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LOGISTICS COORDINATION IN BUILDING THE RESILIENCE OF THE DISTRIBUTION NETWORK

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Purpose: The research article is an extension of the concept related to logistics coordination in distribution networks. The concept of logistics coordination extends the flow mechanisms of network governance presented in the literature so far. The aim of the article is to conceptualize logistics coordination as a set of network coordination flow mechanisms that are to strengthen the resilience of the distribution network. Disruptions analysis was used to assess the resilience of the distribution network.
Design/methodology/approach: The first stage of the research was to identify the gap in the research on network governance. The assumptions of logistic coordination indicated in the literature research were the basis for the methodology of empirical research. The research was carried out in the distribution network of household appliances/electronics. The resilience of the distribution network to disruptions was assessed. Disruptions and deviations in the implemented processes were identified on the measurement cards. In assessing the resilience of the network, indicators of timeliness, completeness and orders without damage were used. Subsequently, a cause and effect analysis and FMEA were carried out. The conducted research was completed with recommendations for the coordinator of flows in the distribution network.
Findings: Recommendations for the coordinator of the household appliances/electronics distribution network include mechanisms for logistics coordination that strengthen the resilience of the network. Other mechanisms that the coordinator is already using have also been identified. Among the identified mechanisms are both proactive and reactive actions. The set of mechanisms, in accordance with the proposed concept of logistics coordination, includes mechanisms focused on flexible resources, redundancy of partners in the network, redundancy of stocks at the material distribution point, extraordinary transport and forecasting for the entire network.
Originality/value: The indicated mechanisms, both those used by the coordinator and those proposed to be used to increase the resilience of the distribution network, go beyond the flow mechanisms proposed in network coordination. Thus, it makes sense to extend the flow mechanisms to include logistics coordination in the broadest sense, which aims to synchronise flows, ensure the continuity of the processes carried out and the coherence of the activities of the network nodes.

Keywords: distribution network; network governance; logistic coordination; resilience, disruptions.

Category of the paper: research paper.

1. Introduction

Distribution networks, as systems made up of many cooperating nodes, are sensitive to disruptions. Sensitivity to disruptions manifests itself in deviations in material flows and reduced customer satisfaction. For nodes coordinating the flows of finished goods in distribution networks, the competence to strengthen network resilience is therefore crucial. The resilience of a distribution network will be understood according to the resilience interpretation for the supply chain (Bukowski, 2019), as the ability to reliably execute finished goods flows in a disruption-affected environment. This capability manifests itself in the proficiency to weaken external and internal factors that cause disruptions, as well as the ability to prevent the propagation of these disruptions. Dissemination of disruptions means that the negative effects of disruptions are transmitted to a larger number of participants in a complex distribution system. This type of competence needs to be supported by high relational capabilities manifested by the coordinator's interaction with other network participants. The coordinating links in a distribution network therefore face challenges that are referred to in the literature as network governance. So far, the network coordination discussed in the literature has not focused on distribution networks. This raises the questions of whether the forms and mechanisms of coordination discussed in the literature are sufficient to ensure high levels of customer satisfaction in distribution networks? There is no answer to such a question in the literature. In the search for an answer, it becomes necessary to detail the types of distribution networks and the determinants and challenges of coordination in such complex systems. The aim of this paper is to conceptualise logistical coordination as a dimension of network coordination for strengthening distribution network resilience. The considerations carried out in the theoretical background concern the construct of network coordination against the background of distribution network determinants. The effectiveness of coordination was referred to the reliability of the realised flows of finished goods under the impact of disruptions. Against this background, the importance of strengthening the resilience of the distribution network is indicated. The methodology covers the research procedure, relating the adopted concepts of disruptions analysis and distribution system resilience assessment to the research of other authors. The results and discussion section presents the results of the disruption analysis in the household goods distribution network and the concept of strengthening the resilience of this network.

The company selected for the study is the central link in the distribution network and is responsible for the appropriate organisation of all processes taking place within it. Disruption data were obtained by continuously completing control cards during the study period. In parallel, an analysis of selected reliability indicators of finished goods flows was carried out during the study period. By comparing the level of the indicators and the identified disruptions, key problems were selected, which were further analysed through an Ishikawa diagram and

an FMEA (Failure Mode and Effect Analysis). In this way, the current state was assessed and possible improvement actions were suggested as a proposal to strengthen the resilience of the network under study. In this way, the relevance of including logistical coordination as an extended flow mechanism of network coordination was indicated.

