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Resilience of Supply Chains in the Automotive Industry during the COVID-19 Pandemic on the Example of Polish Enterprises

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Abstract:

Purpose: *The aim of the article is to present disruptions in the COVID-19 pandemic occurring in the supply chain of companies from the automotive industry. The specific objectives are the identification and characterization of companies operating in automotive supply chains, defining changes in the automotive industry during the pandemic, and showing the types of disruptions in supply chains and ways to counteract these unfavorable situations.*
Design/Methodology/Approach: *Companies from the automotive industry operating in Poland were selected for the research purposefully. Using the random selection method, 500 companies from the automotive industry were selected for the study, which constituted a large research sample. The data sources were surveys conducted in June 2023 among 500 enterprises in the form of a direct telephone interview.*
Findings: *The main disruptions and problems in the supply chain were longer order execution times, increased costs of transport, storage, and labor, as well as limited timeliness of deliveries. However, as a rule, disruptions lasted up to 1 year. One in ten enterprises declared that the disturbances are still ongoing. Half of the enterprises did not experience support from their partners in the supply chain. Despite this, 60% of enterprises did not seek or use alternative suppliers or buyers. The same share of enterprises made operational decisions during the pandemic, while ¼ made strategic decisions. The pandemic also did not*

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affect radical changes in supply chains, such as resigning from Asian suppliers in favor of European ones.
Practical implications: *The results will fill in the gap concerning supply chain disruptions in the automotive industry.*
Originality/Value: *The new information about impact impact of the COVID-19 pandemic on disruptions in supply chains*

Keywords: *Automotive industry, changes in supply chains, disruptions in supply chains, disruptions in the COVID-19 pandemic.*

JEL codes: *D04, D22, D30.*

Paper type: *Research article.*

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1. Introduction

The automotive industry was among the industries most affected by the consequences of COVID-19 during the first wave (European..., 2020). Disruption to the supply chains of the European automotive industry came with the closure of Chinese factories (Accenture…, 2020). However, the closures of factories in Europe between March and May 2020 were the most severe.

In EU countries, automotive factories were closed for an average of 30 days, with the shortest shutdown in Sweden (15 days) and the longest in Italy (41 days) (ACEA…, 2020). In the first half of 2020, the EU automotive industry suffered a production loss of 3.6 million vehicles. According to the valuation, this represented a loss of €100 billion. By the end of September 2020, this figure had risen to 4 million motor vehicles, representing 22.3% of total EU production in 2020 (ACEA…, 2021).

More than 1.1 million workers were directly affected by the pandemic, due to factory shutdowns between March and May 2020. In addition, the number of people actively working in factories was significantly reduced. Such measures were needed to maintain hygiene, distance, and safety measures, as well as due to reduced productivity and drops in demand (McKinsey…, 2020a; Thalassinos *et al.*, 2023).

During the second wave, there were other regularities. New blockades and restrictive measures were introduced in November 2020 in almost all EU Member States (Grima *et al.,* 2020; Khan *et al.,* 2020). In the case of the automotive industry, the problems concerned car dealers, which had to be closed down. This increased overall economic uncertainty for consumers. Of course, there were differences between EU countries. Overall, however, the second wave of the pandemic was less severe for the automotive industry (McKinsey…, 2020b).

The coronavirus pandemic had a devastating impact on the automotive value chain and affected the R&D and manufacturing activities of many Original Equipment Manufacturers (OEMs) (Ecorys…, 2020; Kadlubek *et al.,* 2022). However, there were differences in terms of individual components for cars. For example, the COVID-19 pandemic had a devastating impact on the battery value chain.

In the first months of the pandemic, the global lithium-ion battery value chain was completely blocked in China. There was a decline in the extraction of cobalt and lithium needed for battery production. Lithium could potentially be sourced entirely in the EU, while cobalt and nickel were not (Huisman *et al.,* 2020).

According to data even before the economic crisis caused by the COVID-19 pandemic, the automotive industry in Poland generated 8% of the Polish GDP and at the same time 21% of exports. Poland was in 10th place worldwide in terms of the value of exports of automotive parts and accessories. Based on these data, it can be concluded that the development of the automotive industry is one of the key factors stimulating economic growth in Poland.

