THE ROLE OF DIGITAL TECHNOLOGIES IN SUPPLY CHAIN MANAGEMENT IN THE COVID-19 CRISIS PERIOD

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Abstract

The global market is characterized by the presence of fierce competition. In order to enhance competitive advantage in such a market, companies must continuously digitize supply chain activities and processes. The implementation of a widening range of digital technologies is a sine qua non of the successful functioning of modern companies and supply chains. Digital technologies make it easier to bridge spatial and temporal distances as well as the flow of information between companies in supply chains. The aim of this paper is to present, based on the analysis of relevant academic sources: (a) business relevance of implementing the concept of digital supply chain management, (b) the most used digital technologies, (c) the experience of certain companies in the digitization of supply chain management processes and usage of digital technologies, (d) the role of digitizing the processes and activities of companies and their supply chains during the COVID-19 crisis. The presented research results will facilitate the understanding of the problems in the functioning and business significance of digital supply chains.

Key words: *globalization, digital technologies, supply chain, crisis, COVID-19.*

1 INTRODUCTION

The network between enterprises and their suppliers designed to produce and distribute a specific product is defined as a supply chain. For decades, this has been a necessary step for businesses to succeed in delivering products to their customers [1]. Numerous businesses, such as IBM, Dell, Hewlett-Packard, and Procter & Gamble, were able to obtain competitive advantages and to reduce transactional costs, and their strangeness is based on long-term relationships with their partners [2]. The growth of today's business world has created closer competition in the marketplace because existing industrial markets has become globalized and have penetrated international borders [3]. Globalization is only one of the wider global trends that have affected companies' activities of all sizes to make their businesses effective as much as is possible.

The constant growth of information and communication technologies (ICT) imposed the new trend of doing business. Today, we are talking about digitalization as the newest trend which affects companies and supply chains worldwide. Technology has a major role in the digital transition. Digital transformation involves the merging of advanced technologies and the integration of physical and digital systems [4]. That is the process of digitalized data development, communications integration and process automation improve performance in multiple dimensions [5]. Although not new, digitalization, as a key part of today's business, requires a specific approach to companies in order to adapt to it, and successfully use it in their business.

A lot of organizations are interested in becoming more digital today. They recognized the criticality and value of digital technologies for their growth, and management support is growing for these initiatives as well [3]. According Business Consulting Group (BCG) [10], creating a digital supply chain doesn't mean only automating a single task, as many business leaders think, already supply chain digitization requires a real and serious holistic transformation mindset.

The structure of this paper is as follows, after the short introductory it will be presented the concept of digital supply chains and the most used digital technologies, as well as to present practical examples of digital supply chains and the Covid-19 impact of digitalization. The aim of this paper is to present the significance of modern technologies in today's business activities and its importance and necessity for companies, in order to keep their competitiveness.

2 THE CONCEPT OF DIGITAL SUPPLY CHAIN MANAGEMENT

According to Agrawal & Narain [3], digital supply chain management (DSCM) can be defined as the usage of powerful and innovative technologies that can change the traditional way in which different supply chain processes are conducted, while building integration among supply chain members and enabling establishing a new business model. Successful DSCM implies good knowledge about digital supply chains and what does it include.

In the literature review, there are several definitions of digital supply chain (DSC). There is a slight variation in definitions in terms of use. According to Phyn & Rha [6], there are three main perspectives of DSC. The first one focuses on transforming business processes using digital technology, the second one emphasizes cooperation through digital technology, and the third present it as a process of changing and responding to market conditions through bidirectional detection, response, and adaptation of emerging technologies.

The basic requirements of first perspective are based on the transformation of the so-called paper business procedures into smart business procedures with the appropriate transformation of the organization. In this respect the multinational company PricewaterhouseCoopers (PwC) defines a digital supply chain as a system that focuses on the digital connection of all physical assets beyond the automation of each machine and process, as well as integration into digital ecosystems with value chain partners [7]. Agile Elephant expresses the digital supply chain as the conceptual digital transformation that is the process of transforming the traditional approach to working and thinking into a new method using digital media, social networks, mobile channels, and newly emerging technologies [8].