2. Theoretical background

2.1. Resilience of the distribution network

Distribution networks are configured from cooperating manufacturing, trading and logistics companies. In the literature, it can be described that distribution networks are a particularly complex system (Kramarz 2012; Guan et al., 2021; Kazmi et al., 2017; Abbasi, Varga, 2022). This is due to the interaction of multiple companies (network nodes) with diverse strategies, resources, organisational cultures and key processes. In indicating the attributes of a distribution network, graph theory is used, based on graphically translating the entire structure and determining the relevant links between nodes. Distribution network attributes include (Kramarz, 2012): paths between two nodes (number of intermediaries between two nodes - companies), distance (distance between two companies), node input and output degree (number of direct relationships with suppliers and customers/intermediaries), bridges (entities that are intermediaries between subgroups within the analysed network), node intermediation (ratio of the number of shortest edges that pass through a node to the total number of shortest edges), reciprocity (ratio of reciprocal relationships to all relationships), network density (the ratio of the number of relationships to the number of all potential relationships, it can also be assessed in terms of geographical distances between nodes), clustering coefficient for a given node (the total number of relationships that the analysed entity forms), network diameter (the longest distance between the companies within a single network), the phenomenon of preferential attachment (central links in a network are characterised by a greater ability to attract new network members relative to the other entities in a given network).

These attributes are used to determine the configuration of the network and also the relational characteristics of the cooperating companies in the network. Through attributes such as the phenomenon of preferential attachment, agency and clustering coefficient, it is possible to identify nodes that potentially have favourable conditions to undertake coordination due to their central position in the network and their power to influence other nodes. In this way, in the airline industry, research was conducted by Brintrup, Wang, Tiwari, (2015) indicating that the distribution system studied is a network formed by communities connected by central firms. The authors showed that hub firms also tend to interconnect with each other, providing cohesion but making the network highly susceptible to disruption. Furthermore, based on

attributes drawn from network theory, they also showed how to identify firms that are operationally critical and those that are central to the dissemination of information. In this way, it is possible to isolate organisations that not only have an impact on the coordination of flows but also on building the resilience of the network as a whole.

There is little literature on distribution network resilience, and it is therefore useful to look to the literature in the area of supply chain management, where resilience has been studied for many years. In interpreting supply chain resilience, the most commonly presented approach indicates that it is the ability to respond to unforeseen disruptions and restore planned supply chain operations (Kramarz, Kramarz, 2014). Issues related to resilience in supply chains are a very lively topic for discussion around the world. Analysing academic publications, it can be concluded that the issue of resilience is linked to the ability to control the situation when deviations arise due to emerging disruptions and to have adequate adaptive capabilities. These capabilities allow supply chains to become more flexible, resulting in the ability to adapt quickly to changes in the environment.

The key elements that create supply chain resilience are a supply chain structure that allows information (knowledge) to flow more easily, a supply chain baseline strategy, collaboration between companies in the supply chain, agility and flexibility, creating a risk management culture (Christopher, Peck, 2004).

Fiksel (2004), on the other hand, identifies four key characteristics that foster resilience. These are: diversity in terms of forms of behaviour and action, efficiency, i.e. the ability to achieve high performance with moderate use of resources, adaptability, understood as the flexibility to act under pressure, cohesion, i.e. the effect of dependencies between system variables and system elements.

These are all fundamental components of resilience in supply chains and the distribution networks that are part of them. Lu and Stead (2013) provide a graphical representation of the resilience model in a diagram as the relationship between the change in organisational performance from the onset of disruption to the return of optimal performance. The boundaries from the onset of disruption to the return to a state where the firm regains its ability to control the process are clearly marked. The modelling approach sets the rate of system recovery and the threshold for the maximum possible disruption that the enterprise is able to compensate for without passing on the effects to other supply chain participants.

