

BUILDING RESILIENCE ATTRIBUTES OF SUPPLY CHAINS FROM THE PERSPECTIVE OF THEIR TYPES

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Abstract:

We are currently dealing with disruptions in supply chains. They come from faulty production systems, in poor organization of distribution processes or are related to external factors, often unseen. Consequently, it is necessary to build resistant chains. This article discusses this topic in the context of the basic types of supply chains, i.e. agile, lean and green. The aim of the study was to assess the types of chains in which the tested production entities are embedded and check if the proposed models of building resilience take this into account. The reason this should be investigated further, is to indicate relationships in areas that are rarely captured in research models. Both quantitative and qualitative methods were used in the work. Interviews were conducted in over seventy subjects and a critical analysis of the literature on model of resilient supply chains was performed. As a result of the work undertaken, it can be concluded, inter alia, that in the economic reality, there are hybrid chains in which the characteristics of pro-saving chains prevail. It was also established that the proposed research models for resilient chains should take into account, to greater extent, accents compatible with the nature of the chains occurring an economic reality. It is also necessary to extend their content to include pro-environmental components. At the same time, it is not unequivocal that the chains with the advantage of agility-related attributes are more resistant than the chains in which the greater concentration is attributed to the attributes of lean or green chains. Determining this requires further research.

Key words: agile, disruptions, green, lean, resilient supply chain

INTRODUCTION

Supply chains are increasingly exposed to various types of disruptions resulting from the natural, market, political, climate, economic, and many other causes. It is therefore important that the chains are resilient and robust enough to maintain or regain disrupted competitiveness. It is related to the types of the supply chain [1]. However, while there are studies on green, agile or lean chains, this topic is rarely directly related to the issue of resilience. This is because both the resistance research and the chain hybrid research are in a very early stage of development.

The study aims to:

- determine what types of activities characterizing a given type of supply chain dominate in economic practice,
- identifying what types of chains are predominant,
- diagnosing whether the proposed models and research of resistant chains are adequate to the functioning hybrids in the economic reality,

- an indication of the relationships between individual chain types and the resistant chain; primarily in the context of the identified research gaps.

LITERATURE REVIEW

In definitions of "resilient supply chains" (RSC), emphasis is placed on the aspect of eliminating disturbances through the preparation of appropriate contingency plans, as well as the ability to respond to them in completely unexpected situations [2, 3, 4, 5, 6].

The definitions indicate that resilience supply chains are those which can respond to the negative effects of a disturbance by reverting to the same state or a new, more desirable state. It is also noted that these are chains in which production and distribution systems can meet customer expectations promptly. The study focuses primarily on the supply chain's ability to reduce the likelihood of a disruption, which is also emphasized in the definitions. This capacity can be developed in various ways. One such way is the skillful creation of supply chain types in terms of their resilience.

Therefore, it is assumed that resistant chains are those chains that usually form a hybrid of different chain types (for example, agile, green, and lean) and can use the principles and tools that are characteristic of them to mitigate disruptions in the supply chain.

We can talk about the resistance of food chains [7] of the blood transport supply chains [8] or resistance in the process of drug transport [9]. Each of these chains have their own character.

Therefore, it can be a chain in which environmental aspects are of first and foremost important. So, we are talking about the so-called green supply chain, i.e., one in which the design of products and the management of their flow up and down in vertically integrated cells is carried out with particular emphasis on the need to protect the environment [10]. It can be a lean chain, i.e. a chain based on long-term relationships, mutual trust, in which one strives to reduce costs by reducing all kinds of waste [11], as well as an agile chain, i.e. in which the chain reacts quickly both in terms of the quantity and time of delivery of goods and in terms of adapting the type of product offered to the needs of customers [12]. In the economic reality, we also find several other chains, such as a closed-loop chain, a balanced, elastic, sensitive, or looped chain, but the considerations focus on the three mentioned and fundamental ones.