In addition, the automotive industry is very modern and innovative. Therefore, the proper condition of enterprises operating in this industry has a direct and indirect impact on the competitiveness of the Polish economy. It is important to investigate the disruptions emerging in the supply chains of automotive companies operating in Poland. The COVID-19 pandemic and the disruptions occurring in supply chains at that time may affect operational and strategic decisions. The researchers' knowledge is limited.

The authors have not yet encountered research on such a large group of automotive companies. Usually, information and research results on a selected company or a few companies are reported. The proposed research fills the research gap and will allow us to identify existing regularities in automotive supply chains. The article's main objective is to present the COVID-19 pandemic disruptions occurring in the supply chain of automotive companies. The specific objectives are:

- identification and characterisation of companies operating in automotive supply chains,
- identifying changes affecting the automotive industry during the pandemic,
- demonstrating the types of disruption in supply chains and how to counteract these disadvantages.

The article seeks the answers to research hypothesis:

Hypothesis 1: Supply chain disruptions during the COVID-19 pandemic in automotive companies were short-lived and resulted in operational decisions.

The organisation of the work is as follows: Section 1 provides an introduction to the topic. The disruptions of the COVID-19 pandemic in the supply chains of the automotive industry were presented. The section also includes the rationale and objectives of the article. Section 2 proposes methods to identify disruptions occurring in the supply chains of automotive companies. In Section 3, the research findings were presented. In Section 4, the reference is made to other research results that dealt with the relationships tested. Furthermore, the main conclusions of this paper can be found in Section 5.

2. Materials and Methods

Automotive companies operating in Poland were purposively selected for the study. Using a random selection method, 500 automotive enterprises were selected for the study, which constituted a large research sample. According to estimates, there were approximately 2,000 enterprises in Poland with a strict focus on the automotive industry and several thousand with indirect links, e.g., garages.

The data sources were surveys conducted in June 2023 among 500 enterprises in the form of a face-to-face telephone interview. The interview questions were prepared in advance. Most questions contained closed answers. A few questions also had open-response options. The surveyed enterprises participated in the survey voluntarily. The interview was conducted most frequently with the owner of the company (81% of interviews). Other respondents included logistics staff (10%), administrative staff (7%), and, least frequently, accounting staff (2%).

The data was collected in an Excel form and then coded and processed. The survey results are aggregated so as not to reveal data on individual companies. Based on the resulting survey results, the shares of individual responses can be determined.

The research was divided into stages. In the first stage, basic information about the surveyed companies was presented. Stage two showed the supply and diversification trends in this area. Stage three concerns the identification of existing disruptions in automotive supply chains. Finally, ways of responding to these disruptions were presented.

A limitation of the research carried out is that it was limited to only a subset of companies. It was not possible to survey all companies operating in the automotive industry. For the study, research results concerning only selected questions were presented. Due to publishing limitations, it was possible to present a section of the research, but a fairly significant one.

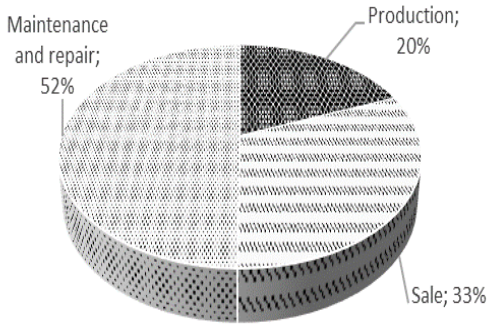
Another limitation of the research is that the results are quite general, as the research does not deal with more detailed patterns and actions taken. In the next stage of the research project, in-depth interviews will be conducted with a smaller number of companies. Then the exact actions and ways of counteracting supply chain crises in the sample automotive companies will be shown.

3. Results and Discussion

The automotive companies surveyed were engaged in a variety of activities. It was possible to distinguish, for example, the production of tyres and tubes, the production of cars, the production of bodies for motor vehicles, the production of electrical equipment for cars, wholesale and retail sale of cars, wholesale and retail sale of car parts and accessories, as well as maintenance and repair of motor vehicles.