Any resilience-building activity in distribution networks is essentially a response to the vulnerability of that system. Vulnerability can be understood as the susceptibility to succumb to changing external factors that are capable of disrupting the functioning of the entire distribution system (Bukowski, 2019). The reaction to vulnerability is the development of mechanisms that constitute a kind of defence system of the system, which is called resilience. Building resilience in supply chains is now being eagerly addressed by academics especially at a time of such severe disruptions as the COVID 19 pandemic. From the point of view of the flow coordinator, it is a long-term process of creating awareness and working continuously to negate the effects of disruptions that may occur in the future.

2.2. Network Governance

Distribution networks, which are characterised by their considerable breadth (large number of participants), diverse relationships and less integration than distribution channels, are much more complex systems than distribution channels. Complexity arises from both the number of interconnected elements and the diverse nature of the relationships between these elements. Making the joint activities of multiple participants harmonious and efficient is a major challenge, especially under the impact of disruptions. This challenge justifies the great importance attached to network governance (NG). Some authors refer to network governance exclusively to collaborative public goods, indicating that NG is defined as 'entities that fuse collaborative public goods and service provision with collective policymaking' (Isett et al., 2011) that is based on the principles of trust, reciprocity, negotiation, and mutual interdependence among actors (Provan, Kenis, 2008). These same elements of NG are also the characteristics in the definitions of collaborative governance (Fadda, Rotondo, 2020).

Other authors interpret NG more broadly. Young and Dulewicz (2008) and Hoetker and Mellewigt (2009) define NG as the effective and efficient use of the resources of all nodes of an inter-organisational network (including infrastructure, knowledge, and other resources) to achieve the set goals. Network governance aims to ensure consistency of activities, to counteract conflicts by arranging, in some purposeful order, the tasks carried out by multiple participants and to adapt participants with different attributes to the established rules through various mechanisms. Heide (2003) mentions a set of three forms of coordination: market, hierarchical and social, which together occur in networks. Czakon (2008) details these into mechanisms: price (e.g. price, bilateral collateral), non-price (e.g. trust, social norms, decision-making style) and flow (e.g. VMI, QR, CPFR). Hierarchy-driven mechanisms prevail in the enterprise. Going beyond the single organisation and analysing distribution networks, one can see the increasing importance of mechanisms related to the market form of coordination. One and the other mechanisms are strongly intertwined with mechanisms characteristic of the social form of coordination. These three types of groups of mechanisms are most often discussed in the literature in the context of NG. Among the mechanisms characteristic of the market form, Czakon (2013) mentions mainly price but also formal relationships and bilateral collateral. Among the hierarchical mechanisms, he identifies: structures and control systems resulting from management styles, bureaucratic allocation of resources, budgeting and organisational integration. A distinguishing feature of hierarchical coordination is the power that one actor gains over others through knowledge. This is an important point, as there are no organisational structures characteristic of companies in networks. Thus, the source of power is not subordination in the organisational structure but the fact that one organisation has more knowledge and capacity to use it than the other organisations. This organisation naturally becomes the coordinator. Among the mechanisms attributed to social coordination, however, he mentions trust, communication systems and information exchange as well as social norms

(Kramarz, 2018). The analysis of the detailed mechanisms requires consideration of the potential effects of these mechanisms. Among the effects considered are risk, opportunism, and costs (Hoetker, Mellewigt, 2009).