Extensive reviews identify research gaps in agile chains [13, 14], green chains [15], and lean chains [16], as well as their relationships. Among other things, it is shown that hybrids of lean and green chains improve the efficiency of an organization in both financial and environmental dimensions [17, 18]. It is also worth noting that relationships of this type should also be considered at a more detailed level and assess which of the specific attributes of the chains affect the organization's performance [19]. This may apply to both the tools used (e.g. lean six sigma) [20] or specific processes (e.g. supplier selection) [21]. In the broader context, i.e. sustainable chains, it is also noted that a leaner environment is conducive to the creation of environmental, economic, and social balance [22]. Reviews in this area reveal many interesting research directions [23]. It is emphasized that when lean practices are based on supply chain flexibility, business outcomes are better [24]. It is worth considering that flexibility has a significant impact on the building of agility [25].

Significantly more studies have begun to address more than one supply chain [26], but their reviews conclude that the association with building resilience is extremely rare [27], resulting from combining the idea of green and resistant chains, i.e. in a situation where we are dealing with the so-called resilient supply chain [28, 29]. Attention is drawn to the importance of selecting green suppliers in weakened supply chains caused by unstable flows [30], testing lean practices to improve the desired immune capabilities [31], the impact of agility on chain formation resistant [32] or the benefits of the coexistence of different types of chains [33].

METHODOLOGY OF RESEARCH

Taking into account the scientific achievements related to the types of chains, it is easy to notice their mutual influence and benefits resulting from the coexistence of individual attributes. Furthermore, in the majority of chains, there is most likely no dominant agility because of:

- the nature of the product being moved (because the demand for it is relatively predictable, it is not characterized by a high level of innovation, it does not have a short life cycle, it is susceptible to positive economies of scale related to production),
- permanent relationships with suppliers or recipients (due to the developed trust, unique competencies, high level of transaction costs in the event of a change of contractors, the permissible geographic distance of the supply or sales markets in terms of costs or logistics time),
- the high cost of flexibility that is not feasible for chains embedded in a highly competitive cost-driven environment.

Therefore, the hypothesis according to which H2. In the economic reality, hybrids containing different types of supply chains dominate, and the promoted agility is not a dominant attribute. In the definitions of resistant chains (widely analyzed in the cited references), their basic feature, which is agility, is primarily emphasized. However, the definition proposals lack concentration on the elements related to other basic chain attributes, i.e. the lean and green chains. Both chains are recommended for implementation and several empirical studies indicate their usefulness in terms of financial, operational, image, and environmental benefits. The literature on this subject is exceptionally rich. In connection with the above, it can be assumed that in the current proposals of the research framework, as well as in their more specific forms in the form of models, there are no constructs that would take into account the above-mentioned threads. Therefore, it is assumed that: H1. The proposals for the research framework for resistant chains primarily propose agility constructs and marginally address the content of lean and green chains.

In the first stage of the research, based on primary data, it was diagnosed what types of supply chains function in the studied group of entities. For this purpose, medium and large production companies were examined, which belong to section C according to the statistical classification. The research was carried out with the use of a questionnaire in the form of an interview. To improve the quality of the research, enterprises from the Greater Poland Voivodeship were selected to be able to directly reach respondents who knew the enterprise in the field of logistics processes. Ultimately, one hundred and fifteen subjects were examined, but 71 questionnaires qualified for the research. Over 40 questionnaires without complete data were not accepted. The research tool was constructed based on the characteristics of chains appearing in the literature on the subject. Agile, green, and lean chains were considered. In total, 45 test items were assessed using the

5-point Likert Scale (where 1 meant "definitely yes" and 5 – "definitely not").

