IMPLEMENTATION OF NEW INDUSTRY 4.0 IN SUPPLY CHAIN MANAGEMENT

Miljana Svrzić [a], Jelena Živković [a], Veljko Milovanović [a,*]

[a] University of Belgrade, Faculty of Transport and Traffic Engineering, Serbia

Abstract: *Industry 4.0's new digital technologies are changing business operations and supply chain performance. Companies are using modern technologies to transform their supply chains from basic operational hubs to the core of business innovation as a result of globalization, increased product complexity, and rising customer demand. In the supply chain, Industry 4.0 technologies and trends help meet client needs more efficiently. To optimize their global logistics, leading supply chains innovate and employ more technological solutions that increase visibility, data quality, and carrier connections. Although some companies are still hesitant to risk their supply networks, the paper examines key Industry 4.0 technologies that have provided many advances and benefits. Future supply chain trends are also discussed, as well as the directions in which they will evolve.*

Keywords: *supply chain, new technologies, future trends, Industry 4.0.*

1. INTRODUCTION

The recent pandemic in 2020 affected every part of the supply chain (SC), from the procurement of raw materials to the end customer. It tests the commercial, operational, financial, and organizational resilience of most companies around the world. COVID-19 highlighted the risks and shortcomings of SC resilience. As the new geopolitical crisis between Russia and Ukraine began in February 2022, it caused an energy crisis and continued to affect the global SC. The main disturbances it causes are production delays, a limited number of third parties, labor shortages, and rising commodity prices (Syed & Zhang, 2021; Hosse, 2022).

The SC environment generates higher business challenges than before. The impact of the COVID-19 pandemic is inevitable. A series of closures and restrictions, including transport bottlenecks, varied in time and severity from country to country. The COVID-19 pandemic was not just a short-term crisis. It has long-standing implications for how employees and

* veljkomilovanovic400@gmail.com

SC function. Companies need to build long-term resilience in their value SC to manage future challenges (Syed & Zhang, 2021; Hosse, 2022).

The economic and business environments have become more challenging. In the UK and the rest of Europe, pressures on the SC have been caused by Brexit as a result of increased bureaucracy and cross-border checks. In a broader sense, companies continue to face a range of international business challenges, ranging from fluctuating courses to building global management teams. This is important as the business has become increasingly international—often global—in recent years due to the reduction of traditional barriers to the cross-border movement of products, services, capital, people, and information (Syed & Zhang, 2021; Evans, 2021). The impact of logistics and SC activities on the environment is beginning to be increasingly understood. If countries around the world want to meet their emissions targets and obligations, they must develop more sustainable SC practices. Glasgow COP26 (UN Framework Convention on Climate Change to Reduce Carbon Emissions to Zero) had a strong focus on transport, including freight and logistics. Normal business is no longer an option if a sustainable future is achieved (Fornasiero et al., 2021).

Companies need to react quickly and confidently to design and implement a short-term tactical plan and a long-term strategic plan that will mitigate risks and protect the functioning of global SC. A wave of new trends and challenges in the SC is generating new prospects driven by new technologies to ensure customer expectations for high-quality delivery of reliable products at an affordable price. The vision of the future SC is based on digitalization and the implementation of Industry 4.0 (Fornasiero et al., 2021; Lowe, 2022; Pierce, 2020). Technologies such as IoT, Blockchain, Cloud Computing, 5G, and Digital Twin Supply Chains would increase and develop efficiency, bringing faster, more flexible, more detailed, and more accurate SC.

2. TECHNOLOGIES IN SUPPLY CHAIN MANAGEMENT

Digitization is taking over the entire logistics and SC. It will intensify in the coming years, and the COVID-19 pandemic has only accelerated it. The SC continues to evolve and change rapidly, keeping pace with the technological advances of the modern era. Companies need to be up to date with new technologies that can help them improve the efficiency of their business. With the help of technology, the manager can optimize the SC to secure undisturbed functioning and prevent unwanted events. IoT, artificial intelligence, 5G networks, blockchain, cloud computing, and digital twins are just some of the technologies that contribute a lot to supply chain management (SCM). IoT and Blockchain itself are predicted to speed up the SCM and reduce the occurrence of adverse events (Syed & Zhang, 2021).

2.1 IoT – Internet of Things

The first SCM technology expected to grow is the IoT. The Internet of Things is a network of physical objects that are powered by sensors and software and connected to the Internet. The main drivers of IoT growth are the availability of cheap and reliable sensors, the penetration of the Internet, a huge increase in storage capacity, data processing, and the emergence of artificial intelligence. IoT plays a significant role in the SC, especially when it comes to logistics, with increasingly diverse applications and will continue to

grow. In just a few years, 50% (Evans, 2021) of large companies could use IoT and other advanced technologies to support SC operations. The future of IoT is projected to lead to a 15% increase in productivity in the SC (Lowe, 2022).

