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SUPPLY CHAIN RISK MANAGEMENT IN THE CONTENT DELIVERY NETWORK (CDN) INDUSTRY

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Purpose: The purpose of this study is to provide new insights into how supply chain risk management influences a company's operations in the Content Delivery Network (CDN) industry. We also provide recommendations to identify opportunities and how to mitigate and reduce risks.
Design/methodology/approach: We adopt a quantitative research approach involving a correlation and effect/probability matrix. This method relies on risk classification, which is determined by assessing the likelihood of occurrence and the associated impact. The probability is derived from historical data about the incidence of specific events in processes, with values ranging from 0 to 1. Conversely, the impact is evaluated by a team of experts from various company departments, and their recommendations are averaged, resulting in a scale ranging from 0 to 10.
Findings: We found that executing the risk management process within an enterprise requires thorough analysis and process auditing. In the context of a supply chain involving numerous globally reaching companies, the task becomes inherently more challenging as changes may be required across multiple if not all, entities. Nevertheless, the adoption of risk management contributes to the implementation of supply chain and organizational strategies by fostering resilience, thereby enhancing the stability of the organization's position.
Research limitations/implications: This study provides only a snapshot of the CDN industry, i.e. as we restricted our research to one company, this research provides only context-specific findings and we are cautious to generalize our results.
Practical implications: The conducted research and analyses took place within an actual enterprise. The analysis provided can be replicated in other enterprises using the presented procedure.
Originality/value: This is one of the first studies examining the CDN industry and providing concrete steps to reduce the risk along the supply chain. We thereby extend and expand the body of knowledge for supply chain risk management both in theory and practice.

Keywords: risk management; effect/probability matrix; risk mitigation; risk reduction.

Category of the paper: research paper.

1. Introduction

Risk management is an integral element of supply chain management and is particularly important for its value (Ho et al., 2015). In the context of a supply chain, risk management should be an integral part of its activities and a structured and holistic approach will contribute to increasing its stability and consistency. The risk management process should be appropriately adapted to the specific nature of the supply chain's activities, and its complexity and proportional to the threats that may appear in its environment (Manuj, Mentzer, 2008; Tang, 2006). One of the most challenging aspects of supply chain management is ensuring adequate product availability. Missing products can hurt customer service and reduce competitive advantage (Ghadge et al., 2012). The dynamics of changes in the IT field require agility in the supply chain area, hence the key aspect in the content delivery network industry is to take management actions in such a way that the risk of a given threat is minimized to an acceptable level, a previously determined level (Barczak et al., 2019; Ivanov et al., 2019).

The aim of the work is to a) analyze the impact of risk management on the activities using the case of the Content Delivery Network (CDN) industry, and b) identify and propose recommendations for risk mitigation and reduction.

2. The essence of risk in supply chain management

Risk management, functioning in synergy with management, reduces uncertainty and allows for better achievement of goals. Risk is defined as the probability of events occurring that may affect the achievement of goals or expected results. The concept of risk can be analyzed using basic risk concepts, which are classified as negative and neutral (Jajuga, 2018). The negative concept presents risk as a threat, the possibility of loss, potential damage, and inability to achieve a goal or achieve the intended effect. In turn, a neutral concept of risk treats it not only as a threat, but also as an opportunity. Risk management takes a negative approach to understanding risk because it is a risk that threatens the organization's results (Aven, 2016).

The risk is caused by a combination of many external and internal factors that influence the decisions made in the enterprise. In the context of a supply chain, risk is defined as an event that negatively affects the activities of the entire chain and the performance it achieves (Dolgui et al., 2021). In another way, it can also be defined as the probability of choosing an inappropriate strategy, making inappropriate decisions, or poor configuration of links in the supply chain system (Kilubi, 2016). It is also an external danger that negatively affects the efficiency of the chain. The risk can slow down supply chain operations and make it more difficult to achieve its goals.