The questions were divided into three groups related to product, logistics, and supply chain. In the second stage was based on the literature contained in SCOPUS and was checked to determine which types of chains are most often associated with the subject of resistance. Subsequently, through qualitative research, items on chain types rarely described in terms of resistance were reviewed to identify proposed research models. These models are supplemented with other exemplary models that appear in the literature as a foundation for the identified research gaps. A more detailed methodology in this regard is presented later in the study. In the final part of the article, the practical aspect of the conducted research was emphasized, pointing to the rarely described relationships of the given types of chains with the shaping of chain resistance.

SUPPLY CHAIN TYPES – RESULTS OF RESEARCH

To identify the nature of the supply chains, questions were asked in three areas: the product being moved, logistics, and supply chain. In total, there were fifteen test questions for each type of chain (lean, agile, green). At the product level, enterprises primarily focus on reducing product defects, dedicating products to specific customer segments, and reducing the level of hazardous substances (Table 1).

Table 1
Activities undertaken at the product level

Average values	Type of chain	Type of activity
1.6	Lean	Focusing on the decrease of defective products
2.2	Agility	Taking into consideration individual needs of recipients
2.2	Green	Limiting dangerous substances
2.3	Lean	Producing products with predictable demand
2.3	Lean	Focusing on the increase of production efficiency
2.5	Green	saving material/energy consumption
2.6	Green	Limiting weight
2.7	Agility	Producing innovative products
2.9	Green	Recycling alone or by third party entities
3.1	Lean	Limiting the quantity of components
3.2	Lean	Designing low-cost products
3.5	Agility	Delaying product configuration
3.5	Green	Making an assesment of life cycle of packagings
3.8	Agility	Producing short life-cycle products
4.1	Agility	Focusing on fad products

At the level of logistics operations, enterprises reduce unnecessary logistic activities, optimize routes in terms of costs and try to adapt flexibly to the transport needs of contractors (Table 2).

Table 2
Activities undertaken in the area of logistics

Average values	Type of chain	Type of activity
1.9	Lean	Limiting unnecessary logistics activities
2.0	Lean	Optimizing transportation routes considering costs
2.1	Agility	Smoothly adjusting to transportation needs
2.2	Lean	Reducing the costs of warehousing infrastructure service
2.3	Lean	Replenishing stock acc. to historical state
2.3	Agility	Reducing delivery time, allowing higher costs
2.5	Agility	Using "flexible" logistics technologies
2.7	Agility	Configuring flexible warehousing infrastructure
2.7	Agility	Keeping stocks as unprocessed as possible
2.7	Lean	Introducing efficient logistics technologies
2.7	Green	Use of ecological means of transport
2.8	Green	Minimization of environmental losses in the inventory management
2.9	Green	Use of green warehouses
3.1	Green	Optimization of trans in terms of CO ₂ emissions
3.1	Green	Advantageously from technologies supporting green logistics

Enterprises primarily manage the supply chain by looking for solutions to problems at the source They try to move goods according to a strictly defined schedule, but at the same time, when necessary, react quickly to emerging sudden delivery needs (Table 3).

Table 3
Activities undertaken at the supply chain level

Average values	Type of chain	Type of activity
1.9	Lean	Eradicating problems "at root"
2.2	Lean	Movement of goods acc. to a specified schedule
2.2	Agility	Movement of goods on the basis of quick response/high availability
2.6	Agility	Reducing inflexible links
2.5	Lean	Relatively static configuration of supply chains
2.8	Agility	Relatively dynamic configuration of supply chains
2.9	Lean	Conducting studies with regard to saving solutions in supply chains
3.1	Green	Managing risk in terms of environmental damage
3.2	Lean	Participating in the trainings concerning lean supply chains
3.2	Green	Organizing the flow of goods with focus on environment protection
3.2	Green	Creating an environmently friendly supply chain
3.3	Agility	Conducting studies concerning agileness of supply chains
3.4	Agility	Participating in the trainings concerning agile supply chains
3.5	Green	Leading courses of environment protection for partners in supply chain
3.6	Green	Expanding knowledge of environment protection

Taking into account the averages obtained from 45 test items for the types of supply chains, it can be concluded that all three dimensions examined, i.e. product, logistics, and chain, scored the lowest for lean chains (2.5 – product; 2.2 – logistics; 2, 5 – supply chain), so these activities dominate because 1 was the most important (Figure 1).