Slightly more than half of the businesses surveyed were engaged in car maintenance and repair (Figure 1). Sales accounted for 33% of the enterprises surveyed and manufacturing for 20%. This share is not a coincidence. This is more or less the structure of enterprises in the total population. Those involved in production are the least. There are more links involved in sales. Distribution is generally done through cooperating dealerships. Service and repair-related services are essential for the proper functioning of cars, so these types of entities are the most numerous.

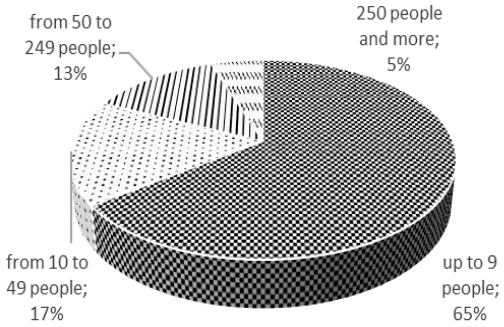
Figure 1. *The main activity of the surveyed enterprises.*



Source: *Own study.*

Another aspect was to determine the size of the respondents in terms of the number of employees. Micro-enterprises with up to 9 employees predominated (Figure 2). Examples of such entities are mechanical repair shops, where the owner often worked and employed a few workers. In contrast, there were the least number of large enterprises. These tended to be car manufacturing enterprises and also involved in the commercial distribution of cars and car parts. The distribution of enterprises is in line with that found in many market-based industries.

Figure 2. *Number of people employed in the surveyed enterprises.*

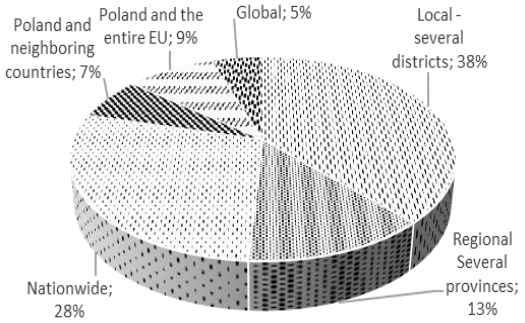


Source: *Own study.*

The companies surveyed had different sourcing markets. There was a very high proportion of those using local suppliers (Figure 3). This was followed by national suppliers and also regional suppliers. This type of entity was mainly sourced by small-scale enterprises, such as repair shops. Only 7% of entities had suppliers from Poland and neighbouring countries, 9% from EU countries, and 5% from the rest of the world (especially Asia).

The results are correlated with the structure of the companies surveyed. It should also be remembered that smaller entities used, for example, the supply of parts from wholesalers. Wholesalers, on the other hand, may have ordered parts on international or global markets.

Figure 3. *The main supply market of the surveyed enterprises.*

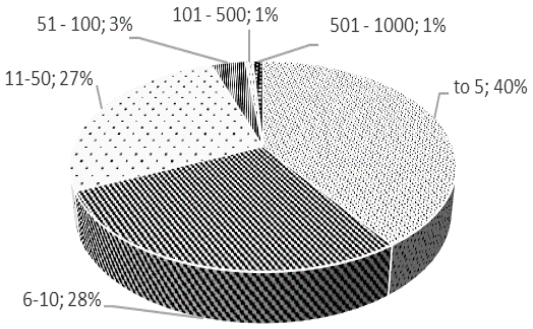


Source: *Own study.*

The number of suppliers used by the companies was then identified. The most common was up to 5 such suppliers (Figure 4). There was a fairly high proportion of enterprises with 6 to 10 suppliers (28%) and 11 to 50 suppliers. Only a few enterprises had more than 100 or even more than 500 suppliers. A limited number of suppliers allows for better coordination of deliveries. On the other hand, in crises becoming too dependent on a few suppliers can be a problem. In such a situation, it

is either necessary to look for one-off or ad hoc supplies from other suppliers, or to try to enter into longer-term contracts to diversify supply.

Figure 4. *The number of suppliers of the surveyed enterprises.*



Source: *Own study.*

In a further step, the research looked at the changes that occurred in automotive companies as a result of the COVID-19 pandemic. As many as 65% of the surveyed entities stated that the company had experienced some kind of disruption or problem in the supply chains, e.g., delays, lack of goods, price increases, etc.

Such a result shows the high dependence of the surveyed companies on the situation in global markets. These dependencies can be direct, but also occur in supply chains.

