



IMPACT OF THE PANDEMIC ON BLOCKCHAIN AND THE IoT APPLICATION IN SUPPLY CHAINS FROM THE SAME ASPECT

Zoran Ćekerevac, Milanka Bogavac

zoran@cekerevac.eu, bogavac.milanka@gmail.com

*Faculty of Business and Law, MB University
Teodora Drajzera 27, Beograd
THE REPUBLIC OF SERBIA*

Key words: *transport, logistics, COVID-19, blockchain, IoT, SME.*

Abstract: *The long-lasting COVID-19 pandemic has caused a series of disruptions in production and transportation. The automotive industry was among the first to feel the consequences of the pandemic, primarily in a significantly reduced demand. This affected all participants in the production and sale of cars, and especially the supporting industry composed mainly of small and medium-sized enterprises. After the reduction in mortality from COVID-19, trade, and tourism began to accelerate sharply, which resulted in increased demand. Again, the automotive industry was among the most threatened, but also other industries that are large consumers of electronic components, and manufacturers of mobile phones and computers. The article discusses the impact of the pandemic on supply chains from the perspective of SMEs and the possibility of applying blockchain technology and the IoT to improve the functioning of supply chains.*

INTRODUCTION

The long-lasting COVID-19 pandemic has caused enormous problems in production and transportation. The problems caused by the isolation significantly affected world trade. Fearing the unknown almost all countries have imposed movement restrictions. Seeing the danger, China responded to the spread of the coronavirus with harsh measures and reacted to each case of infection with isolation. Even the big cities are "locked down". I.e., the port of Shanghai, which handles 20% of China's exports, is closed. [1] The port operated for three months with a significantly reduced capacity. The cargo transport was directed to other ports, which caused great difficulties in supply. [2] During the pandemic, vaccination and air transport games began. Western countries did not recognize Russian vaccines and prevented the travel of Russian citizens vaccinated with Russian vaccines. Countermeasures immediately followed. Even citizens vaccinated with Russian vaccines could not fly from EU airports to airports in Russia. For example, Serbian passengers could fly to Russia only from Serbian airports. There have also been enormous restrictions on passenger air traffic between the US and the EU. Time has shown that the bans were more of a political nature than a real need.

The epidemic has led to risks in supply chains, primarily in the supply chain of agricultural and food products. Risks are characterized by occasional breakdowns of the logistics network, supply and demand mismatches, and sustainability issues. Various IoT

technologies, including blockchain, robotics, big-data analysis, and cloud computing, have become the means suitable to combat the crisis. Companies, including SMEs, have progressed in initiating, and implementing new ideas.

One can classify risks into functional and disruptive. The functional risks are connected with daily disorders in the functions like lead time of product production, processing and demand fluctuating, and the disruption risks are associated with low-frequency highly impacting actions.

Disrupting actions (pandemic) instantly impacts logistics and its networking system. They result in a shortage of retailers, distribution centers, transportation facilities, etc. Product shortages and delaying of services propagated downstream and degrade performances.

Internal relationships in supply chains are dynamic but globalized standards and traceability demanding for the interaction of the focal firms with their sub-suppliers in a multi-tier system. Globalized production must match the consumer's demands, which may increase global sustainability issues. Multi-tier-based sustainability may help in the reduction of losses at different phases by minimizing deterioration of the qualities and thus contribute to sustainability. Without considering sustainable factors, a secure system may not be achieved. [3]

BLOCKCHAIN AND IoT IN THE SUPPLY CHAIN

A modern supply chain must provide end-to-end visibility, flexibility, trust, and process control. With its transparency, the Internet of Things is bringing revolutionary changes to supply chains. At the same time, it provides operational efficiency and the possibility of income. Companies that understood the supply chain is more than just a way to track a shipment have gained an edge over their competitors. According to i-SCOOP (2018), simply moving a container from one point to another often involves over 30 participants, with an average of 200 interactions between them.