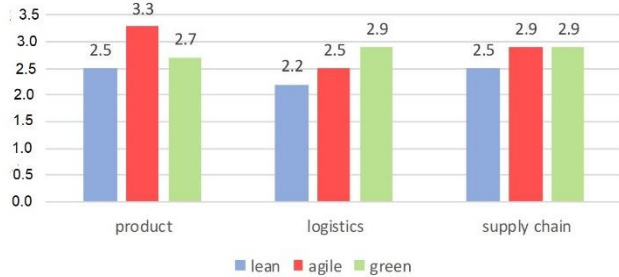


Fig. 1 Type of supply chain

Taking into account agile and green chains, in the group concerning logistics operations and supply chain management, fewer points were indicated when it came to agile chains (respectively: 2.5 compared to 2.7 and 2.9 compared to 3.3). In terms of product policy – 2.7 was indicated in the attributed items of green chains, and 3.3 in relation to agile chains. Based on the data obtained, analyzing individual 45 attributes, it can be concluded that supply chains are obvious hybrids in which activities related to lean activities predominate, then agile and, lastly, green. As a result of the conducted research, it can be concluded that, despite the slogans about the need to operate dynamically in an agile environment at the chain level, lean strategies are primarily adopted. This is probably due to the fact that the greatest value comes from long-lasting relationships, which lower transaction costs and increase trust in business partners. It is especially justified at the beginning of the chain, because its efficient supply determines timely production and sale. It can be assumed that a greater dynamic of activities usually occurs at the exit of the chain due to the search for new customer segments in terms of products and geography.

RSC MODELS AND THEIR RELATION TO THE TYPES OF THE CHAIN – RESULTS OF RESEARCH

The depiction of the issue related to the types of the supply chain is a starting point for broader analyzes in the context of their relationship with resilient chains. When we consider it on this level, it is reasonable to distinguish the pillars of resistant chains. The starting point for systematization was bibliometric research based on SCOPUS. The search path was adopted as literature resources containing the words: resilient/resilience and supply chain in the title.

In total, 886 items were generated, but some of them, for example, related to cybersecurity or resilience built with the use of technology 4.0. The number of literature resources is growing rapidly. In 2021, there were 261, in 2020 – 128, and in just the first month of 2022-25. The largest number of affiliations is from the United States, Great Britain, China, and India. They then searched for agility, green, or lean in the titles.

Additionally, literature on this subject was searched for in the records contained in bibliographies of searched articles.

Because agility is a popular attribute of resilient chains, the search was narrowed down to the subject of lean and green activities in the next step. Twenty-eight articles were generated in the area in question which also contained the slogan "lean" and 32 with the slogan "green". Most articles linked to these activities do not discuss their effects on building immunity. In addition, some works related to linking resilience with sustainable development [34] or with sustainable supply chains, and not only to the pro-environmental aspects. It turned out that there is a large research gap in this area and only a few of them include models. These models are supplemented with other exemplary models with word "agile" (Table 4).

Table 4
Models and research frames in the field of resilience supply chains, which include the basic dimensions of resistance associated with a chain that is lean, agile, and green