The second perspective at the core, highlight the cooperation through digital technologies. In that sense DSC can be defined as smart technology-optimised systems that perform functions such as big data processing and excellent cooperation and communication with the help of digital and software that synchronises and supports interactions between organizations [1]. According to Bhargava at all. [9] DSC is a means to mediate partner activities within the supply chain, through software, hardware, and a communication network to support interactions in the processes among organizations across the world. DSC can be defined as a customer-centric platform that captures information in real time from various sources and maximizes its usage [6]. As one of the most important benefits of DSC is that its usage can at the same time optimize performance and minimize risks through demand stimulation, matching, detection, and management.

DSC at the third perspective, as a process of changing with new technology, explains the DSC as a system that uses modern technologies (as IoT, blockchain, cloud technology, robots etc.) which has a positive impact on business operations through the supply chain. A digital supply chain develops and applies technologies to automate, integrate, and illuminate all processes, including data capture, communications, analyses, decision-making, transactions, and transformations [5].

Agrawal & Narain [3] highlighted that supply chain managers who are interested in digitizing their current supply chain approaches will need to discover the opportunities and challenges facing their current processes. They must also consider the digital transformation of the entire organization, including its products and services and the interaction partners, suppliers and clients with their company. Numerous digital technologies are available to managers today. However, in order to choose the ones that suit them best, managers need to know them well. The following is an overview of the most common technologies that can be used in establishing digital supply chains.

3 APPLICABLE DIGITAL TECHNOLOGIES IN DSCM

For companies in a modern market environment, it is necessary to use state-of-the art technologies in order to improve productivity and competitiveness for their supply chain [3]. A certain group of authors [11, 12] points out that digital transformation can lead to improved performance in

supply chain relationships and activities, but only if digital tools are used in the right way. The aim of process digitalization is to achieve the operational excellence. The relationship between digital transformation, smart technologies and business performances is shown in the figure 1 [2]:
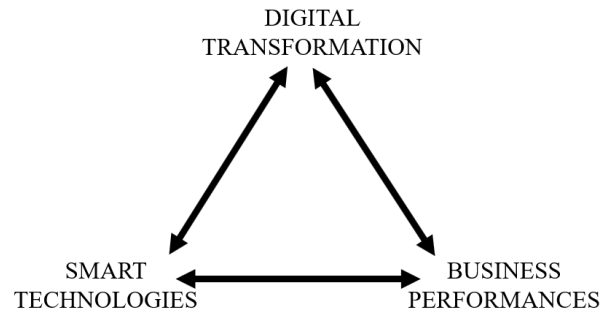

Fig. 1 *Relationship between digital transformation, smart techologies and business performances*

The use of information and communications technologies (ICT), digital technology, and big data analysis develops traditional supply chains to make them smarter supply chains and enable efficient management of future challenges in the digital age. Technology and data have always been integral to supply chain management, and that dependence will grow in the future, too [13]. Until 2010, supply chain companies had several widespread techniques and methods at their disposal to facilitate their business, among which they are the most famous: enterprise resource planning (ERP), materials requirement planning (MRP), vendor management inventory (VMI), warehouse management system (WMS), etc. Today, there are a lot of technologies which use can improve business activities. They allow for supply chains to become more competitive, more complete – digital mature. The level of digital maturity is linked to the level of DSC development. The figure 2 [5] presents the levels of maturity, and technologies that are used for each level.
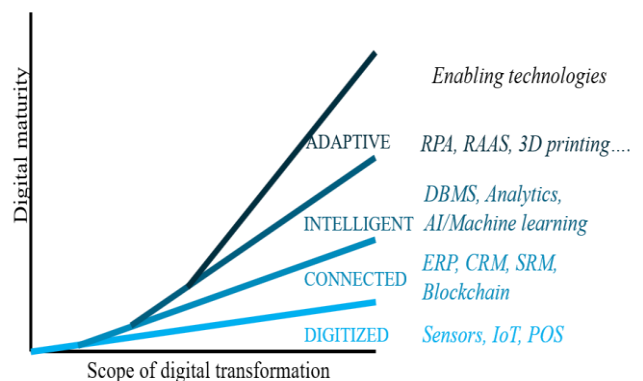