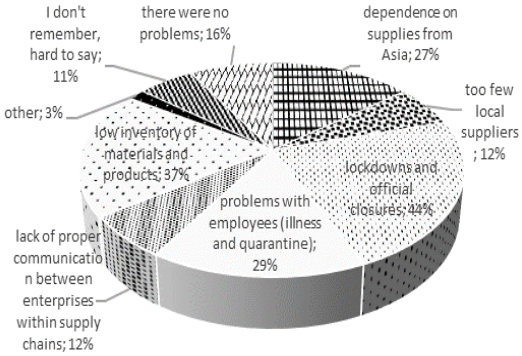
According to the representatives of the companies surveyed, the most important causes of problems in the automotive supply chains during the pandemic were lockouts and official closures (Figure 5). These were causes beyond the control of the companies. Low stocks of materials and products were indicated just as frequently (37% of indications).

In this case, problems resulting from the management of the company and the inventory management strategy adopted were indicated.

Problems with employees (sickness and quarantine) were indicated in 29% of companies. These were problems independent of the company in the case of workers being. outside the workplace, but already dependent when working on company premises.

Less significant problems were too few local suppliers and a lack of proper communication between companies within supply chains. Only 16% of the companies surveyed had no disruption to their supply chains during the pandemic.

Figure 5. *The most important causes of problems in the supply chains in the surveyed enterprises.*



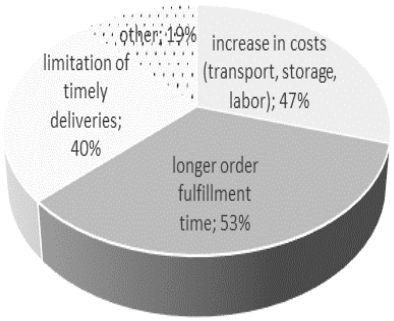
Source: *Own study.*

Those representing the companies indicated specific types of disruption. Most common, 53% of the companies surveyed, were problems with longer lead times during the pandemic (Figure 6). Equally common were problems related to increased freight, storage, and labor costs (47%), as well as those related to on-time delivery (40%). Such a high percentage of companies experiencing problems indicates that the COVID-19 pandemic had an impact on the operation of automotive companies.

However, disruptions to supply chains were most often short-lived, lasting up to six months or between six months and a year (Figure 7). These ranges were indicated in 36% and 35% of companies respectively. Disruptions lasting between one and two years were indicated by 13% of the companies surveyed. Interestingly, as many as 12% of the companies still had such disruptions at the time of the interview.

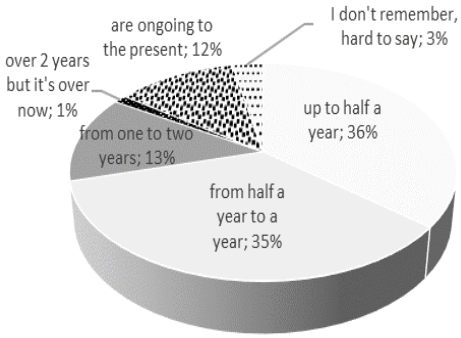
This means that perhaps appropriate measures were not taken to reduce disruption. Perhaps some of the companies did not have alternatives or did not look for other suppliers of materials or customers for their products.

Figure 6. *Types of disruptions (problems) related to the supply chain during the pandemic in the surveyed enterprises*.



Source: *Own study.*

Figure 7. *Duration of supply chain disruption during the pandemic in the surveyed companies.*

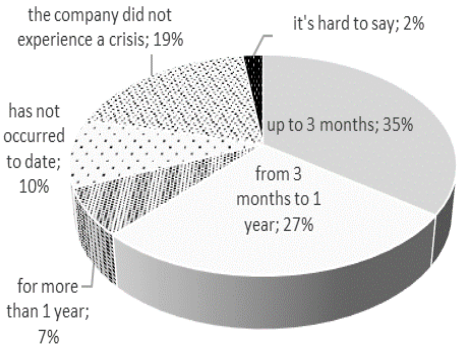


Source: *Own study.*

The COVID-19 pandemic has been halted and even ended. This is evidenced by regulations and the lifting of all bans and restrictions. In Poland, for example, all restrictions were lifted on 1 July 2023. The return to pre-crisis activity caused by the COVID-19 pandemic was mostly rapid in the surveyed companies (Figure 8). It was generally 3 months (35% of respondents) or between 3 months and 1 year (27%). Some companies indicated continuous problems (10%). In 19%, no crisis was observed. In general, companies adapted quite quickly to the new situation and reacted accordingly, thus avoiding long-term problems.