Authors	Agility	Lean	Green
M. Al-Talib et al. 2020* [35]	✓		
S. Bag, S. Gupta and C. Foropon 2019 [36]	✓		✓
A. Belhadi et al. 2021 *[37]	✓		
E. Brandon-Jones et al. 2014 *[38]	✓		
H. Carvalho, G. Azevedo and V. Cruz-Machado 2012 *[33]	✓		
M.H. Chowdhury and M. Quaddus 2017 [39]	✓		
M. Christopher and H. Peck 2004 *[40]	✓	✓	
Y. Cui, H. Idota and M. Ota 2019 *[41]	✓		
G.F. Frederico 2021 *[42]	✓		
S.K. Gouda and C. Foropon 2018 [43]			✓
L. Ji, C. Yuan, T. Feng and C. Wang 2020 [44]			✓
G.S. Hundal et al. 2021 [45]	✓	✓	
D. Ivanov 2021*[46]	✓	✓	
N. Johnson, D. Elliott and P. Drake 2013 *[47]	✓		
U. Jüttner and S. Maklan 2011 *[48]	✓		
C.L. Liu et al. 2018 [49]	✓		
A. Mohammed 2020 [28]	✓		
M.S. Mubarak et al. 2021 *[50]	✓		
C.R. Pereira, M. Christopher and A.L. Da Silva 2014 *[51]	✓		
R. Rajesh 2020 [52]	✓	✓	
Q. Schoen et al. 2018 [4]	✓		
C.S. Singh, G. Soni and G.K. Badhotiya 2019* [53]	✓		
U. Soni, V. Jain and S. Kumar 2014 *[54]	✓		
V.L.M. Spiegler, M.M. Naim and J. Wikner 2012 [55]	✓		
A. Spieske and H. Birkel 2021 *[56]	✓		
B.R. Tukamuhabwa et al. 2015 [5]	✓		
M. Umar, M. Wilson and J. Heyl 2021 [6]	✓		
A. Wieland and C.M. Wallenburg 2013 [57]	✓		
A. Zavala-Alcivar, M.J. Verdecho and J.J. Alfaro-Saiz 2020 *[58]	✓		✓

The list includes models in which:

- the password "agility" or "flexibility" appeared, usually treated as part of "agility",
- lean management terms such as "process mapping", "Lean SixSigma" or "standardization",
- the password was "green".

Many models have the slogan "visibility", which can be assigned to both agile chains (usually about the chain configuration, its visibility) and lean chains (usually about separate processes – for example, warehouse or production). In model terms, this is not always precisely defined, but it can be assumed that in the majority of cases, it is not related to lean practices. Models that included these terms were marked with asterisks next to their names. It should also be noted that some authors explicitly distinguish "visibility" as a component of "agility". As already noted, the mutual overlap between the dimensions of the resistant chain takes place on many planes.

Because agility is the basic attribute mentioned in the models constituting the resistance of chains, it can be assumed that it is their key pillar. At the same time, it can be assumed that each of the basic types of chains, including green and lean, can support the creation of resistant chains, but these reference models are rare.

RELATIONSHIP OF SUPPLY CHAIN TYPES WITH BUILDING RESISTANT CHAINS – DISCUSSION

Because the influence of agility on resistance is described in the literature on the subject (Table 4), further considerations focus on two less described dimensions, nevertheless agility.

When it comes to lean chains, it can be said that the impact on building immunity can have positive and negative connotations. On the one hand, in this type of chain, an attempt is made to reduce the level of inventories, to reduce unnecessary resources, and it is the redundancy of various potentials of enterprises that supports resilience. On the other hand, lean chains eliminate all kinds of waste and there is more organizational discipline. In critical situations, when it is necessary to survive at lower margins, the pro-saving policy works. However, it is necessary to adopt a trade-off principle in terms of the level of inventories and costs, and the possibility of meeting the needs in the event of disruptions [59].

A few literature references emphasize the importance of the lean approach for building resistant chains [31]. It is noted that this can be achieved by such tools as Value Stream Mapping (VSM), standardized work, 5S, Kanban, Just-in-time, continuous improvement. Tools such as visual management, pull system, VMI or Poka-Yoke can also be useful. Among other things, it is proved that Lean Six Sigma practices have a direct impact on IT management and big data analysis, risk management and process management, and this, in turn, increases the disruption readiness and the possibility of reconfiguration of processes and resources in the supply chain, which ultimately affects their resistance [45]. It is also worth mentioning that lean

management tools help reduce losses in the procurement, production, and distribution process and thus affect the resilience of the chain [60].