Fig. 2 *Supply chain digital maturity*

According to Agrawal & Narain [3] emerging technologies that enable digital supply chain transformation, which have found wider application in practice are: cloud computing, big data analytics, internet of things, social media, user interface, robotics, 3D printing, nanotechnologies, artificial intelligence/machine learning.

The application of these technologies in their supply chains has been realized by some of the world's leading companies. Which are the most successful among them, as well as on which technologies they based the digitalization of their supply chains, are presented in the text that follows.

4 EXPERIENCES OF COMPANIES IN THE APPLICATION OF DIGITAL TECHNOLOGIES IN SCM

Supply chain business has attracted much attention from analysts for many years. Every year, Gartner [14] analyzes the supply chains of hundreds of companies, in order to determine what makes them stand out as the most successful - what makes them exceptional in business, because the best among them offer lessons on successful business. The ranking is based on estimates based on key attributes such as ESG, three-year return on physical assets (ROPA) and revenue and inventory growth (cost of goods sold in 2020 / average quarterly inventory in 2020) [14]. Table 1 shows the top 10 ranked supply chains, accorting Gartner, for 2021.

Table 1 Top 10 supply chains for 2021

Rank	Company	Score
1	Cisco Systems	6.37
2	Colgate-Palmolive	5.58
3	Johnson & Johnson	5.22
4	Schneider Electric	5.07
5	Nestlé	4.41
6	Intel	4.40
7	PepsiCo	4.37
8	Walmart	4.23
9	L'Oréal	4.05
10	Alibaba	3.90

All these companies, listed in the table 1, deservedly took their positions, however, only some of them, in addition to good business performance and contribution to the community, also demonstrated digitalization through their supply chains.

Some of the listed companies are those who are generators of digital technologies (Cisco, Schneider Electric, Intel and Alibaba), while the rest are simply users of various digital technlogodies, and in different stages. Their experiences, digital steps and technologies which they are using, will be discussed bellow, in order listed in the table 1.

4.1. Cisco Systems – technical innovator in digital transformation

In the first place on the Gartner top 25 list, is the company Cisco Systems, an innovator of high technology, which is at the top for the second year in a row. From the aspect of digitalization, this company is specific precisely because it provides the technology on which the digitalization of supply chains is based.

Cisco outstanding itself as a company which gives a solid foundation for digital transformation, bringing software, processes, and systems together in a digital-ready infrastructure that is simple, intelligent, automated, and highly secure. It makes things simple by providing cloud-ready products and services with flexible consumption models [18].

4.2. Colgate-Palmolive and digital technologies

Colgate-Palmolive Europe (CP EU) is a leading oral, personal, and household care producer with sales in Europe of over $2.4Bn [19]. They recognized the potential for further growth of online sales and were aware of the potential for improvement in digital and e-commerce, and focused on developing business in that direction.

According to Energy Capital [20], Colgate-Palmolive invested in emerging technologies such as AI, Machine Learning, IoT, Blockchain, Autonomous Database or in cloud-based ERP, HCM, CRM, EPM, Procurement or Treasury applications.

In support of their global digital transformation efforts, Colgate-Palmolive's Global Supply Chain group had been exploring tools to digitize equipment changeover and maintenance operations plus integrate into Colgate's SAP ERP and MES Wonderware Systems and have selected Augmentir's Connected Worker Platform [21].