From an operational efficiency perspective, a company using IoT can count on asset tracking, better supplier relationships, and more accurate forecasting and inventory. Along with the growth of the supply chain, there is a growing imperative to ensure that all carriers stay connected. And IoT does it. Moreover, with its sensors, it can also help with planned maintenance.

Deloitte [4] summarized the effects of blockchain into four essential impacts: fast settlement of transactions, low cost, transparency, auditability, and reliability. Using IoT with blockchain, the company gets the opportunity to register every event and every transaction in the supply chain (SC) and share this information with other participants in the SC. This distribution of information increases efficiency and reduces the number of intermediaries and costs. [5] The benefits of IoT have come to the fore, especially in monitoring the movement and conditions of vaccine transport during the COVID-19 pandemic. For some vaccines, it was vital to maintain the required conditions during the manipulations to ensure the correctness of the vaccine.

Internet of Things (IoT) devices are becoming part of intelligent transportation systems. Smart supply chains are emerging increasingly frequently, and blockchain technology is becoming one of the most popular topics among scientists. The application of blockchain eliminates the need for a centralized third party to perform transactions on a global scale. The hybrid of IoT and blockchain technology solves the problems with centralized IoT systems. Blockchain needs consensus between the network nodes to agree on a unique state of blockchain data.

The integration of IoT devices through the blockchain network is suitable, but the resource-intensive computation within the consensus mechanism is an excessive burden for IoT devices with limited resources. Therefore, designers face significant challenges in

analyzing, determining, and developing consensus algorithms that can adapt to the IoT devices' limited resources and provide the best possible consensus among IoT devices with minimal compromises. Such a need is particularly evident in the use of IoT devices in supply chain management.

Muhammad Anas Baig and colleagues discussed blockchain-driven IoT and their consensus methods in their study [6]. In their IoT-based supply chain scenario, there were a lot of transactions among the IoT nodes. When the leader node directs all the operations, it becomes the bottleneck. In that case, the follower nodes are idle most of the time. The authors proposed improvements in the Raft consensus mechanism for Hyperledger Fabric utilize the follower nodes in disseminating the VoteRequestMsg messages, AppendEntriesMsg message, and the replication of the log messages via the ReplicateLogMsg function among the followers. That way they reduced the workload of the leader node. The results of the experimental study revealed that the proposed improvements in the Raft consensus protocol provide a better selection time, latency, and throughput.

SMAL AND MEDIUM-SIZED ENTERPRISES AND PANDEMICS

There are several ways in which the pandemic affected the economy and especially small and medium-sized enterprises. On the supply side, companies are experiencing a reduction in labor supply, as workers are either sick or must care for others. Schools were closed, and people had restrictions in motion. Quarantine control measures led to a significant drop in capacity use followed by shortages of parts and raw materials. Supply chains were disturbed.

On the demand side, there was a dramatic drop in demand for some products. That led to a sharp fall in the income of SMEs and seriously affected their liquidity and ability to function. In addition, consumers faced the loss of earnings, fear of contagion, and increased uncertainty, which reduced spending further. Workers' layoffs amplified these effects. Some companies could not even pay salaries. Tourism and transport, especially air transport, were highly affected, contributing to a decline in business and consumer confidence. Generally, SMEs were more vulnerable to "social distancing" than other companies. The effects on SMEs were serious especially due to the higher level of vulnerability and less resilience related to their size.

In all countries, SMEs constitute the vast majority of companies, with added value and employment. In some regions and sectors highly affected by the pandemic effects, the prevalence of SMEs is even higher. For example, in some of the most affected regions, such as northern Italy, the importance of SMEs in the economic structure is even more significant. Small and medium-sized enterprises are very prevalent in tourism and transportation but also, in fashion and food. Short delivery times are essential there.

SMEs have a limited number of suppliers. In some cases, this can protect them from shock. At the beginning of the pandemic, that appeared to be the case for German SMEs that work more in regional supply chains and were less affected by developments in Asia. In other cases, SMEs may rely on suppliers from countries and regions with more cases of COVID-19, increasing their vulnerability. Similarly, barriers to transport by sea, road, or air affect these SMEs. In the long term, many SMEs will find it hard to rebuild ties with former networks. Former partners formed new alliances and business deals when supply chains broke.