Risk management is a set of activities that are coordinated to manage and control an organization in the context of risk (ISO 31000). The main goals of risk management are to identify threats, establish their acceptable level, and strive to maintain them at this level, as well as ensure safety in achieving the organization's goals (Puzyrova et al., 2020). An additional goal implied by the remaining goals is to achieve benefits related to risk minimization activities in the organization (Ziemiński, 2016). For supply chain operations, it is crucial to identify the categories of risk that may occur. Assigning risk to its category appropriately allows for measurable benefits for the entire supply chain, as it creates the opportunity to establish priorities about processes that should be taken into account when creating strategies and allocating resources (Roth et al., 2002). Thanks to this, it is possible to minimize its level and negative effects already at the stage of strategy creation. Taking into account the complexity of supply chain operations and the lack of clarity and uniformity in defining the concept of risk, there is no single common risk classification. Taking into account the most important processes carried out within the supply chain, risk groups can be distinguished, which are summarized in Table 1.

Table 1.
Selected types of risks occurring in supply chain processes

Process	Risk groups
Customer relationship management	• incorrect identification of key recipients, • failure to properly identify needs, • inappropriate offer of products and services about the needs and expectations of customers, • lack of ability to react quickly in the event of a change in customer expectations, • possible loss of key customers.
Managing the customer service process	• lack of external and internal integration of supply chain management, • lack of appropriate customer orientation, • inability of supply chain participants to respond quickly and flexibly to new orders, • high customer service costs, • problems with the efficient flow of information.
Demand management	• the inappropriate flow of information about the demand for products from key customers, • lack of integration with clients, • lack of appropriate methods and tools for analyzing and forecasting demand, • lack of understanding of market needs and trends, • changing fashion, • the impact of promotion and advertising, • emergence of substitute products.
Order fulfillment	• no fixed order processing time, • reducing the number of orders fulfilled, • non-integrated production, distribution, and transport processes, • lack of reliability of product and service suppliers, • failure to comply with technical standards and lack of product quality control, • unstable delivery conditions and product prices.
Production	• inappropriate production planning, • failures of production lines, machines, and devices, • lack of flexibility in the production process, • shortage of products necessary for production, • technological limitations.

Cont. table 1.

Supplies	• inappropriate inventory structure, • low quality of the products obtained, • problems related to the exchange of information.
Product development and commercialization	• the long process of developing and implementing new products, • delay compared to the competition, • lack of experience, • half-baked solutions, • too high costs of new solutions, • lack of integration between customers and suppliers, • lack of analysis of market needs and customer preferences.

Source: own study based on (Kulińska, 2007).

When analyzing the types of risks that may occur in supply chain processes, it should be noted that disruptions occurring in one process influence problems in subsequent processes (Ho et al., 2015). For this reason, it is important to analyze possible risks in each process and try to predict the effects on others. For this reason, it is also important to identify the risk categories occurring in the supply chain, which are summarized in Table 2.

Table 2.
Risk categories occurring in the supply chain

Risk category	Occurrence example
Supply chain players	• incorrect selection of participants, including inappropriate location, • no possibility to negotiate prices or choose the form of payment, • divergent action strategies, lack of a common goal, • mismatch of organizational cultures, • mismatch of production and investment possibilities, • financial instability, • customer service differences.
Coordination and cooperation	• the need for a thorough analysis of potential business partners, • delegation of competencies and related financial outlays to another entity, • sharing confidential data with external entities, sometimes competitors, • the possible opportunistic approach of other participants, consequently acting for their benefit and not the entire chain, • difficulties in establishing relationships and common goals for participants, • reluctance to share benefits, • lack of established conflict management procedures, • lack of a clear leader in the chain.
Standardization	• failure to establish common standards • lack of a common chain management strategy, • inconsistent or incompatible data carriers, • unsecured data transfers, • divergent technologies and infrastructure, e.g. product identification (barcodes, RFID).
Information	• lack of information exchange management, • incorrectly designed information flow process, • lack of use of modern techniques and technologies for data collection and analysis, • „bullwhip" effect.

Source: Myszak, Sowa, 2016.

Myszak and Sowa (2016) pay particular attention to the place of origin of the risk in the supply chain and its category. Each of these categories influences each other and is distinguished by the possibility of mutually reinforcing or interpenetrating each other. Moreover, the increasing complexity of supply chain management processes contributes to the

emergence of new risk categories. Risk is inherent in supply chain activities, therefore its management should be a natural activity at the levels of chain planning and management. Risk management requires a change in approach and changes in the organizational culture strategy. It is also necessary to identify and precisely define the goals of this process as well as its constant monitoring. Continuous risk analysis and efficient communication between units responsible for managing individual risk categories are also necessary (Prakash et al., 2017).