4.3. Johnson & Johnson: successufl digital transformation

Johnson & Johnson (J&J) is an American multinational organization founded in 1886. It operates more than 250 companies. Over the past few years, the company has evolved in many ways into an innovative healthcare technology company [16]. For more than 130 years and with more than 130k employees strives to improve access and affordability, creates healthier communities, and put a healthy mind, body and environment within reach of everyone, everywhere [15]. They produce life-changing breakthroughs. Even though health care lags behind other industries in digitization efforts, many leading pharma and medtech companies have started to put efforts in transforming themselves to create more value for patients and embrace opportunities in the digital era and Johnson & Johnson is one of them [16].

Johnson & Johnson launched its first global mobile gateway in 2013 with SAP, which launched its digital supply chain transformation. This gateway was used on desktops, smartphones and tablets. In 2014, they continued to improve their portal with the introduction of custom Fiori mobile apps for workflow approvals. In 2016, Johnson & Johnson implemented Neptune Software and the Neptune DX Platform for SAP IM/WM, PM, AutoID, GRC and more than 20 other applications [17].

J&J has created several digital tools to help guide people in their healthcare journey by leveraging their clinical knowledge and technology, as:
- *RA-RA (Remote Assessment in Rheumatoid Arthritis)* - a mobile app that can collect behavioural and health information (heart rate, sleep duration, etc.) and help indicate how well the medication is working and whether the patient's condition is improving or worsening;
- *One-touch Reveal* - mobile app that helps diabetic patients easily monitor and manage their blood glucose levels;
- *Digital ecosystem* that helps accelerate surgical consults for people with knee pain;

- *Robotizing Surgery* - the platform which will leverage five technology pillars – robotics, visualization, advanced instrumentation, data analytics, and connectivity – and use a large amount of data to help the surgeon make highly informed, fast and accurate decisions, in order to increase a number of robotic surgeries rate;

- *IoT* - in order to track goods in real time and the possibility of implanting sensors into some medical products, like artificial joints or contact lenses, to get real-time data on the health condition of patients;

Teams from J&J's consumer, business is still creating digital tools to help people track the health of their skin. Those working with medical devices are 3-D printing artificial joints personalized for each patient, while researchers in pharmaceuticals use AI to discover lifesaving drugs. They are redefining what it means to be a big company in today's world [17].

4.4. Schneider Electric & digital transformation

Schneider Electric SE is a French multinational company providing energy and automation, digital solutions for efficiency and sustainability. They highlighted that the driver behind this digital reboot is the customer, and that no longer can any company build technology in a vacuum; instead, it must leverage technology advancements (e.g., IoT, AI, cloud, sensing, mobility) to advance customer-centric innovation and R&D [22].

This company achieved positive business performances. Its place at the top 10 list is deserved also, taking into consideration that they are providing digital solutions for various business areas, as: healthcare, engineering and design, food and beverage, etc.

4.5. Nestlé – connecting through digitalization

Digitization is a determining factor in Nestlé's continuous evolution. It covers every aspect of their business and helps them to build new platforms for growth, improves agility and generates efficiencies [23]. As consumers are more pressed for time, digitally-engaged and health-conscious than ever before, they expect from Nestle's brands to offer or recommend 'fit-for-me' solutions that can be accessed on demand and seamlessly integrated into their lives. To succeed in this connected world, the company focused digitalization efforts on:

- Scaling growth in *e-commerce* - E-commerce is part of multichannel strategy, combining online and offline, to delight consumers with the best shopping experience however, wherever and whenever they decide to shop;

- *Digitalizing* operations - deploying flexible and scalable digital solutions to enhance responsiveness.

In 2020 Nestle increased the scope of its Transport Hub technologies to cover 50% of their global logistics network. In parallel, they extended the scope of AI-powered network optimization tools to evaluate different product sourcing and delivery scenarios [23].

4.6. Intel – driving the digital enterprise transformation

Intel Corporation is an American multinational corporation and technology company, the world's largest semiconductor chip manufacturer, and is the developer of the x86 series of microprocessors, the processors found in most personal computers. Intel provides a strong, scalable foundation of technologies for enterprise business solutions, small businesses, and everything in between [24].

