Management and Finance in Real Estate

### **Cyberspace and Social Communication**

- Communication and Image Creations
- Safety in the Cyberspace

### **Internal Security**

- Administration and Management in Security
- Security and Public Order
- Security and Development in Euro-region
- Security of Information and Information Systems
- Security in Business
- Criminology and Investigative Studies
- Criminology and Forensics
- Protection of People and Property
- Public Order Agencies

### **Law**

- this program gives strong legal foundations to undertake further professional training for judges, prosecutors, attorneys, notaries, bailiffs.

### **Administration**

- Fiscal Administration
- Local Government Administration

### **Logistics**

- this program gives good preparation for work in logistics companies as well as in other economic and administrative units.

### **Information Technology**

- Databases and Net Systems
- Computer Graphics and Multimedia Techniques
- Design of Applications for Mobile Devices
- IT Services in Public Administration Units

### **Postgraduate courses**

- Administrative studies
- Fiscal Administration
- Law and management in health service