For example, VMI increases the integration between supplier and manufacturer. On a trust basis, data is shared with suppliers, so you can control inventory flows more smoothly. Process Mapping (VSM) enables the identification of non-value-added activities as well as the identification of tipping points that disrupt the flows. Process visualization allows you to increase the transparency of supply chains, which are the basic pillar of resilient chains. In turn, the poka-yoke system allows you to prevent errors by improving the organization of work. Standardization of work and visualization enables more transparent processes that facilitate the identification of waste and the identification of ineffective movements.

Considering the results of research on the activity of enterprises influencing the nature of supply chains and the specificity of the lean concept, it can be concluded that there is great potential in strengthening supply chains based on this concept. These types of chains can be referred to as "lresilient" chains, which are chains that build resistance using the principles and tools of a lean concept. This can be achieved through an appropriate product and operational policy, which in turn affects the cost-effectiveness of supply chains. This manifests itself primarily in simplifying processes and reducing unnecessary operations that reduce the number of potential disruptions and increase the reliability of deliveries in line with the adopted level of service.

For example:

- reducing the variety of raw materials in products leads to less complexity in the process of closing the loop of supply chains,
- reducing product defectiveness, leading to a reduction in reverse logistics flows. Attaching great importance to determining the size of demand in each link of the supply chain minimizes the so-called bullish effect,
- increasing production efficiency by quickly retooling machines and keeping them in constant readiness facilitates the management of the variability of the size of production flows,
- simplification of processes and elimination of unnecessary activities from them, makes it easier to detect critical points in flows that cannot be seen in the case of redundancy,
- on-time deliveries require alternative routes to be anticipated in the event of flow congestion,
- work in a stable configuration of cells facilitates communication and joint decision-making regarding the supply policy and risk-sharing in the event of disruptions in transport corridors and insufficient production volume,
- increasing the transparency of production and warehouse processes using traffic lights reduces the level of disruptions,
- elimination of problems at the root, reporting improvements to the bottom-up system minimizes the defectiveness of the systems.

It can be assumed that taking up activities characteristic of lean chains can be a good introduction to strengthening the chains by making them more flexible. For example, making chains more flexible through resource redundancy causes redundancy in both essential and redundant activities.

In regards to green chains, it has been proven, among other things, that the integration of green suppliers has a positive impact on both the proactive and reactive dimensions of supply chain resilience [44]. For example, by optimizing routes, sensitive products are protected and CO₂ emissions are reduced [61]. The positive effects of eliminating distortions in the reverse logistics system, through the use of additive manufacturing (AM) technology, are indicated [62]. It is also proposed to create a hybrid of a resistant and green chain by using the SCOR model, because it effectively measures the efficiency of processes and defines the supply chain in all its aspects, which allows for comprehensive measurement and evaluation [63].

Although the level of environmental activities in the chains is still low, there is a strong trend towards their development. This is done both due to the need to protect the welfare of the environment, out of necessity imposed by law, and the desire to create a positive image of the chain. Based on the research, it can be concluded that in the initial stages of green chain development, companies focus primarily on changes in the attributes of the product being moved [10]. This is because such changes can be made at the level of a single link or in cooperation with suppliers with which producers usually have more bargaining power. Along with entering a higher level of pro-environmental activities, related undertakings rely on joint investments with suppliers, recipients, or logistics operators serving the supply chain. Breaking this type of relationship is unprofitable, because there is a dependency between the participants of the chain related to expenditure on technologies, on joint research work with contractors, with the development of positive image values provided by ecological operators or trade brands. Therefore, it can be assumed that the higher the level of greening in supply chains, the easier it is to build lasting relationships, trust, and thus resilient chains.