As one of the digital change's generators, they provide technologies to their customers, as: *cloud computing, artificial intelligence, edge computing, internet of things*.

For this company, digital transformation refers to the use of technology that generates, stores and processes data to achieve a fundamental change in an organization's day-to-day business.

4.7. PepsiCo accelerates digitalization

Food and beverage giant, PepsiCo, has created "digital hubs" in Dallas and Barcelona, Spain, in order to centralize and advance enterprise efforts around technologies such as predictive analytics, artificial intelligence and machine learning. The primary goal is to become even faster, stronger and better company, and to assist the company in improving customer access to real-time sales and inventory data and provide employees with predictive decision-making tools to manage complexity with greater efficiency [25]. It may also include product development, customized customer services and targeted advertising campaigns [27].

The skills and technologies cultivated in the new spaces are expected to help PepsiCo mature in its ongoing digital transformation and strengthen the company's digital delivery ecosystem [26].

4.8. Walmart transforms to digital retail giant

Walmart is an American multinational retail corporation that operates a chain of hypermarkets, discount department stores, and grocery stores, which operates in the US. It serves 270 million customers each week online and are located within 10 miles of 90% of the U.S. population.

It transforms itself from a traditional retail company to a technology and an innovative company. Today, Walmart can be observed both as a technology company and an innovative company. During the 2018 fiscal year, Walmart has spent a total of 11.7 billion in technology investment, making it the third largest IT spender in the entire world behind Amazon and Alphabet [28].

Walmart has designed a digital-factory like system to try and test new technologies and scale it if the method reaches their KPI. They automate the inventory scanning process on the shelf space so that when customers come in to the store, they will always get what they were looking for. Walmart is also testing Electric Shelf Labels in two stores in U.S. to make price adjustment automatically as dictated by store management. Walmart define the future of retail with their Walmart Neighborhood Market in Levittown, New York, it's Walmart's new intelligent Retail Lab – or "IRL".

Walmart has continued to leverage technology, such as machine learning, cloud powered checkout and pickup capabilities to offer more convenience and enhance the overall shopping experience for customers [29].

4.9. L'Oréal reinventing the digital future of beauty

L'Oréal is a French personal care company, the world's largest cosmetics company focused in the field of hair

colour, skin care, sun protection, make-up, perfume, and hair care.

L'Oréal: As a digital first company, L'Oréal put digital at the service of their consumers but also of their teams to meet today's challenges, arouse interest in a world of hyper-connectivity and build relationships based on trust [30].

L'Oréal has transformed their web sites, in order to establish set of *e-commerce* solutions. Their transition to online purchasing is accelerating [33]. So far in the process of digitization, this company offers to their customers opportunity to try all their products in a virtual environment, thanks to *augmented reality*. L'Oréal hired 2,500 digital experts in recent years, and they promise that this is just a beginning. This company strives to create the transparent relationships with their customers, and that is possible thanks to usage of *Big data and apps.* Their project, My Little Factory, which is presented at VivaTech 2019, uses automation, collaborative robots, artificial intelligence, and computer vision to produce customized foundation on demand [32].

This company is using a various digital technology, which are recognized as a major tool for the future. One of them is *3D printing*, which is implemented for fast prototyping in order to be used for rapid creation of packaging, as well as for spare parts and format parts in our factories. In manufacturing, they have implemented agile lines so that some the factories can shift between a range of 20 different products in under 20 minutes, which in the past would take over four hours [31].

L'Oréal continues on the digital transformation journey, and the technologies as *Blockchain, Internet of Things, and Artificial Intelligence* is going to have a specific place in it.

4.10. Alibaba digitally connecs buyers and sellers

Alibaba is a Chinese multinational technology company specializing in *e-commerce, retail, Internet, and technology.* Over the years, Alibaba has made serious efforts to serve clients from every industry, helping them accelerate their business development and navigate the challenges of these volatile times.