3. Risk analysis in supply processes carried out in a company from the Content Delivery Network industry

One of the largest companies in the world operating in the Content Delivery Network industry was selected as the research subject. The company was founded in 1998 in the United States and currently has units in 50 countries around the world. It deals with data flow management, storage, and acceleration of work on the Internet. It also ensures network security and offers cloud computing services to clients. The company has a network of over 350,000 servers located in 3000 locations in over 130 countries around the world, and its customer portfolio consists of approximately 2900 enterprises, including clients such as Microsoft, Facebook, banking and government institutions, and leading car manufacturers. The company's annual revenue in 2022 was $3.5 billion. The company's supply chain is a coordinated network of logistic and operational connections, and its operational efficiency is reflected in the efficiency of the network built by the company. Ensuring adequate availability of servers and complementary products allows placing further units in the network, consequently increasing its capacity and the possibility of faster and safer transmission of larger amounts of data, which may constitute a competitive advantage in the CDN industry. The company serves many global enterprises, and due to the scale of operations and the complexity of processes, the risk occurring in the enterprise is complex and has a significant impact on its operations. Therefore, risk analysis is extremely important in risk management, the results of which constitute the basis for implementing actions aimed at identifying opportunities for risk mitigation and reduction.

Risk analysis in the company was carried out in stages based on shared internal data, the research method used is correlation, effect/probability matrix. The first stage of risk analysis was to identify all possible types of risk that may hurt the supply chain activities. In the next step, the risk description was developed in more detail and the possible impact on the supply chain activities was identified. Each risk was then assigned a probability of occurrence and a weight. The next stage of the analysis was the classification of risk and its division into internal and external risk. This division was extremely helpful in further steps of the analysis and establishing a plan for improvement actions. Identified risks related to the supply chain of

servers that occur within the company are presented in Table 3. The company has a direct impact on the verification, assessment, and implementation of improvements. The risks concern both the specificity of the product, the ordering process, and difficulties related to communication between teams. Probability was assigned in values from 0-1, and risk weight was assigned in values from 0-10.

Table 3.
Identification and characterization of internal risk occurring in the company's supply chain

No.	Risk	Description of the hazard	Possible impact	Probability of risk occurrence (0-1)	Impact impor-tance (0-10)
1. W.	Changes in long-term forecasts for needs	Forecasted server demand increases significantly above the prior period forecast due to new business, organic growth, or unforeseen errors. The seller is unable to react to changes, only part of the new demand can be fulfilled within the required time	Insufficient hardware to implement it	0,8	10
2. W.	Mistakes during the implementation of new servers	New generations and types of equipment increase the complexity of the planning schedule. Bad assumptions when implementing new equipment can lead to purchasing the wrong parts or quantities	Insufficient or inappropriate equipment for implementation	0,3	1
3. W.	Difficulties in introducing new system integrations	The internal complexity of company "X" (with multiple vendors, specialized routing guides, etc.) can make the onboarding period for new vendors long. Internal and external bureaucracy can play a role in the delay	Supply delays	0,25	2
4. W.	Order acceptance process	The order acceptance time is a minimum of 3 days before it can be sent to the seller	Supply delays	0,3	5
5. W.	Communication problems between the supply chain and "hardware" departments	Decisions made by departments responsible for production equipment (e.g., changes in the number or types of servers) without notifying the supply chain	Purchasing the wrong part; delay in obtaining the correct product	0,25	4
6. W.	Server generation changes	Major changes in the transition map from one generation to the next	Insufficient ability to obtain the old version before the new version is in full production	0,05	6
7. W.	No acceptance of the purchase of spare parts	When a company is faced with supply problems, it takes a long time to test alternative solutions	Buying the wrong part; delay in obtaining the correct product	0,6	2
8. W.	Changes to projects	Design changes affecting used parts are not always communicated in time (e.g. factory)	Buying the wrong part; delay in obtaining the correct product	0,55	10

Cont. table 3.