2.3. The construct of logistical coordination as a network coordination mechanism

In line with the concept presented in an earlier publication, forms of NG are assumed to indicate the source of the coordinator's authority, giving him or her the power to coordinate the network through any set of mechanisms (Kramarz, Twaróg, 2017). Sahin, Metzer (2006) emphasise that the effectiveness of the use of a combination of coordination mechanisms depends on the extent to which they are matched to the type of network of interacting organisations. Distribution networks, regardless of their detailed attributes in terms of breadth, degree of centralisation and others, are geared towards ensuring the availability of products in the quantity, time and place expected by the customer. The coordination of distribution networks must therefore be aimed at synchronising processes in such a way as to ensure reliable fulfilment of customer orders (Kramarz, 2018). In this type of network, flow mechanisms that affect the timeliness, completeness, of orders being fulfilled become particularly important. This group of mechanisms is insufficiently discussed in the literature. The set of flow mechanisms will constitute the construct of logistics coordination in the research. As logistical coordination is aimed at reliable process execution (i.e. timely, damage-free and complete fulfilment of customer orders), also under the impact of disruptions, it can be assumed that the selection of flow coordination mechanisms simultaneously aims to strengthen the resilience of the distribution system. Thus, mechanisms are sought that allow for consistency of operations and continuity of processes, regardless of the factors affecting the flows of finished goods. In the study of NG, the authors point to VMI, CPFR and others. These are detailed tools in flow management; however, they do not exhaust the impact on logistical problems that face the coordinator of distribution networks, supply networks or supply chains. Intuitively, the flow mechanisms identified by NG researchers touch on key areas for flow management, including forecasting, inventory management. The proposed construct of logistics coordination in networks of cooperating organisations adopts a broader spectrum, building on the concepts of strengthening resilience.

Sheffi (2005) examining the ways in which companies are able to respond to severe disruptions and carry out actions to reduce the risk associated with disruptions found that:

- Bottlenecks related to disruption are reduced through monitoring, early warning systems, rapid response to changing needs, collaboration and redundancy.
- Operational flexibility is increased through standardisation of parts to facilitate interchangeability (product modularity, logistics-oriented product design), a deferred production strategy or mass customisation of products (multi-variants) in response to hard-to-predict changes in needs, customer and supplier relationship management.

Dos Santos and Alcantara (2015) identified approaches to strengthen the resilience of logistics systems, including supply chains and networks: flexibility of logistics processes, increasing the number of suppliers, minimising process lead times, planning with other links (joint planning in the supply network), preparing contingency plans, certifying suppliers, introducing a risk management culture, increasing network density (a reference to the geographical distribution of individual nodes in a distribution network, where density is inversely proportional to the geographical distance between nodes), redundancy (redundancy, excess resources and (reserve) relationships that offset the impact of change).

Kramarz, Kramarz (2017) combine the aforementioned approaches in proposing four concepts for enhancing resilience, conditional on the degree of product differentiation and demand fluctuations: increase in network width and density (surplus suppliers and intermediaries), flexible resources and processes, surplus inventories (at the material distribution point of the supply chain), emergency transport. The ways of enhancing resilience included in these four groups, extended by a fifth group capturing the transparency (visibility) of resources and needs at the nodes of the network (including integrated forecasting for all network participants), provide a set of logistics coordination mechanisms aimed at synchronising flows, ensuring process continuity and network coherence. At the same time, it is a collection of heterogeneous mechanisms, some of which are proactive and some of which are reactive. A proactive approach to resilience refers to actions taken before a crisis situation occurs (network density, redundancy, visibility, forecasting). Reactive approaches, on the other hand, are actions taken to recover lost capacity after an emergency has occurred (emergency transport, subcontracting, flexible processes).

3. Methodology

The risk of disruption to entire logistics processes is significant. The number of methods available for the identification and analysis of disruptions is also high. Most often, several complementary methods are used, which together give a more accurate picture not only of the number of disruptions themselves, but also of the strength of their impact, understood as effects on the implemented processes or the entire organisation. This makes it easier to adjust corrective actions (Khan et al 2022). Such an approach was used in the conducted research.

Two disruption measurement cards were used to identify disruptions (Table 1 and Table 2). Disruptions were marked at the central node of the network over a period of 2 months on a daily basis by employees at different stations. The first card was generated by the person carrying out the measurements on the basis of the data collected in the IT system.

Table 1.
Disruption measurement sheet

Planned delivery		Delivery made		Does it contain damage?	Has there been a return?	Assortment	Carrier	Delivery type
date	size	date	size					

Source: compiled on the basis of Kramarz M. Kmiecik M. – " Pomiar zakłóceń w wybranym węźle sieci dystrybucji", Zeszyty Naukowe Politechniki Częstochowskiej, Zarządzanie, Nr 26, 2017.

The processing of the collected data started with the determination of cause-and-effect realisations. In order to collect this information, a disturbance measurement sheet for each site was used (Table 2).