Today Alibaba's business units offer a data-driven digital ecosystem, including a payments platform, mobile media and entertainment, marketing services and local services, all powered by its cloud business [34]. As a pillar of Alibaba Group's digital technology and intelligence, *Alibaba Cloud* is experiencing continued growth alongside its clients in different parts of the world. Cloud computing and AI technology have been shown to be the cornerstone for businesses seeking to be fully equipped in the digital era [36]. Alibaba Cloud covers a wide range of industries, including farming, FinTech, public sector, Internet, aviation, and more. It has 20 regions, 61 available zones, and 2800+ CDN Pops worldwide [35].

In China, *e-commerce* accounts for around 18% of total retail. According to previous, Alibaba's focus is to enable companies to digitize 82% (the rest), and not because they want these companies, but because they believe that digitization of different pieces of the value chains will be able to deliver more value to their target consumers. Alibaba wants to help them [35].

5 DIGITIZATION DURING THE COVID-19 – IMPLICATIONS AND CHANCES FOR BUSINESS

The COVID-19 crisis has caused numerous changes in the company's operations, by changing the work and market environment globally. Due to the new market conditions, many companies had to modify the way of doing business. Some introduced work from home en masse, as one of the measures to fight the pandemic. Research has shown that a third of companies began to use the Internet, social networks and digital technologies more intensively during the COVID-19 crisis. The COVID-19 crisis is also having a strong impact on supply chains. As supply chains are complex structures consisting of several different entities, they usually include markets wider than the borders of one state. Any slow or difficult flow of information and goods in the international context negatively affects the functioning and profitability of supply chains [37]. One study found that the COVID-19 crisis caused supply chain disruptions in 94% of 1,000 according to the revenues of the largest US companies [38]. In its Digital Supply Chain Survey 2020 report, consulting firm Grant Thornton [39] points out that more than half (57%) of the companies that survived the COVID-19 pandemic in the past 24 months had to redesign supply chains in order to successfully address the newly identified risks.

There are positive impacts of COVID-19, too. According to McKinsey & Company [40], it pushed companies over the
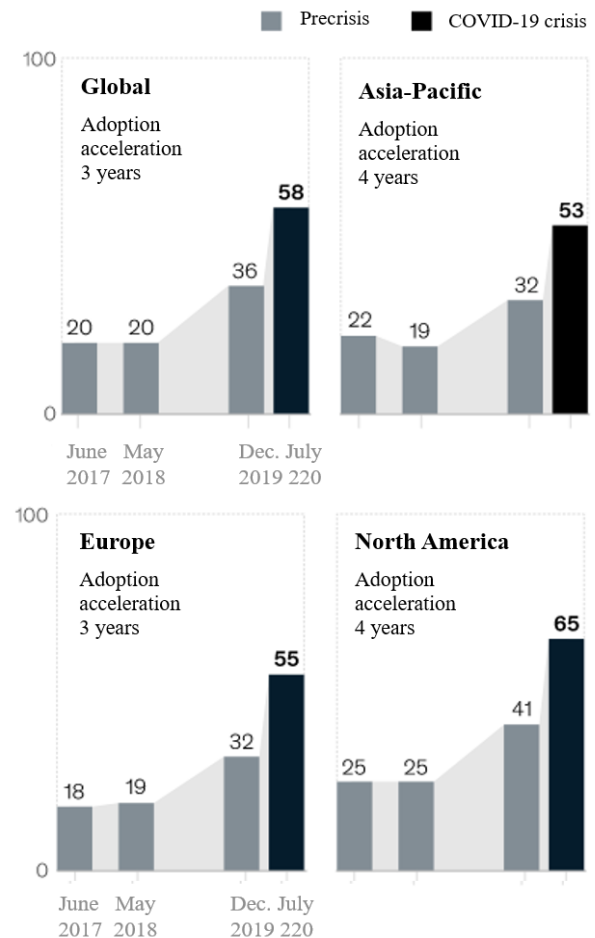

***Fig. 3** Average share of customer interactions that are digital, in %*

technology tipping point and transformed businesses forever, by accelerating the digitization of customer interactions. In COVID-19 period, digitization of customer interactions increases significantly compared to precovid period. This growth, as one of the positive effects, is shown in the figure 3 [40].

