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INTERNATIONAL SUPPLY CHAINS IN PHARMACEUTICAL INDUSTRY AFTER SARS-CoV-2

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Purpose: The paper presents the issues related to international supply chain in the pharmaceutical industry.
Design/methodology/approach: The study used world-bank reports from Statista portal and the own research.
Findings: The international supply chain is a sequence of events, a process of moving goods with a goal of meeting the demand for certain products. The simplest chain can be defined by three components: supplier, enterprise, recipient. Due to the coronavirus pandemic, the supply chain has been interrupted and disrupted, as shown by the example of a company from the pharmaceutical industry. Components are sourced from suppliers around the world, and thus that the company and its production cycle do not has been disturbed, schedule timely deliveries. Unfortunately, due to the outbreak of the coronavirus pandemic, timeliness has been disrupted, which means that companies relying on one supplier had to acquire new ones in order to be able to implement production plans and meet deadlines from orders. On the example of a company from the pharmaceutical industry, one can come to the conclusion that through the pandemic in the logistics chain, the following were most affected: fluidity of deliveries, compliance of notifications, disturbances in production planning, execution of orders in accordance with the schedule. The article is theoretical and overview in nature. It uses content analysis and identifies specific analytical categories such as supply chains in pharmaceutical industry and trends in the international trade. The research methodology uses the literature analysis and critique method, as well as the document research and case study method.
Originality/value: The publication presents the results of research conducted on the basis the Statista portal.

Keywords: supply chains in pharmaceutical industry, SARS-CoV-2, international trade, global value chains.

Category of the paper: Research paper.

1. Introduction

The supply chain is a network of suppliers, producers, wholesalers and retailers performing the functions of supply, production, storage and distribution.

The supply chain consists of a network of factories and contractors who supply raw materials and components then convert them into semi-finished products and components then produce the final product from them and enable their consumption by the final consumer. Transport and storage are key elements of the supply chain. All literature definitions point to three basic characteristics of the supply chain:

- Subject structure, i.e. clearly distinguished entities participating in the supply chain,
- The subject of flow, understood as products, materials, goods processed and transferred through subsequent links in the supply chain,
- Objectives, functional scope and areas of cooperation of participating entities

Enterprises in any supply chain must make decisions, alone or together, in five areas: production, wrestling, location, transport and information. The sum of these decisions defines the scope of possibilities and efficiency of the supply chain.

2. International Supply Chains

Transformations taking place in the global economy have significantly contributed to increasing the level of commitment of individual countries in global value chains. Logistics is of a global nature because it is associated with international trade, often of a global range, which is characterized by concentration of turnover, geographical dispersion of highly competitive supply and sales markets. The basic directions of global logistics are achieving operational excellence, cost leadership and a high level of customer service, especially in the field of supply (distribution) logistics and distribution. In the global economy, the supply chain is transformed into an international, integrated network of coordinated dependencies and logistics activities implemented by external and internal partner companies within the framework of global logistics systems. Such a global chain provides companies with the highest achievable availability of goods, increased productivity and improved service quality at an optimal level of costs, acquisition and maintenance of inventory, transport, storage, distribution and the amount of working capital. The most important trends in the functioning of global supply chains - continuation to reduce costs - the need for a better understanding of cost sources and the location of their origins. Expansion of supply bases - optimization of human resources - improvement of business expansion methods. By analyzing the supply chain internationally, it can be defined as a network of related and dependent organizations that operate on the basis

of mutual cooperation, jointly controlling, directing and improving material and information flows from suppliers to final recipients, with some of these organizations being outside the borders of the country where the final recipients of the good (customers) live. There must therefore be a crossing of the state border in the supply chain.

Management of the global supply network should focus more on improving management and distribution efficiency by improving efficiency and effectiveness, rather than supply chain management.