9. W.	Using only customized servers	Company "X" servers are designed by us and built to our specifications. We are unable to run "X" software on off-the-shelf servers, which makes us dependent on our specialized supply chain	Only custom servers can be deployed - if they are not available, there is no way to expand the network	1	5
10. W.	Too many server types	Different parts must be ordered for different types of servers	Buying the wrong part; delay in obtaining the correct product	0,75	3
11. W.	Failure to return unused products from data centers	Parts and servers are stored as spares in data centers, affecting the entire supply chain	Need to order more additional parts and products	0,75	4
12. W.	Components produced only by one manufacturer	Relying on a single supplier for the parts needed for implementation means we have no support if something disrupts that supplier's business	Not enough equipment to implement our actual demand	0,9	9

Source: Own study.

In the next step, a risk map was prepared (Fig. 1) allowing the development of appropriate strategies for each risk. The risk weight is marked on the vertical axis and the probability of its occurrence is on the horizontal axis. The analysis of the data included on the map allowed for the identification of the so-called "most urgent risks", which are located in the upper right corner, i.e. risks with high probability and high importance (risk of changes in long-term demand forecasts and components produced only by one manufacturer). There is also a borderline risk of using only custom servers, this is also a critical risk because the company uses 100% only such servers. This area of the map also includes the risk of changes in projects. This will result in the need to incur high costs and possibly also long-term use of storage space if the use of servers turns out to be impossible. It is essential to act very quickly to minimize the impact of these risks on supply chain operations and, if possible, make changes that could help eliminate them.

In the upper left corner, there is the risk of changing the server generation and related problems. The change in server generation means that new servers will have completely new physical, technical, and IT properties. Another threat is the order acceptance process, which in extreme cases can take up to several days. It is necessary to introduce decisive changes and take action to eliminate their impact, but this will not be as urgent as in the case of the previous quarter.

The next quarter, in the lower right corner, covers risks that are unavoidable and result from the characteristics of the company's operations, but it can be assumed that they are not urgent. Examples of such a threat could be keeping unused servers in data centers or maintaining too many server types.