Table 2.
Site-specific disruption measurement sheet

Date	Disruption	Cause (description)	Responsible entity	Effect (description)	Point assessment of disruption (organisational)

Source: Kramarz M. Kmiecik M. – „Pomiar zakłóceń w wybranym węźle sieci dystrybucji", Zeszyty Naukowe Politechniki Częstochowskiej, Zarządzanie, Nr 26, 2017.

A five-point scale was used to assess the effects of disruptions, where 1 - the effects of a disruption are negligible, while 5 – results the effects of which are very strong. The effects of disruptions and the ways in which they are dealt with are reflected in the reliability of the orders processed, so reliability indicators were determined in parallel to the measurements carried out. Among the indicators proposed for the distribution study, the following were used:

Completeness of orders carried out

$$KRZ = \frac{Number\ of\ complete\ deliveries}{Number\ of\ all\ deliveries} * 100\%$$

Share of damage in deliveries

$$UWD = \frac{Number\ of\ deliveries\ containing\ damage}{Number\ of\ all\ deliveries} * 100\%$$

Timeliness of deliveries

$$TD = \frac{Number\ of\ on-time\ deliveries}{Number\ of\ all\ deliveries} * 100\%$$

Share of returns

$$UZ = \frac{Number\ of\ returns}{Number\ of\ all\ deliveries} * 100\%$$

The data collected with the second card allowed the calculation of indicators. The research was conducted for stationary sales and online sales. After the deviations in the implemented processes were identified by means of an indicator analysis, three reliability problems were selected and subjected to a cause-and-effect analysis followed by an FMEA. As a result, recommendations were developed for the coordinator of finished goods flows in the distribution network under study.

4. Results and discussion

4.1. Household appliances distribution network

The distribution of household appliances, due to the great diversity of customer segments, is carried out in complex omni-channel networks. The network includes 74 manufacturers, a distribution company (central node of the network which has 3 central warehouses) and retail nodes. The omni-channel system combines three distribution channels: sales in the online shop, sales in the household appliances shop and sales in furniture studios. These channels are integrated with each other and the customer is free to order and return products throughout the system. There are currently 419 shops in the specialist household appliances retailer network and 300 hubs in the furniture studio group. Points belonging to the company's own brand are also points of self-collection by the customer. Increasing the width of the distribution network allows additional services to be offered, which builds the company's competitive advantage against its competitors. At the same time, market penetration and network density increase. To deliver products to its points, the company uses both its own and third-party transport means. The company's own means of transport include 80 fully equipped trucks adapted to adequately secure the transported white goods.

4.2. Analysis of disruptions in material flows

The data collected with Card 1 refers to the operation of the entire distribution network using channels such as sales in household appliance shops, internet sales and sales to customers who additionally place a furniture order at a particular kitchen studio.

This was measured over 2 months on weekdays. Three reliability parameters were identified that deviated from the expected values. These cases were further analysed. The reliability indices of the completed orders determined during the study period are presented in Table 3.

Table 3.
Reliability indicators of the omni-channel procurement process

Indicator	Sale at the point of sale of household appliances	Sales in a furniture shop	Internet sales
KRZ	100%	100%	100%
UWD	0%	0%	12%
TD	92%	94%	86%
UZ	0%	0%	16%

The problems shown in the indicator analysis were selected for analysis, i.e. timeliness in each of the channels analysed, as well as returns and damages in the case of online sales.

In further analysing and looking for what might influence a particular effect, an Ishikawa diagram was a helpful tool.

Delays in order fulfilment can generally have multiple sources of the problem. In the B2B system, employees completing questionnaire 2 indicated that the main problem is the inability to know exactly which of the company's warehouses the goods are in and how many items are in stock. Such information is not available on the B2B platform, which is very problematic because the suggested lead time in some extreme cases can differ significantly from the actual lead time. This is due to the need to add the movement of goods between the company's respective warehouses to the lead time. Equally problematic is outdated and inaccurate information in the system. Discrepancies occurring can be caused by poor input of order data into the system, or by inventory taking being carried out incorrectly or too infrequently to catch such value differences. In addition to this, other causes have also been identified, such as delays from a lack of adequate servicing of the transport fleet, sudden breakdowns or congestion, among others.