One more interesting fact, that McKinsey & Company [40] found out based on their research is that the majority of analyzed companies had a clear attitude that technology capabilities stand out as key factors of success during the crisis. Increased focus on digital technologies was greather in those companies whose revenue decreased by less than 25% in the past 3 years in regard to those which revenue increased by less than 25%.

The importance of technology is widely noticed. The OECD highlights the importance of reinventing digital services in the age of COVID-19 and observes that the COVID-19 crisis has made digital infrastructure of any country a backbone of their entire economy. The need to accelerate the digital transformation stems from an unprecedented change in consumer behaviour as the demand for government digital services has increased since the COVID-19 crisis [41].

Beside all listed, there are many more research of the usage of technology in the COVID-19 period. That implied a massiveinvestments in the digital technologies. According to KPMG research, the key technologies that companies are investing are presented on the figure below [42]:
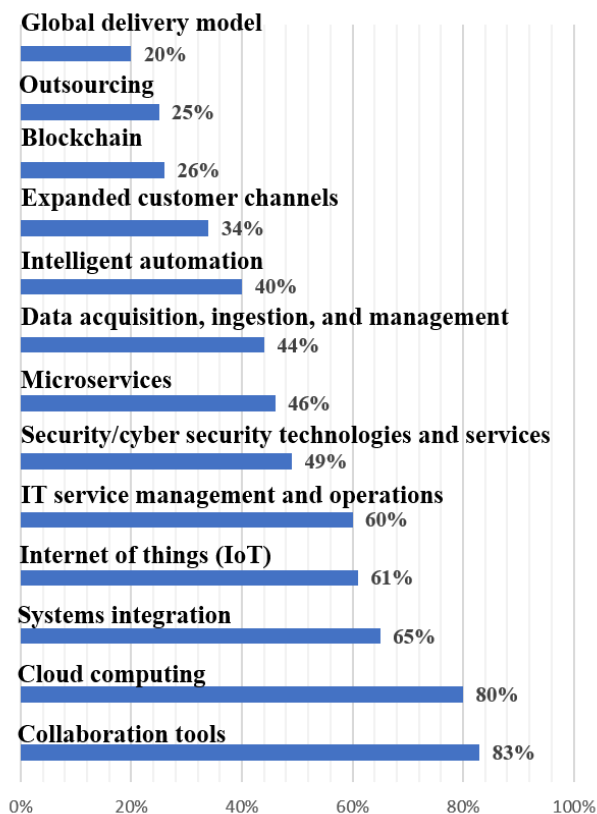

Fig. 4 *the key technologies that companies are investing during COVID-19 period*

6 CONCLUSION

DSCM is, as it is presented in the paper, the new era of supply chain management. The digital technologies are at the core of everything in business, as well as in SCM. The most successful supply chains are directing their businesses into digital. Some of the analyzed supply chains in this paper are the generators of digitization, and the others are users. Together, as the most succesfull, they are making the completely new environment for operating. These changes, which the analyzed companies (supply chains) have started, represent a growing trend in business, today and they can be used as role models.

In this paper, an analysis is performed - a short case study that included the operations of the largest supply chains that generate / use digital technologies in their business, which further indicates their importance.

When it comes to the use of digital technologies, their importance becomes even greater in the COVID-19 period. Among the companies analyzed in this paper, their business was already based on technologies before the crisis, and the crisis itself only further accelerated their use. However, for many other companies and supply chains, which are not covered in this paper, technologies have become a lifeline in such crisis conditions, enabling them to continue their business and survive in the market. For many of them, this was the only possible business solution.

So, based on everything presented, we can draw one general conclusion, and that is that digital technologies definitely have a special role in business, and that their impact on business is significant.

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