However, as with lean chains, the positive effect of greening the chain is not clear-cut. For example, it is believed that creating a green and resilient chain can result in higher costs [64]. In addition, in crises, when the profitability of the company declines, they focus on costs, so pro-environmental investments, if they are long-term, make it difficult to maintain liquidity.

Taking into account the results of research on the pro-environmental activities undertaken in the area of the product, logistics, and the supply chain, the specificity of this type of chain, it can be concluded that combining pro-environmental issues with building resilience has a great economic and scientific potential. Chains of this type are referred to as "gresilient", i.e. chains that are green and resistant at the same time. The literature focuses primar-

ily on the positive environmental effects of creating resistant chains. Nevertheless, there are several issues that argue that creating green chains can also strengthen them. This is manifested, inter alia, by the fact that:

- promoting products that contain a low level of hazardous substances reduces the level of risks in the supply chain,
- reducing the weight of materials and creating products that are easy to recycle simplifies processes while closing the loop in the supply chain,
- investing in environmentally friendly means of transport is usually associated with the purchase of modern rolling stock, which includes several innovative solutions; as well as in the area of safety, and produces lower failure rates,
- the use of green warehouses, which must first undergo an audit, with BREEAM or LEED green certificates are considered to have a higher level of security,
- the implementation of the European Eco-Management and Audit Scheme involves the need to demonstrate compliance with legal regulations on environmental protection, as well as with the requirements of ISO 14001 and other EMAS requirements, which reduces the likelihood of disruptions in the supply chain,
- creating joint pro-environmental projects with participants in the supply chain strengthens the level of integration, which favors building resilience,
- conducting pro-environmental activities is characteristic of better organized chains, which is reflected, among others, in GRI reports edited by the leaders of supply chains compiled in the rankings of analytical companies such as Gartner. Preparation of such a report requires prior monitoring of the processes, which makes them more resistant.

CONCLUSION

Based on the research, it can be concluded that there are two significant cognitive dissonances: – it is assumed that resistant chains must be agile, while in practice, hybrids with a predominance of classic chain attributes, based on pro-saving policies, may also be specific tools characteristic of lean chains – in models and research frameworks, it is sporadically noted that resistance may be supported by elements characteristic of lean and green chains. It can be concluded that based on each of the analyzed types of the supply chain, it is possible to create resistant chains. The mere fact that the studied entities are primarily embedded in traditional, stable, and low-cost chains does not mean that such chains are more difficult to eliminate disturbances. The stability of the links has a positive effect on the resilience of the chains and returning to the starting point. On the other hand, organizations that report their pro-environmental activities are often enterprises with a mature, well-established market position that cope better in crises and build more durable relationships through joint green investments with other participants in the supply chain.

At the same time, it has been shown that individual types of chains coexist. In the future, it is, therefore, worthwhile to expand the research explaining how chain hybrids can complement each other in creating resistant chains. For example, the literature on the subject proves that both the lean, agile, and resilient chain have a positive effect on pro-environmental activities [65], lean tools have a positive effect on green practices and the resilience of the supply chain [60]. Taking lean and resilient practices at the same time has a positive effect on green practices [66]. Because, according to the author's knowledge, the hypotheses formulated in the development are being tested for the first time – no conclusions can be drawn to similar studies. The obtained research results have practical value because entities can check what kind of hybrid they create in the context of the types of supply chains. The compiled list of research models can provide a decision base for developing resistant chains since each model contains constructs constituting resistant chains. The awareness of the nature of the chain and their relationship with resistance makes it easier to develop the attributes of chains, which in the event of disruptions in the flow of goods facilitate their elimination. Critical situations disrupting the functioning of the economy strongly determine the flows in the supply chains. Crises related to the financial market, climate change, and a change in the balance of political or economic forces become an exam for the competitiveness of supply chains. Therefore, the issues raised on the nature of chains and resilience need to be placed in a broader context. It is therefore important to build resilience also through the geopolitical prism (eg Brexit, the US-China trade war) [67], or taking into account the current pandemic problems [46, 68].

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