The identified damage to delivered goods relates to the processing of online orders via courier companies. Here, the percentage of damage is very high and this is due, among other things, to poor preparation of the consignment for shipping. Such preparation should include adequate additional protection with foils and tapes as well as appropriate additional labelling that informs about the contents and the need for more attention. The identified damage concerned both cooker hoods and induction/gas hobs. This situation occurs due to the use of damage- prone glass in the majority of the product.

The returns identified during the period under review also related to orders placed through the online shop. The main problem with returns is the combination of this problem with the previously mentioned damages. The research did not separate returns from complaints. The occurrence of damage is synonymous with the return of goods. However, there are other reasons for returns, which depend on adequate pre-sales preparation. Such preparation includes creating as accurate and reliable a description as possible of the item the company wants to sell. If there is a discrepancy with the description, or confusion between the description of one product and another, the customer can request a cash refund and send back the ordered product because of the discrepancy. In the cases investigated, there were also hidden defects in the products. The responsibility in this case lies with the manufacturer. Of course, customer confusion by buying goods that do not match, for example, the technical specifications of furniture, is also a factor that can affect returns.

4.3. Analysis of identified causes trough FMEA

The identified causes of the effects were analysed in the next stage using the FMEA tool. The use of likelihood ratios and the importance of given causes in the analysis provided a more complete picture of the risks involved, which made it possible to identify logistical coordination mechanisms for strengthening the resilience of this network.

Table 4.
FMEA analysis

ANALYSIS OF CAUSES AND EFFECTS OF DEFECTS										
No.	**Potential error**	**Consequences of an error**	**Causes of the error**	**CURRENT STATE**				**COMMISSIONED ACTIVITIES**		
				Probability of error occurrence	**Relevance to the customer**	**Probability of error detection**	**Number of risks**	**Recommended preventive measures**	**Responsibility**	**Implementation deadline**
1	Failure to deliver on time	Delay in order fulfilment	Wrongly entered order	3	9	3	81	Provision of additional training for employees	Head of logistics	Immediately for each new employee; periodically once a month for older employees
		Entry of a goods order with a long waiting time	No check on product availability	1	9	2	18	Introduction of control cards requiring the input of values from the B2B platform	Head of logistics	Immediately
		The need to carry out the order again	Incorrectly prepared consignment note	4	9	2	72	Provision of additional training for employees	Head of logistics	Immediately for each new employee; periodically once a month for older employees
		Uncertainty of lead time due to movement of products between warehouses	No quantitative data on the availability of goods in specific warehouses	10	9	9	**810**	Redesign of the B2B platform to increase the volume and accuracy of information	Head of IT	Immediately
		Ordering of goods from the manufacturer only upon receipt of an order from the customer	Outdated data in the system	3	9	4	108	More frequent updating of the product database on the platform	Head of IT	once/week
		Need to order missing goods from manufacturers	Data in the system not in line with reality	3	9	2	54	Taking stock more frequently	Warehouse manager	once/month
		Delay in execution	Car breakdowns	4	6	7	168	Increasing the frequency of inspections	Head of Technical Maintenance	Daily checks on drivers before they start work

		Delay in execution	Obsolete fleet	4	3	1	12	Fulfilment of closer orders using an older fleet	Head of logistics	Immediately
		Delay in execution	Road accidents	5	5	10	250	Use of alternative modes of transport with less risk of accidents	Head of logistics	Immediately for all possible orders
		Delay in execution	Excessive traffic	3	2	6	36	Optimisation of transport routes using routes with less traffic	Head of logistics	Immediately for any orders on a permanent basis
2	Damage to goods in the process of delivery to the customer	Damage to goods	Inadequate protection of the consignment by the packer	6	9	3	162	Training for staff responsible for safeguarding	Warehouse manager	Immediately for new employees; once/month for older employees
		Damage to goods at transshipment depots	Lack of care by the person responsible for handling the goods	7	8	10	**560**	Changing contract terms with courier companies to be stricter when shipments are damaged at subcontractors' warehouses	Head of logistics	Immediately for all contracts with courier companies
		Damage to the consignment due to lack of awareness of the goods at increased risk of damage	Lack of appropriate additional marking of consignments	9	7	8	**504**	Introduction of a commodity database and necessary additional markings for use in packaging	Warehouse manager	Immediately; Immediately on each change of assortment
		Failure to secure the consignment thoroughly	Too much haste in the performance of duties	7	5	9	315	Reorganisation of the work of the postal packer	Warehouse manager	Immediately
3	Return of products from the customer	Misleading information to the customer	Inadequate description of the item for sale	3	8	2	48	Controlling the description of products displayed in the webshop	Head of logistics	Immediately; Daily spot checks on descriptions
		Lack of relevant data necessary for delivery	Incorrectly prepared consignment note	3	7	2	42	Provision of additional training for employees	Head of logistics	Immediately for each new employee; periodically once a month for older employees
		Sending goods to the wrong address or person	Improper shipment of goods	2	9	3	54	Introduction of random label checks	Warehouse department manager	Randomly tested labels on a daily basis