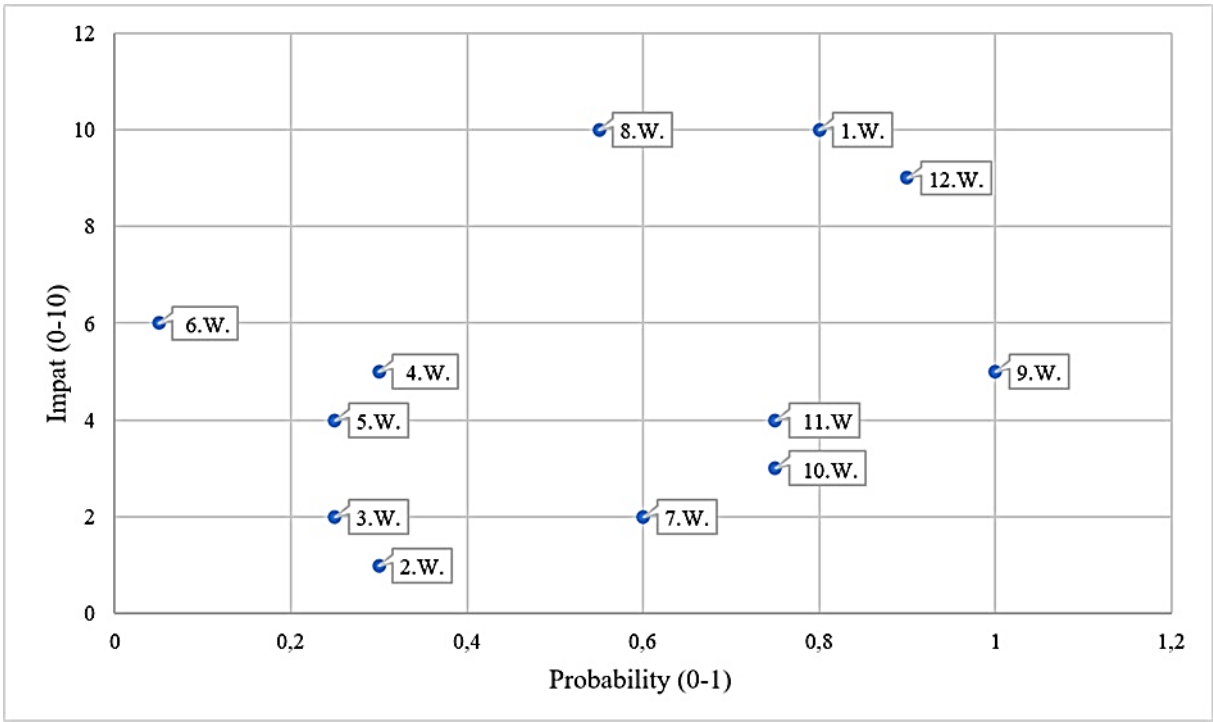

Figure 1. Internal risk map.

Source: Own study.

The last quadrant, in the lower left corner, includes the risk group with the lowest probability and the lowest impact on supply chain operations. They are minor and it is acceptable to ignore them and take no action to minimize their effects. However, you should remember to monitor them and pay attention to whether their impact has changed.

Due to the scale and specificity of the company's supply chain activities, as well as the complexity of its processes, many risks appear outside the company. The impact of external risk usually has a greater impact on the functioning of the company. The characteristics of the external risks threatening the proper functioning of the company's server supply chain are presented in Table 4.

Table 4.

Identification and characterization of internal risk occurring in the company's supply chain

No	Risk	Description of the hazard	Possible impact	Probability of risk occurrence (0-1)	Impact importance
1. Z.	Long delivery time of parts and products	Some parts may take over 12 weeks to complete. It is not possible to provide supplies in a shorter time	Inability to quickly build additional hardware needed. Lack of adequate availability of parts for network construction	0,7	6

Cont. table 4.

2. Z.	Seller's internal supply chain business problems	Suppliers may lose their ability to obtain necessary parts to manufacture our equipment, which may be due to mergers/acquisitions, cash flow, problems with their suppliers, or problems with their processes	The seller cannot provide servers. Insufficient hardware to deploy to actual demand	0,3	9
3. Z.	Problems with suppliers' production capacity	Sellers may not have the ability to produce to meet demand due to financial, human, space, and time constraints	Not enough equipment to implement our actual demand	0,35	8
4. Z.	No long-term contracts with suppliers who do not supply servers, e.g. spare parts for servers	Without a long-term supply agreement, forecasts provided to sellers without an order are not binding delivery commitments. Sellers may decide to ignore the company's demand and therefore deliveries will not be made	Failure to ensure the availability of parts to build the necessary servers	0,6	7
5. Z.	Devices entering the last phase of the product lifecycle without following the appropriate process	The manufacturer or supplier fails to notify the company of a product recall, which prevents the company from providing a timely replacement	Insufficient number of servers for installation. Possible downtime	0,35	5
6. Z.	Changes in market prices	A price increase from a selected supplier means that it is no longer price-competitive	The loss of an alternative supplier may reduce your negotiation options. Shopping costs will increase	0,85	6
7. Z.	Inadequate communication of delivery issues	Sellers often decide too late when to inform the company about supply or production disruptions	We cannot decide on an alternative with sufficient time; we have to wait to receive the equipment	0,65	7
8. Z.	Delays in customs clearance and shipping	The equipment was stuck at customs for a long time due to various problems. For example, strikes, documentation, or pricing problems may cause shipping and clearance delays	Difficulties in importing to a specific country	0,75	4
9. Z.	Lack of import certificates	The seller may not be able to provide regional certifications for the equipment. This may prevent equipment from being imported into specific countries	Difficulties in importing to a specific country	0,25	9
10. Z.	Force majeure / global crisis	For example, volcanoes that change air traffic routes, disrupt the flow of goods, or tsunamis that destroy manufacturing factories. Infectious diseases stopping production	Unable to obtain equipment	0,4	8

Cont. table 4.

11. Z.	Change of supplier ownership	Suppliers may merge with or be acquired by other companies. The new owners can influence production schedules, what is currently produced, escalation paths, prices, etc.	Delay in supply during the transition period, need to change and adapt processes	0,1	5
12. Z.	Product theft	Theft takes many forms, from hijacking a truck in Brazil to stealing disks from servers in a data center. Each theft reduces the availability of servers for deployment	Shortage of supplies – inability to expand the network	0,35	7

Source: own study.