SMEs may have less resilience and flexibility in facing the challenges of these shocks. The costs of prevention, as well as required changes in work processes, such as the transition to remote work, can be relatively higher for SMEs considering their smaller size, but also, in many cases, the low level of digitization and difficulties in accessing and adopting technologies. If companies reduce production in response to developments, the costs of underutilized labor and capital fall more heavily on SMEs than on larger firms. Moreover, it

was more difficult for SMEs to obtain information about measures to stop the spread of the virus and possible business strategies to mitigate the shock and government initiatives available to provide support.

Given the limited resources of SMEs and existing barriers to access to capital, the period during which SMEs can survive a shock is more limited than for larger firms. Research in the United States suggests that 50% of small businesses operate with less than 15 days of cash reserves and that even healthy SMEs have less than two months of cash reserves [7]. As signaled by the OECD, there is a risk that otherwise solvent firms, especially SMEs, could go bankrupt while austerity measures are in place [8].

When analyzing opportunities, SMEs can focus on elements of their "soft competencies", i.e., negotiation skills [9] and "hard assets", i.e., mutual investments with partners or long-term contracts. Although such "hard assets" are crucial in a crisis [10], they are unlikely to be developed in a short time when a crisis already hits SMEs and their supply chains. In such situations, it is hard to expect any new investment because companies usually withdraw from new commitments to resources. Complex contracts, as a solid element of business networking, can be a better solution during a crisis because they act as protective mechanisms [11] [12].

TRANSPORT DURING THE PANDEMIC COVID-19

The coronavirus pandemic had an impact on transportation worldwide. Air passenger traffic was the most affected by the pandemic. Many airlines have grounded. Some maintained a minimum number of flights to keep their licenses and maintain contracts with airports. For example, the volume of air passenger traffic worldwide decreased from 4.54 billion in 2019 to 1.8 billion in 2020 (post-COVID), and 2.28 billion in 2021. Since the pandemic starts, most of the world's companies have reduced the number of employees to a minimum to reduce costs. The staff number reduction had a particularly negative impact at the time of the abolition of sanitary measures and the sudden increase in the number of passengers in the middle of 2022. Airline companies experienced record demand for personnel. The situation aggravated the absence of workers from work due to illness. And while passenger traffic was returning to normal, that was not the case with global supply chains, which remained disrupted. Road transport, which requires a lot of human resources, was hampered by sanitary and road restrictions. Road freight transport fell by 0.9 % from 2019 to 2020 in the EU. That broke the upward trend seen in recent years, culminating in an increase of 3.2% from 2018 to 2019. The lockdowns and the measures imposed by the many Member States in 2020 to counter the Covid pandemic hurt freight transport by road, particularly during the second quarter of 2020. Compared to the first quarter of 2020, the number of ton-kilometers performed in the EU in the second quarter of 2020 fell by 7.9% to 416 billion ton-kilometers, an effect of the Corona-related lockdowns and restrictions on cross-border movements. [13]

Meanwhile, rail freight transport achieved better results. For example, freight transport between China and Europe reached record results during the pandemic, which was positive for the New Silk Road promotion. Transport routes connecting China to Europe have experienced a boom in recent decades. During the COVID-19 pandemic, this was especially true for the rail link, which was extremely popular in satisfying the automotive industry's needs. The primary corridor passed through Russia, Belarus, and Poland and extended toward Germany, France, and other European countries.¹

¹ Due to the current boycott of Russia, that route is no longer dominant. Some companies are re-routing products to an alternative rail route, but most are reverting to an ocean freight mode, which means more time to get goods to market.

The pandemic, lockdown, and decline in the production of some types of products have left a visible mark on transport and means of transportation. In the middle of 2022, it has become quite hard to buy a new car because, for many cars, the waiting time for a vehicle has become longer than a year. One of the main reasons is the stagnation in the electronic components necessary for modern vehicle production. In Serbia, the wait for new Korean-made vehicles was the shortest, but for example, for the Škoda car Superb, buyers must wait up to a year and a half.