3. Supply chain management

For the first time, the term "supply chain management" appeared in the literature in 1982 and was initially associated primarily with the reduction of inventories within the enterprise and the companies cooperating with them. The creators of this concept are considered R. Oliver and M. Webber, who wrote about the supply chain in the context of the role that the top management of international companies should play in recognizing conflicts, the goals of various functional areas of the organization that cause an uncoordinated flow of products, information and financial resources (Christopher, 2021).

One of the first definitions of supply chain management in the logistics context (Witkowski, 2003) was the formulation that it was planning, coordinating and controlling the flow of materials, parts and finished products from suppliers to recipients, which include two separate flow streams (materials and information). An example of logistic interpretation is also the supply chain model disseminated by the Supply Chain Council (SCC) existing since 1996. The association, similarly to the APICS organization for MRP II class systems, has developed a reference model in relation to the function of software tasks for supply chain management. The reference model developed by SCC containing the principles and elements used in the creation and computerization of supply chains is called SCOR (Supply Chain Operations Reference). The SCOR model regulates operations related to planning, purchasing, manufacturing and supplying products in the supply chain.

Management of integrated supply chains began to develop dynamically only in the early 1980s. However, it should not be forgotten that the source of the theoretical and methodological foundations of the management idea discussed were the results of research on distribution channels, cooperation of production enterprises or system integration, published at least twenty years earlier. Researchers in supply chain management even refer to the achievements of the late 1950s and early 1960s. This is especially true for Forrester's publication, which, by examining flows between suppliers and customers, pointed to the problems of excess inventory at suppliers as a result of a gradual increase in information distortions about small

changes in demand as they moved away from the market, which was popularized under the meaningful name of the "bull effect".

The latest methods of supply chain management developed in the years 2005-2013 were preceded by the reconstruction of the subject scope of research on the supply chain. Experience to date has been limited to transport, inventory management and optimization of logistics networks, and demand analysis. The new approach is that supply chain management should be combined with financial, marketing or information management to ask the question of how and why. The modern supply chain influences the competitiveness of the transnational corporation. There were even theses that integrating all functions of strategic management with logistics can be described by 53 other scientific disciplines such as sociology, philosophy, political sciences and psychology besides economics.

Supply chain management aims to provide the highest value to the customer at the lowest cost for the entire chain and consists in managing relations with: suppliers, recipients, and clients.

Each organization that is on the path of material flows in the supply chain alters their characteristics and increases their value. Controlling the flow of goods and related information is an essential task of supply chain management. This management is synonymous with planning, controlling and controlling the flow of goods through all phases of creating value added to goods from the place of obtaining raw materials, through production to the final buyer.

All this aims to offer these goods to buyers at the right place and time, in the right quantity and quality, and at pre-determined costs. Thus, effective supply chain management often translates into a reduction in operating costs and an increase in the level of customer service. The most frequently formulated goals of supply chain management in terms of logistics are: minimization of the total costs of product and information flow while maintaining the level of quality of delivery service required by customers; ensuring the shortest possible lead time and the highest possible reliability, frequency and flexibility of deliveries at the assumed level of flow costs; optimization of inventory levels in the supply chain scale along with flexible adaptation to the preferences in handling delivery of individual market segments, the key elements to manage the supply chain are: locating production plants and warehouses, transport activities, storage and handling, shaping and inventory control, collection, processing and transfer of information accompanying the physical flow of the product, cooperation with marketing in the area of customer service, and packaging and residue management.

In addition to the interpretation of supply chain management from a logistics point of view, more and more authors emphasize integration features and the need for space-time synchronization of demand flow management with the physical flow of product supply. The views of the authors emphasizing the integrative aspects of sustainable cooperation of enterprises for which the supply chain and supply chain management are broader concepts than the logistics chain and their management is distinguished by:

- Process orientation, which means treating activities and flows implemented in supply chains as processes;
- Recognizing the significant opportunities for cooperation of chain links in research and development, logistics, production, marketing and financial processes;
- Striving to optimize the value added to the products and services offered, and as a consequence increase the value of the supply chain itself;
- The need to integrate and coordinate the three streams, which are material, information and financial flows.