External factors influencing the occurrence of risk in the company's supply chain have a significant impact on the occurrence of problems with server availability and, consequently, on the maintenance and expansion of the network. Another difficulty is import problems. Each country has its own legal and technical regulations related to the import of products. In the case of servers, this is even more complicated because they require additional certification. Due to their intended use, some countries also require additional permits issued by special state units to introduce products into the country. Large and often complicated bureaucracy slows down and, in extreme situations, prevents network expansion. The external risk map is presented in Fig. 2.

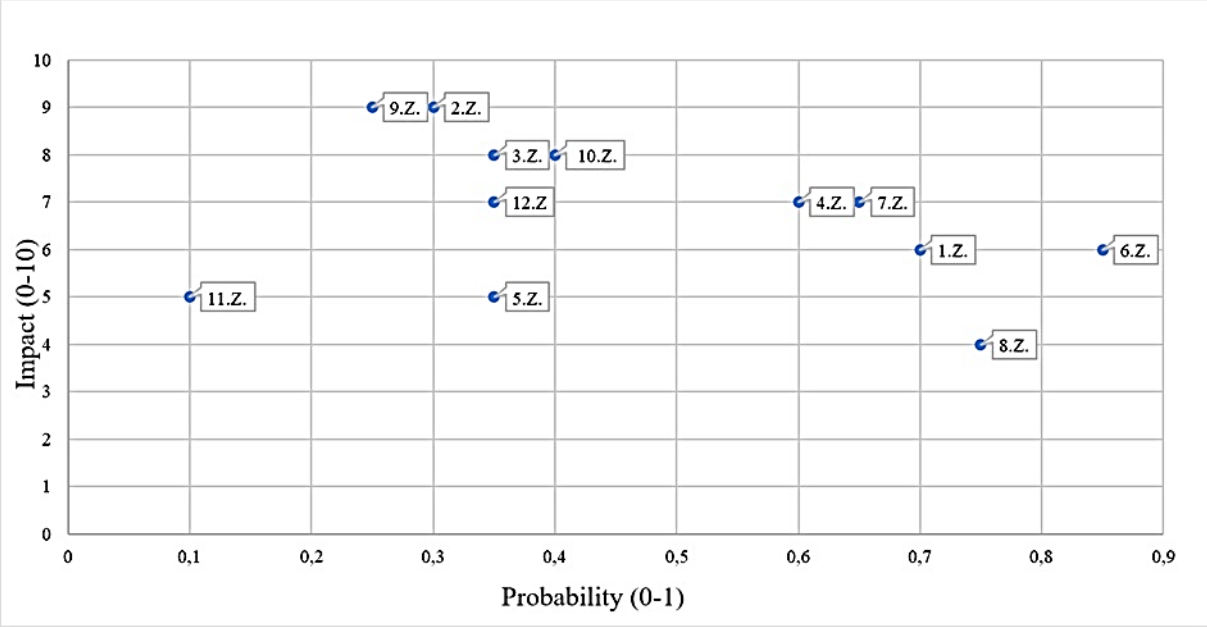

Figure 2. External risk map.

Source: Own study.

The figure above shows a risk map for factors affecting outside the company. As you can easily see, the vast majority are in quadrants one and two. This is because most factors have a large impact on the functioning of the supply chain and have more serious consequences. These are potential problems that may disrupt the continuity of supplies. Risk mitigation in this

case may be more difficult because it requires the involvement of more units, which the company may not influence. Often, the only way to reduce risk for a company is to "shift" it to other links, for example by forcing suppliers to maintain higher levels of inventory.

The upper right quadrant contains factors with high probability and high importance. In this case, it is necessary to take quick actions to minimize their impact. An example is the lack of long-term contracts with component suppliers or changes in market prices. It is also very important to improve communication with suppliers, especially in the event of delivery problems. And also improve the product delivery process to reduce the delivery time of parts and products.