The New Silk Road still works. One can note that freight forwarders are trying to find alternative routes to the Silk Road. More and more Western companies operating in Europe and Asia actively seek to switch from the China-Europe-China rail to maritime routes. The railway line transports approximately one million containers per year. If all that volume moves to the sea corridors, there will be an increase in the price of transportation, especially for shipping from Asia to Europe. On the other hand, there will be a reduction in capacity in the transport market, which was already a weak link in the supply chain in 2021.

The additional problem is that some Western countries, including the US, view China with suspicion and try to limit the purchase of certain Chinese products. Thus, the supply situation becomes even more complex. And the world began to return to local production. The almost forgotten phrase "import substitution" appears more and more often. [1] In some areas, import substitution becomes an opportunity for SME development. Entrepreneurs and SMEs get a chance to fill gaps in the market, but this is not possible for all types of goods and services. In any case, producers must pay more and more attention to alternative sources.

HOW TO ADJUST BUSINESS TO THE NEW REALITY

Hard days come for the economies of many countries, especially in Europe. Since SMEs are the most numerous in all economies and the mainstay of large companies, SMEs can expect they will be exposed to extraordinary trials. Panic statements of numerous businessmen that overpriced energy and a lack of energy sources can threaten European industry are becoming more frequent. They introduced the term deindustrialization.

First, the COVID-19 pandemic, and then the war in Ukraine and sanctions against Russia and Belarus led to radical changes in supply chains. We should also not forget the tension between the US and China, which has existed for a long time and was intensified recently by the crisis over Taiwan.

In today's environment, real-time supply chain and cargo location data are more significant than ever. Modern software allows monitoring of operations in real-time, and tracking algorithms consider many data that allow the generation of expected delivery times. Currently, disruptions in the markets are, as expected, the greatest in Ukraine and Russia. Deliveries to Russia have dropped significantly since February 22nd. By March 15th the weekly volume of imports into Russia by all modes of transport decreased by 59 percent compared to the week of February 16-22. It affected various industries: manufacturing, chemical industry, retail, food industry, and consumer goods. [1]

If we do not count the import of weapons, in Ukraine, at the same time and by the same standards, the volume of imports decreased by 96 percent. [14]

In Central European countries, there were import disturbances, but at a low level.

Due to the state of war, the specific position in the case of Ukraine, and sanctions against Russia and Belarus, companies from Western Europe are forced to cancel orders and look for new suppliers worldwide. Exports from the west to the east (to Russia and Belarus) have decreased to a great extent, although "parallel imports" are taking place. For example, between May and July 2022, Russia imported goods worth about 6 billion euros through parallel import or black market purchases. [15] Sanctions have made goods available but at a higher price. [1]

Although the situation is very unfavorable for SMEs, those companies that adapted to the new conditions have a chance for quick recovery and/or development.

CONCLUSIONS

The COVID-19 pandemic and the special military intervention of the Russian Federation in Ukraine have led to fundamental changes in world trade and the circulation of goods and services. Maybe the changes occurred suddenly, but they have been going on for a long time, and SMEs should have already adapted to the new conditions. However, even the measures taken during the pandemic were not long-lasting and predictable. They changed from month to month and thus made it difficult for SMEs to create a business policy for a long time. They had to adapt to each new change and challenge. SMEs became dependent not only on market conditions but also on the policies of their countries, which were often not in their favor.

There is no end in sight to the war in Ukraine and probably no end to the sanctions against Russia and Belarus. Although the US complicates the situation with China and Taiwan, it is difficult to expect that sanctions will be extended to China. That would be an economic war for which the Western economy is not ready.

An interesting fact is and can be the subject of analysis that new hotspots of crisis are consciously opening, and conflicts are opened by parties from whom it is not expected at first glance. For example, several small EU countries provoke China about Taiwan.

It is for sure that the coming years will be very turbulent, and it is hard to expect SMEs to be able to plan for the long term. They must monitor the situation constantly and adapt to changes, or they will be doomed.