In addition to providing greater oversight of operations and transportation, it is believed that IoT can be used to improve warehouse management, fleet monitoring, inventory control, and technological and mechanical maintenance. IoT technology could also be used to create completely smart warehouses and fleets, increasing the efficiency and accuracy of the SC. Depending on which IoT devices are used, they can be combined with other technologies to achieve even greater benefits. A high level of integration will be essential as the SC raises the level of digitization. The SC has historically been a black box for businesses, with customers not knowing where and in what condition their goods are. Manufacturers are wasting a lot of time, money, and supplies due to unforeseen freight movements. India alone spends about $160 billion (Evans, 2021; Lowe, 2022; Pierce, 2020; Evans, 2021) on-road logistics, twice as much as countries with efficient transport infrastructure. Many companies are already turning to artificial intelligence to optimize their SC.

2.2 Artificial intelligence and 5G

Artificial intelligence will play a key role in improving SC efficiency. The technology can be used to automate procedures using an algorithm based on data from previous processes. Automation makes SC more efficient, eliminating human error. The use of artificial intelligence is on the rise in many SC. In a world where speed and precision are key to success, artificial intelligence is a great way to speed up the SC and compete. The increase in artificial intelligence is predicted to address many of the inefficiencies that are still present in today's SC. Artificial intelligence can design business models by changing the way we look at future SCM trends. It can also analyze patterns of today's processes (e.g. in manufacturing) and predict possible outcomes of future scenarios. The 5G networks that have appeared on the global stage are becoming very attractive, both because of the speed and the density of the devices. As IoT devices have flooded the market, networks that can handle a huge number of devices are needed. The difference between 4G and 5G networks is staggering, as 4G networks can only manage about 10,000 devices per square mile, compared to 5G, which can support almost 100 times the amount (Lowe, 2022; Pierce, 2020). 5G is expected to not only improve the quality of life but also optimize vital parts of the SC, from supply to distribution and warehousing management.

2.3 Blockchain

SC visibility is a major source of concern for most companies, and for this reason, more and more of them want to integrate blockchain technology into their chains. It can help improve the transparency of the entire SC, reduce interference, and improve communication with customers. Through blockchain, all chain components can be integrated into a single platform. Carriers, delivery lines, shippers, and logistics service providers can use the same platform to inform companies and customers about the journey of their products. Blockchain also provides unparalleled information protection. Technology has the potential to positively impact SC processes in three key areas: providing accurate, up-to-date information at all times; ensuring the visibility of data and information to all stakeholders; and ensuring the security of all information contained in

the blockchain. As time goes on, technology evolves, and there is no doubt that those who get used to this technology will be a big step ahead of the competition (Lowe, 2022; Evans, 2021).

2.4 Cloud Computing

Cloud-based software solutions represent the future of SCM. All data is stored in the cloud, information can be obtained at any time, and there is great reliability and security. Cloud computing now provides various degrees of capability and security while lowering costs and addressing issues associated with traditional software adaptations. The cloud market is projected to grow in 2022 and beyond (Evans, 2021). Recent reports show that the cloud-based SCM market is growing to nearly $8.6 billion by 2025 (Lowe, 2022). Companies need technology platforms that will enable product visualization at every stage of their life cycle, in real-time, from raw materials through delivery to the end customer. Management must be able to make quick decisions on redirecting deliveries, locating containers, and cooperating with suppliers to meet customer demand. The real power of cloud computing lies in the way it changes the computing economy. By packaging and delivering computer services as a utility, consumers of those services have the benefits of ubiquitous access to computing infrastructure, along with the economic benefits of scale and the flexibility to pair service payments with the value they deliver to an organization. In today's highly competitive global environment, companies need SC that is agile, smart, and adaptable. Customers, suppliers, and partners are demanding. They want information immediately and demand that the right products arrive at the right location at the right time. This can best be achieved by using cloud computing. Instead of a manually operated SC, solutions are used that will transform the SC into an automated, dynamic SC that offers accessibility, control, and cooperation between all partners (Pierce, 2020).

2.5 Digital Supply Chain Twins

As social distancing becomes the norm, making decisions based on real-time SC data using manual methods is becoming less attractive. On the other hand, real-time data is necessary to avoid all interference and problems. Digital SC twins meet this need by creating an entire SC and their processes in an easily accessible, digital environment. Real-time information collected from IoT devices can give a crystal clear picture of everything from customer orders to individual items moving through the SC. Digital twins can point out production delays and their possible consequences, give notifications of equipment failures or things that need to be repaired, etc. (Lowe, 2022).