The upper left quadrant contains factors with high importance but lower probability. An action plan must be developed and decisive steps taken to minimize their impact, but this will not be as urgent as in the previous quadrant. Most external risk factors are found here. An example is the lack of shipping certificates causing delays in customs inspection or product theft. Others include a change in supplier ownership, devices entering the final phase of the product life cycle without a proper process in place, supplier capacity issues, and the seller's internal supply chain business problems.

In the lower right quadrant, there is only the risk of delays in customs clearance and shipping. This is a relatively high probability and low severity problem. In the case of a large number of international shipments, this is unavoidable, but it is worth taking steps to minimize it. The last quarter, in the lower left corner, remained empty. This is because external risks usually have a large impact on supply chain operations, making it necessary to take action on each factor.

The identification and analysis of risk in the supply chain constitutes the basis for further risk management steps, i.e. to develop actions to improve risk management, as well as ways to reduce the impact of risk.

4. Characteristics of activities improving risk management in the supply chain

The extraction of data collected after the risk analysis of supply processes implemented in a company from the Content Delivery Network industry allowed for the development of proposals for actions to mitigate and reduce the risk.

Proposals for reducing internal risk are presented in Table 5. The table also includes the risks that may occur during this implementation. In most cases, the developed proposals are based on the need to increase the stocks held by company "X" in warehouses. This solution will certainly ensure better continuity of supply, as it will reduce the risk that servers will not be available when the actual demand for them occurs in the data center. However, this will increase

the cost of keeping servers in stock and create a risk of underutilization of inventory. Risk reduction proposals also present opportunities to improve existing processes and create new ones. These processes, of course, take place within the company and are intended to minimize the impact of risk on supply chain operations.

Table 5.
Proposed improvements for internal risk occurring in the company's supply chain

No	Risk	Possibility to reduce risk	Risks associated with this activity
1. W.	Changes in long-term demand forecasts	Consistently taking into account changes and errors in the forecast. Thorough forecast reviews and error identification. Investment in additional buffer stocks to cover likely growth	The cost of unused inventory may outweigh the benefits of covering the risk. The potential cost of revaluation if commodity prices decline
2. W.	Mistakes during the implementation of new servers	Building flexible forecasts by creating overlapping server types and a longer implementation period	High cost of stocking additional parts, risk of not using less desirable inventory before switching to new equipment
3. W.	Difficulties in introducing new system integrations	Create thorough documentation for the new supplier onboarding process, with all key stakeholders outlined	Frequently changing processes can mean that documentation may need to be updated too frequently to be useful
4. W.	Order acceptance process	Periodically review the most current sellers and add them to the exception list. Thanks to this, the acceptance process will be simplified	Possible price increases from accepted suppliers - no possibility of frequent changes and free choice of supplier
5. W.	Communication problems between the supply chain and "hardware" departments	Establish a process in which both departments must accept any design changes	Lengthening of processes and possible conflicts if changes are not consistent with the assumptions of both teams
6. W.	Server generation changes	Maintain more inventory and longer transition periods between generations	Using older, more expensive, and often more unreliable servers longer than necessary
7. W.	No acceptance of the purchase of spare parts	Introducing a requirement to have two approved dealers for certain types of parts at all times	Both vendors may use the same component supplier, which invalidates mitigation for some
8. W.	Changes to projects	Design changes must go through an approved checklist to which project managers must sign off	Delays waiting for approval of changes to be signed
9. W.	Using only customized servers	Selection and qualification of specific universal servers that can be used in case of shortage	The company's software does not work properly with an off-the-shelf system
10. W.	Too many server types	Reduction of the number of server types	Less customization may result in higher costs or poorer performance matching
11. W.	Failure to return unused products from data centers	Standardize the policy and process for what can remain in the data center as 'spare'	Increase in expenses taking into account authorized spare parts in stock (working stock)
12. W.	Components produced only by one manufacturer	The requirement to have 2 approved sellers for the product at all times	Insufficient sales capacity to meet company demand

Source: Own study.

To provide a holistic approach to risk management, a proposal for improvements aimed at reducing it has been developed for internal risk occurring in the supply chain. Introducing changes in this case will be more difficult than in the case of internal risk. All links in the supply chain must cooperate here, which will additionally require efficient communication and willingness on the part of partners. Supply chain participants will have to agree to the requested audit and implement recommended changes, which may be costly. Proposals for risk reduction and the potential additional risks these changes entail are presented in Table 6.