REFERENCES

- [1] Z. Čekerevac and M. Bogavac, "Impact of COVID-19 and Ukraine-Russia war on the international trade and logistics," 31 08 2022. [Online]. Available: https://www.meste.org/mest/M/a_m.html.
- [2] PL, "Shanghai Port is back to normal - The supply chain situation will get worse before it gets better (in Serbian: Luka Šangaj se vraća u normalu – Stanje u lancima snabdevanja će se pogoršati pre nego što krene na bolje)," Pluton Logistics, 10 06 2022. [Online]. Available: <https://plutonlogistics.com/logistika/luka-sangaj-se-vraca-u-normalu-ali-stanje-u-lancima-snabdevanja-ce-se-pogorsati-pre-nego-sto-krene-na-bolje/>.
- [3] S. Yadav, S. Luthra and D. Garg, "Modelling Internet of things (IoT)-driven global sustainability in multi-tier agri-food supply chain under natural epidemic outbreaks," *Environmental science and pollution research international*, vol. 28, no. 13, pp. 16633-16654, 2021.
- [4] Deloitte, Continuous interconnected supply chain - Using Blockchain & Internet-of-Things in supply chain traceability, Luxembourg: MarCom at Deloitte, 2017.
- [5] Z. Cekerevac, L. Prigoda и J. Maletic, «Blockchain Technology and Industrial Internet of Things in the Supply Chains,» *MEST Journal*, т. 6, № 2, pp. 39-47, 15 July 2018.
- [6] M. A. Baig, D. A. Sunny, A. Alqahtani, S. Alsubai, A. Binbusayyis and M. Muzammal, "A Study on the Adoption of Blockchain for IoT Devices in Supply Chain," *Computational Intelligence and Neuroscience*, vol. 2022, p. 25, 2022.
- [7] FRBNY, "Small Business Cash Liquidity in 25 Metro Areas," 04 2020. [Online]. Available: <https://www.jpmorganchase.com/institute/research/small-business/small->

business-cash-liquidity-in-25-metro-areas.

- [8] OECD, "Coronavirus (COVID-19): SME policy responses," 15 07 2020. [Online]. Available: <https://www.oecd.org/coronavirus/policy-responses/coronavirus-covid-19-sme-policy-responses-04440101/>.
- [9] M. Mitrega, S. Forkmann, C. Ramos and S. Henneberg, "Networking capability in business relationships—Concept and scale development," *Ind. Mark. Manage.*, vol. 41, no. 5, pp. 739-751, 2012.
- [10] J. Dyer and H. Singh, "The relational view: Cooperative strategy and sources of interorganizational competitive advantage," *The Academy of Management Review*, vol. 23, no. 4, pp. 660-679, 1998.
- [11] S. D. H. Anderson, "Management control for market transactions: The relation between transaction characteristics, incomplete contract design, and subsequent performance," *Manage. Sci.*, vol. 51, no. 12, pp. 1734-1752, 2005.
- [12] N. Gorovaia and J. Windsperger, "The choice of contract duration in franchising networks: A transaction cost and resource-based view," *Ind. Mark. Manage.*, no. 75, pp. 125-133, 2018.
- [13] eurostat, "Road freight transport statistics," 10 2021. [Online]. Available: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Road_freight_transport_statistics#EU_road_freight_transport_fell_from_2019_to_2020.2C_the_pandemic_reducing_both_international_and_national_transport.
- [14] G. Koepke, Interviewee, *Logistics during the war: how supply chains have changed and how to adapt the business to new realities (in Russian: Logistika v period voyny: kak izmenilis' tsepochki postavok i kak adaptirovat' biznes k novym realiyam)*. [Interview]. 22 03 2022.
- [15] A. Pandej, "'Parallel imports': How Russia circumvents sanctions (in Serbian: „Paralelni uvoz“: Kako Rusija zaobilazi sankcije)," DW, 23 08 2022. [Online]. Available: <https://www.dw.com/sr/paralelni-uvoz-kako-rusija-zaobilazi-sankcije/a-62894790>.