A digital SC twin is a detailed simulation model of the real SC that uses real-time data, based on which analysts can understand the behavior of the SC, predict possible situations, and create an action plan. Data is collected from sources such as IoT devices (e.g. sensors); logistics and transport databases; operational databases; vendor information; and user experiences. With the help of digital twin technology, overall SC processes can be optimized by tracking certain risks, identifying bottlenecks, transportation planning, optimizing inventory, and predicting the performance of packaging materials. Also, many challenges can be overcome; that is, data quality can be improved and the adoption of new technologies can be increased (Evans, 2021; Lowe, 2022).

3. FUTURE TRENDS IN SUPPLY CHAIN MANAGEMENT

Different industries and companies of different activities on a global level are constantly fighting against major disruptions that occur during the realization of SC. The goals of these industries and companies are to optimize the realization of SC themselves, reduce the risks involved, improve efficiency, and ultimately identify ways in which they could gain an advantage in the market compared to existing competition. To achieve these goals, it is essential to overcome today's intense and ubiquitous challenges. In addition to the mentioned challenges, it is necessary to apply digital technologies in the right way, rationally manage supply and inventory, and define priority and customer focus. Defining key trends will enable SC to proactively shape a successful and sustainable strategy. SC will continue to evolve exponentially, keeping pace with the technological advances of the modern age. For these reasons, the organization and implementation of SC must try to keep pace with all the global changes in the market (Syed & Zhang, 2021; Alice, 2022).

3.1 Shorter product life cycle

Reducing the lifespan of products affects the fact that companies make various innovations in the organization of their own business to be able to operate efficiently and profitably. When product life is shorter, customers will continue to demand as many new products as they can meet, while companies will have to deliver those new products within defined deadlines. For these reasons, SC needs to run faster and more efficiently (Alice, 2022). In addition, different products with different lifespans will require the existence of different SC, which further complicates the overall organization. Many companies use the same chain for all products, despite the differences in their lifespans. For that reason, they will have to develop a variety of strategies to maintain their profitability. Advanced tools and technologies can help track inventory and automate the ordering process. To this end, companies will simplify their return logistics processes to improve the handling of obsolete products (Filipović, 2022).

3.2 Flexibility of Supply Chains

SC adaptability can be defined as the ability to adjust the SC configuration to meet structural changes, various disruptions during implementation, as well as changes in customer behavior. Adaptive SCM provides insight into the dynamics, complexity, and uncertainty during implementation, further increasing stability and resilience in the event of disturbances and crises (Alice, 2022). The traditional way of SCM was linear within all components, i.e., all parts functioned together, thus achieving the appropriate price, quality, and speed of implementation. In such management, agility and flexibility are lacking in cases of various internal or external changes. Some of the advantages of this way of managing SC are (Slevin, 2022):
- Better adjustment and redesign of the supply network in response to external changes,
- Identification and response to changes in customer preferences and requirements,
- Transparency and visibility of supply chains from start to finish,
- Improving business innovation based on real-time feedback.

3.3 Sustainability of Supply Chains and Green Logistics

The sustainability of SC is defined as complementing traditional ways of SCM by adding environmental, social, and corporate aspects to the procurement of raw materials, production of finished products, and delivery to customers. In addition to environmental benefits, companies that use sustainability principles in their SC save money on storage, delivery, and expired products. By applying sustainability in SC, the benefits are reflected in three aspects: customers, profits, and the planet (Kluwer, 2021). Customers and SC entities are becoming increasingly concerned about environmental issues, which has an impact on the brands that promote and address sustainability concerns. Consumer knowledge and environmental concern are growing, influencing the SC to become less and less environmentally harmful. At the same time, there is a trend of green logistics, which is becoming more popular due to increasing CO_2 emissions during transport. Green logistics is just one of many trends affecting storage in SC. Eco-warehouses have an advanced energy management system that uses meters to monitor energy consumption, heating, water, and gas in all facilities. Such systems help reduce excessive resource consumption. Electric and powered vehicles are increasingly used in supply chains, and such vehicles reduce the overall carbon footprint of the chain (Filipović, 2022; Alice, 2022).