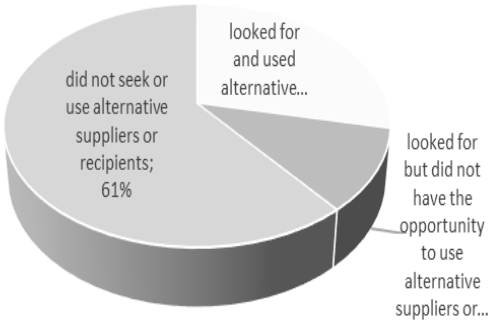
During the COVID-19 pandemic, automotive companies generally did not seek and use alternative suppliers or customers (Figure 9). This was indicated by 61% of company representatives. The reasons for this could be various, such as independence from suppliers or trust in supply chain partners. Only 28% of companies were taking steps to diversify their supplies. 11% of the enterprises surveyed were looking for alternatives but did not have the opportunity to use new suppliers.

Figure 8. *The time of return to activity from before the crisis caused by the pandemic in the surveyed enterprises.*



Source: *Own study.*

Figure 9. *Actions taken during the pandemic in the surveyed enterprises.*

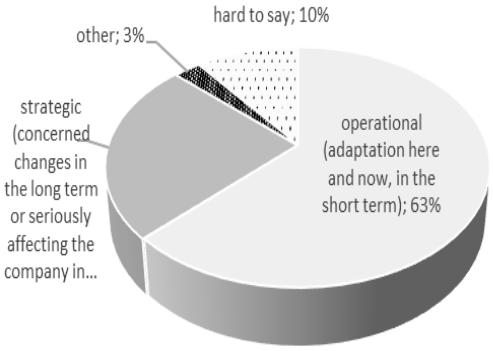


Source: *Own study.*

In 61% of companies, supply chain activities and decisions during the pandemic were operational (Figure 10). Adaptation was about actions in the here and now, in the short term. Perhaps company managers were hoping for short-term problems that the company would survive. In such a situation, abrupt and radical decisions were not advisable.

One in four of the companies surveyed took strategic decisions. The decisions of the managers concerned changes in the longer term or seriously affecting the company in the future. It can therefore be concluded that the vast majority of companies decided to wait out the worse period.

Figure 10. *The nature of activities and decisions regarding the supply chain during the pandemic in the surveyed enterprises.*

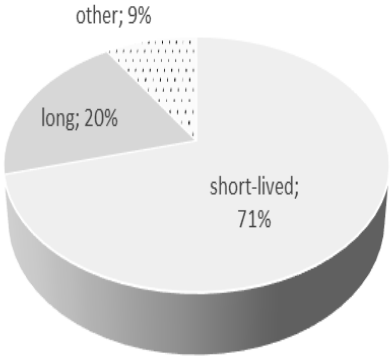


Source: *Own study.*

Representatives of the automotive companies surveyed also assessed that the changes and adjustments as a result of the pandemic were short-lived in their companies (Figure 11). This was indicated by as many as 71% of company representatives. Only in 20% of the companies were the replacements assessed as long-term.

Thus, it can be concluded that a large proportion of enterprises made some adjustments only during the crisis and, once the effects of the crisis had subsided, returned to their previous operating model.

Figure 11. *The nature of changes (adjustments) in the supply chain as a result of the pandemic in the surveyed enterprises.*



Source: *Own study.*

4. Discussion

The Global Supply Chain (GSC) is a multi-level system with many invisible downstream suppliers that are extremely important to the overall supply system. An automotive company generally has more than 900 tier-1 suppliers, each with an average of more than 500 tier-2 suppliers (Burns and Marx, 2014). Few companies can track their tier 2 or higher suppliers. Such extended networks reduce GSC visibility and result in slow responses to unexpected damage (Hofstetter, 2018).