Table 6.
Proposed improvements for internal risk occurring in the company's supply chain

No	Risk	Possibility to reduce risk	Risks associated with this activity
1. Z.	Long delivery time of parts and products	Requiring suppliers to maintain a buffer stock for all parts with a production time greater than six weeks. Developing relationships with higher-level suppliers. Sharing forecasts or creating contracts for the supply of key parts. Demand that our suppliers provide the necessary information and give us greater visibility up the supply chain. Have them do a full supply chain audit	Providers may need financial support to maintain an additional buffer. Less flexibility to switch to new products as schedule changes. Excessive stocking of parts with expiration dates may lead to unused inventory expiring
2. Z.	Seller's internal supply chain business problems	Have vendors audit their internal processes and inventory levels. Making sure sellers are responsible for delays or shortages caused by their error	Possible costs of additional work
3. Z.	Problems with suppliers' production capacity	Quarterly/annual review to assess financial stability, capability, etc. Proper screening of new salesperson's capabilities during onboarding	Possible costs of additional work
4. Z.	No long-term contracts with suppliers who do not supply servers, e.g. spare parts for servers	Selection of strategic suppliers to implement supply contracts	The need to bear the responsibility of maintaining relationships only with selected suppliers
5. Z.	Devices entering the last phase of the product lifecycle without following the appropriate process	An alternative source or viable substitute from an existing catalog	Using a more expensive substitute before a permanent device is accepted
6. Z.	Changes in market prices	Having a minimum of two sellers approved for each product at all times. Immediately look for an alternative seller if one of the two sellers becomes too expensive	The need to allocate additional company resources. Possible additional costs
7. Z.	Inadequate communication of delivery issues	Establish a policy for sharing information and communicating any disruptions, no matter how trivial	Additionally, time is spent sifting through the noise once the policy is officially implemented. Lack of consent from the supplier
8. Z.	Delays in customs clearance and shipping	Having enough standard parts in all warehouses to cover two-quarters of the demand	Additional charges for variable price parts. Increased inventory holding costs

Cont. table 6.

9. Z.	Lack of import certificates	Start the certification process for all regions at once. Continuation of production by the existing multifunctional enterprise until the new multifunctional enterprise is certified. Documenting the certification process to make it available to future equipment manufacturers. More thorough supervision of the certification process	Certification cost
10. Z.	Force majeure / global crisis	Maintaining excess inventory of standard parts and providing equipment to quickly complete custom builds. Document and track how much a supplier's throughput can increase in a short period	The financial burden of helping the supplier with costs
11. Z.	Change of supplier ownership	Diversification of the manufacturer and supplier portfolio to adapt to changes in supply sources when switching to another supplier	A diversified portfolio may lead to higher product costs due to diluted quantities
12. Z.	Product theft	A review of the likelihood of theft and shrinkage in a market to determine whether Company "X" should be in that market. Paying additional fees for lanes that require additional security for the flow of goods. Changing lanes and vendors where theft is a problem. Purchase an insurance policy for goods in transit	The insurance premium depends on the value of the goods being moved and the number of events. Increased costs of additional security in countries where it is required

Source: Own study.

5. Summary

Risk is an inherent element of every business activity, especially supply chains in the content delivery network industry, the aim of which is to efficiently provide high-availability content to end users. Due to the specificity of the activity and the number of links they cover and connect, the risk has more sources. For this reason, risk management is an issue of ever-increasing importance. Risk management in the supply chain should be implemented in a way aimed at limiting its occurrence and minimizing its effects. Risk minimization is often a key activity in a functioning supply chain, especially if the chain operates in a very turbulent, unstable, and unpredictable environment, as is the case in the content delivery network industry. Building mutual trust and efficient sharing of information is also an important activity in the supply chain. Mutual trust can be strengthened by jointly sharing risk costs and equitably sharing responsibilities among all supply chain participants. Implementing the risk management process in an enterprise is a task that requires in-depth analysis and process audit. In the case of a supply chain that consists of many companies with international reach, it is reactively more difficult because changes may be necessary for many or even all

companies. However, risk management helps implement supply chain and enterprise strategy by building resilience that will make the enterprise's position more stable.

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