3.4 Improving the predictability of Supply Chains

Predictability will become a competitive advantage as the SC breaks through barriers and obstacles and becomes more economical, secure, and faster. Most companies want to improve their resilience to the constant fluctuations that occur during the realization of SC, but this creates additional high costs. The need to adopt new technologies has enabled companies to be competitive in the market. Companies that have invested more in digitalization and the development of modern ways of doing business now have leading roles in the market. Innovation in ongoing operations and improvements can consume up to 90% of the IT budget (Hosse, 2022; Alice, 2022). One way to save money is to optimize existing IT resources. This achieves simplified, efficient operation of business processes and the ability to integrate with modern applications and technologies outside the company. However, the adoption of new technologies and their implementation brings with it certain risks that some companies are not ready for. An alternative to this is to maintain basic business applications because they are stable, meet certain needs, and perform essential tasks related to human resources and finances. This means that it is still possible to improve and develop basic applications, but there are deadlines for the end of full support for many existing software applications, which impose new technologies on companies. For some time to come, companies will be maintaining ERP (Enterprise Resource Planning) systems, reducing their current spending on IT, and shifting savings to invest in innovative technologies that will make the SC more resilient.

3.5 Using autonomous robots

Autonomous robots are designed to perform routine, repetitive tasks and operations that require complex programming, setup, and implementation. However, they are not intended for tasks that require a high degree of flexibility. As autonomous robots become more sophisticated, their advantages over humans during the realization of SC are increasing (Alice, 2022). In warehouses, autonomous robots will be used more and more

to speed up demanding and hard work. Combined with the commonly used technologies, robots can significantly improve the productivity of SC (Filipović, 2022).

The increasing use of robots does not mean that they will completely replace humans. The technology is intended to increase human efficiency by speeding up the performance of simple tasks. If such tasks are performed by machines, people can dedicate themselves to more important tasks that have a direct effect on business growth and better communication with consumers (investors). The use of autonomous robots drives innovations in SC, which reduces direct and indirect operating costs and, in addition, increases revenue. Some of the benefits of using autonomous robots are (Fitzgerald, 2021):

- Reduction of risk, re-production, and error rates,
- Improving the safety of workers in high-risk environments,
- Performing simple tasks that will enable employees to focus on more complex tasks that cannot be automated and on their strategic work,
- Strengthened the corporate brand by following good practices and applying innovative technologies,
- Exponential learning by collecting and analyzing machine data.

4. CONCLUSION

In a relatively short time, the world has changed significantly. The SC is also changing, and chain management is no longer as simple as it used to be. However, technological advances provide more and more ways to optimize the SC. The SC's development, which largely depends on its environment, conditions the application of various digital technologies of the new era and the emergence of key trends for globalized SC. The coming future is very uncertain and challenging. Based on existing indicators, it is possible to create a picture of the barriers facing supply chains. Companies strive to minimize their costs by using limited resources. Future SCs will use fewer resources but will be more flexible to meet the needs of local and foreign markets. New technologies and trends are already being applied in supply chains and represent their secure future and progress.

Many companies are introducing IoT devices to improve the visibility of their SC. They can also use real-time information to proactively respond to customer needs, reduce downtime, and increase SC efficiency. Increasing the efficiency of SC can also be achieved with the use of artificial intelligence and 5G networks, high speed, and device density. Blockchain technology is seeing increasing application and development. Many are unaware of the value that blockchain technology brings, especially because of the importance of data and its integration into a single system. Cloud Computing represents the future, primarily due to data protection, availability of information at any time, security, reliability, and several advantages. Digital twins are becoming more and more popular and in use. The implementation of sensors in facilities, vehicles, or objects in any part of the SC and the collection of data from these sensors will enable the supply SC to run without disruption and with greater accuracy. Product life is getting shorter, and deliveries are more frequent, which leads to the main problem—increasing the number of vehicles and kilometers traveled. In the future, companies will need to develop a variety of supply chains to stay profitable and speed up processes to keep up with demand. SC flexibility is very important to meet certain changes, disruptions in implementation, and

changes that are present in customers. Sustainability means that resources are used and spent in a way that will enable future generations to use them. Increasing emphasis is being placed on ecology and environmental protection. In addition, sustainability in the SC should be viewed from the perspective of the company's customers and profit, in addition to the environment and the planet. Another trend that is becoming more common is the reduction of human labor, which is being replaced by autonomous robots. Robotics is currently playing a major role in transforming supply chains. More and more companies are using drones and driverless vehicles to modernize their logistics operations.

Businesses and consumers can expect drones to become perfectly capable of delivering smaller packages in the future. On the other hand, driverless cars will still progress and will have the ability to make automated decisions in traffic. All the listed technologies that are already in use and future trends that are in great development are just the beginning of the improvement and optimization of SC.

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