Since the mid-nineties of the twentieth century, the dominant view is that cooperation in supply chains begins already at the stage of product creation and development. On the other hand, the next of the basic processes that should be managed on a chain scale include demand planning and order fulfillment. An even broader scope of cooperation in supply chain management results from the analysis of the relationship between the product and relationships in the supply chains. Under both these variants, R. Cooper and R. Slagmulder distinguished between the stages of creation and implementation.

Analysis of the relationship between product design and production and network design allows you to determine areas of supply chain management which are: product and network configuration, product design, formation of production networks, optimization of processes in the supply chain.

Operational management, closely linked to strategic, concerns techniques and technologies supporting strategic decision-making, and new solutions in this area include: RFID as a new way to identify goods in the supply chain; a team of techniques for using voice, e.g. pick by voice, to issue orders regarding the relocation of inventory; EU directive called WEEE (Waste Electronical and Electronic Equipment) for the implementation of sustainable supply chains for environmental protection for recycling.

These methods can be introduced and implemented subject to the use of information technology, which at the same time helps to make the necessary decisions but also provides a lot of necessary information needed to manage the supply chain.

4. International supply chains in the pharmaceutical sectors after SARS-CoV-2

The international supply chain of the pharmaceutical industry was running very smoothly until the COVID-19 pandemic. However, the pandemic period revealed two disturbing phenomena. Firstly, the high dependence of the supply chain on air transport. Secondly, the crisis revealed a very strong dependence of the pharmaceutical industry on India and China, which account for 60 to 80 percent of the production of active substances. Radical shift in drug

production to be tackled by the European Commission in the coming weeks. However, international observers of the sector point to difficulties in recreating national factories of active substances. Therefore, more than a return to active substance production in Europe, there is now more talk about diversification of supply sources as a more viable and less expensive solution.

The United States was the largest domestic pharmaceutical market in 2022, accounting for more than 42 percent of total pharmaceutical spending worldwide. China is the second largest market with a market share of around eight percent (although it only includes the hospital market). The global pharmaceutical market was valued at approximately $1.48 trillion in 2022. Pharmaceutical sales in the United States generated approximately $630 billion in 2022, more than $500 billion more than any other country.

Differences between countries result, among other things, from the prices of prescription drugs. In the United States, the prices of branded drugs increased significantly between 2011 and 2019. In 2021, the United States had the highest per capita pharmaceutical spending in the world at an average of US$1,310. Branded drugs benefit from patent protection and the lack of competition means that both manufacturers and pharmacies can charge what is acceptable to the market.

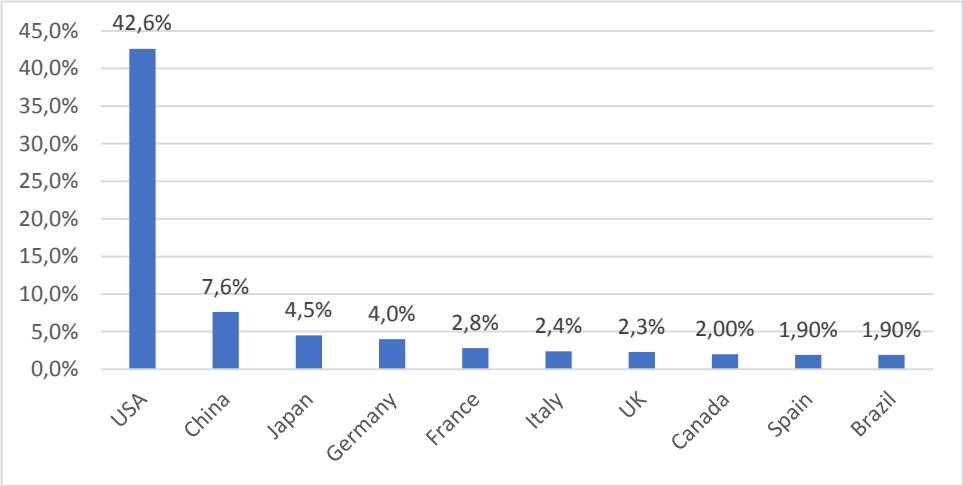

Figure 1. Market share of leading 10 national pharmaceutical markets worldwide in 2022.