In such a situation, disruption to a key player in the supply chain can have detrimental consequences for the entire GSC. It is estimated that at least 5 million companies worldwide had one or more tier 2 suppliers in the Wuhan region (Wallace, 2022). Often these were irreplaceable suppliers for whom it was virtually impossible to find suitable alternatives elsewhere, especially during such a crisis. In our research, we also found that companies often did not seek alternative suppliers or simply did not have them. Such dependencies are particularly damaging during crises such as the one caused by COVID-19.

During the pandemic, what companies needed most was action to quickly restore their own, as well as their upstream and downstream supply chain partners' capacity. During the pandemic, the central supply chain company needed the support of its supply chain partners, especially small and medium-sized suppliers.

Measures were also taken to safeguard supply chain partners' employees during the pandemic, such as the production of or purchase of protective masks (Xie, 2022).

From a supply chain perspective, such measures prevented the spread of COVID-19 and preserved human resource capacity and the ability to respond and recover quickly according to market needs (Sheffi and Rice, 2005). Companies should adopt proactive initiatives and strategies to achieve flexibility, responsiveness, and visibility.

Particularly important is an effective response to disruptions as an important indicator of supply chain resilience (Kumar and Anbanandam, 2020; Shashi *et al.*, 2020). In the case of automotive companies, characterised by a large network, a supply chain disruption in one segment often creates a ripple effect and affects the entire chain (Dolgui *et al*., 2018; Queiroz *et al*., 2022).

In times of crisis, responsiveness is particularly important, as it enables automotive companies to respond quickly and cost-effectively to disruptions. However, most activities involve operational processes. Our research also showed that it was operational actions that were taken by the companies surveyed. Strategic decisions were taken much less frequently.

In the short term, rapid improvement within the GSC is enabled by alternative sourcing and stock redundancy (Worstell 2020). Adequate stock levels are a logistical issue. Of course, companies aim to minimise stocks, but the recent crisis has shown that their importance is crucial.

On the other hand, it is also important to propose and verify alternative materials and to source local substitutes (Paul and Chowdhury, 2020).

Alternative materials enable companies to have more sourcing options, while local suppliers guarantee high material availability. In long-term planning, supplier diversification and capacity redundancy reduce the risk of disruption when supply chains experience reduced operations due to crises (Manning and Soon, 2016). Working with suppliers in different geographical locations should be the preferred strategy. Alternative sources provide a safety buffer against supply, production, and distribution disruptions (Kraude *et al*., 2018).

However, it must be stated that during the COVID-19 pandemic, the most important task for automotive companies was to survive the pandemic, not to spend extra money on developing a new supply chain. In our research, we also found such patterns.

The companies surveyed were focused on their chains. There was a small proportion of companies looking for new alternative suppliers. The reason may have just been to focus on the company's current issues, to ensure its survival. In addition, companies may have anticipated that problems in their supply chains would be short-lived.

5. Conclusions

Based on the research conducted, it was possible to identify the types and frequency of disruptions in the supply chains of automotive companies. The research presented allows several conclusions to be drawn:

1. In Poland, the automotive industry was dominated by small-scale enterprises involved in car maintenance and repair. The larger the scale of operation, the smaller the proportion of enterprises. Such a result demonstrates the high fragmentation of the automotive industry.

2. Most often, companies were dependent on local or national suppliers, while few companies had global suppliers. The reason for this may have been the extensive and multi-level supply network used in the industry. A small number of suppliers, up to 5 or 10, were used most often. There was a small proportion of companies with multiple suppliers. Another reason was the structure of companies in the industry with a small proportion of large companies with very many suppliers.

3. Most of the companies surveyed experienced disruptions in their supply chains. Among the most important reasons for such situations were lockouts and official closures, low stocks of materials and products, and problems with employees (illness and quarantine). When concretising the types of disruptions, problems with longer lead times, increased freight, warehousing, and labor costs with on-time delivery were indicated above all.

4. In the companies surveyed, supply chain disruptions were most often short-lived (up to 1 year). Operational measures were most often used to counter irregularities. The hypothesis posed in the study was confirmed. The reason may have been the belief that the pandemic was short-lived and that everything would quickly return to its previous state. On the other hand, companies may have been surprised by the situation and were just trying to survive. Most often, strategic decisions, such as looking for alternative suppliers, were not taken.

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