		Receipt by the customer of goods not in conformity with the order	Dispatch of goods not in conformity with the order	2	10	2	40	Introducing the need to scan the codes of products being shipped	Warehouse department manager	Immediately
		Lack of adequate customer service; loss of reputation	Receipt of damaged goods by the customer	5	10	9	**450**	Introducing a policy of additional packages offered to customers in case of such situations	Customer service manager	Immediately
		Lack of adequate customer service; loss of reputation)	Receipt by the customer of goods of dubious quality	2	9	8	**144**	Introduce a policy of additional packages offered to customers in case of such situations	Customer service manager	Immediately

Source: own work.

The proposed mechanisms for responding to disruptions relate to increased transparency in the distribution network, both in terms of order information in the system and stock positions at individual warehouses. Since part of the disruption concerns flow security, it is necessary to strengthen the solutions for securing shipments and the certification of carriers and higher requirements for courier companies. At the same time, it is also necessary here to improve the transparency of information about products and the necessary way of securing and labelling them. The coordinator in the network studied uses mechanisms related to redundancy of stocks in central warehouses and redundancy of intermediaries and carriers as well as sales forecasting for individual assortment groups. One of the necessities of reactive actions is the organisation of emergency transport, which is applied in the network studied thanks to the fact that the central link has its own fleet and at the same time cooperates with carriers.

The indicated logistics coordination mechanisms do not exhaust the possibilities of building the resilience of the studied logistics system. The limitation of the obtained results is the time of conducting the measurement. Thus, the results obtained should be treated as a contribution to further research on logistical coordination. The construction of a system for managing knowledge about disruptions in the distribution network should be a further stage of building the concept of strengthening the resilience of the distribution network.

5. Conclusions

By examining the resilience of the distribution network using a selected distributor as an example, it was possible to identify disruptions and assess the risk of disruptions using analytical tools. During the analysis, the focus was on the reliability parameters that performed weakest in the indicator analysis.

The main problems identified relate to the dispatch of goods via courier companies and the lack of adequate information in the B2B system. In order to adequately improve information exchange, the B2B platform needs to be redesigned. The second major problem is damage to parcels, in transport carried out by a courier company. In this case, the financial impact for the company is not so great due to parcel insurance, but it is an undesirable situation in terms of the final level of customer service.

The solutions identified relate to strengthening resilience using mechanisms that allow for increased transparency (visibility) of the network by all participants.

High resilience to disruption, on the other hand, can be seen in the parameter of completeness of orders processed. Operational activities at the picking stage, a high degree of process flexibility - including combining assortments from different warehouses, surplus stock across the network and surplus suppliers and intermediaries are responsible for this. An additional advantage is the combination of the company's own fleet with external transport companies, which also increases the flexibility of the processes carried out.

The indicated mechanisms, both those used by the coordinator and those proposed to be used to increase the resilience of the distribution network, go beyond the flow mechanisms proposed in network coordination. Thus, it makes sense to extend the flow mechanisms to include logistics coordination in the broadest sense, which aims to synchronise flows, ensure the continuity of the processes carried out and the coherence of the activities of the network nodes. For the implementation of this concept, it will be important to design a system for managing knowledge of disruptions in finished goods flows. At the same time, the research conducted should be extended to other types of networks (characterised by other attributes).

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