The global pharmaceutical sector has an oligopolistic structure also at the level of enterprises. It is dominated by strong global companies. In 2019, 42% of the value of the pharmaceutical market was among the 16 largest global enterprises in the world. They are: Roche (Switzerland/Germany), Novartis (Switzerland), Pfizer (US), Merc & Co (US), Bristol-Myers Squibb (US), Johnson & Johnson (US), Sanofi (France), AbbVie (US), GlaxoSmithKline (UK), Takeda (Japan), AstraZeneca (UK), Amgen (US), Gilead Science (USA), Boehringer Ingelheim AG & Co KG (Germany), Bayer Pharma (Germany), Eli Lilly (USA).

5. Supply chains in the pharmaceutical industry

The analytical part of our paper is presented on the basis of one of enterprises supply chain disruption caused global pandemic since December 2019. The plant produces medicines and is located in several countries around the world. At work we will analyze the data on the acceptance of deliveries in one of the Polish branches companies. The Polish branch has 2 warehouses, and the components necessary for production supplies from over 150 different suppliers from around the world. From companies vans: 48 are located in Poland, 8 in Asia, and over 80 in Europe. European suppliers are stationed in countries such as: Germany, Great Britain, Slovakia, Italy. Italy – with the largest share among European suppliers. Imported goods from Poland and Europe are transported by trucks – land transport accounts for 97%. Sea transport is only 3%, it is Asian supplier. Deliveries are made on the basis of previously placed orders, adapted to a strictly defined production plan. In warehouses safety stock is maintained.

In this section, a comparison of the number of deliveries in 2019 will be presented and the first half of 2020. All deliveries arriving at the site are registered. This means that all goods are delivered to the warehouse in a planned manner, which facilitates not only unloading, but also the work of all departments companies. Below we present the differences in the compliance of the actual arrival of a delivery vehicle to the plant with the time of entry, based on last year 2019 and 2020, in which the structure of work was disturbed due to the prevailing pandemic.

Table 1.
Deliveries in 2019

2019	**2019**
Month	**Amount of deliveries**
Januar	383
Febrauar	500
March	525
April	568
Mai	576
Juni	600
July	492
August	520
September	594
October	568
November	596
December	515

Table 2.
Deliveries in 2020

2020	**2020**
Month	**Amount of deliveries**
Januar	206
Febrauar	260
March	65
April	61
Mai	89
Juni	230
July	392
August	420
September	494
October	540
November	550
December	501

Analyzing the number of deliveries accepted in 2019 and 2020, we can observe a dramatic decrease in the number of cars arriving at the plant. In 2019, except for two months in which the number of working days was lower. However, even in months parking, this number was not as low as in 2020, where from the first month we can observe a decrease in accepted deliveries. These are the lowest values recorded in the company's history. The worst period is in March, April and May, i.e. months where the economic situation was most disturbed. This resulted in stoppages of production lines or delays in their delivery. The situation began to return to normal in June 2020.

6. Summary

As shown in the presented example, interrupted supply chains can affect the operation of a pharmaceutical company in many ways. The largest areas of negative impact of the pandemic are:

- Liquidity of deliveries - in 2020, the number of accepted deliveries decreased compared to the same period of the previous year. It has it direct connection with the forced stoppage of production at suppliers and failure to deliver according to schedule.
- Disruption of production planning - untimely deliveries result in shortages component in stock, which translates into the inability to implement a specific production plan. The production planning department is forced to adjust plans based on the current availability of materials in warehouses. This is due to the increased inventory of the stock.
- Fulfillment of orders as planned - sudden changes in the production plan led to some orders not being fulfilled.

It can be said that as a result of the pandemic, global supply chains have been severely strained. This can be seen in the examples mentioned above, though pharmaceutical companies use alternative solutions whenever possible dealing with the economic crisis.

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