



# ResC4EU

RESILIENT SUPPLY CHAINS FOR EUROPE

## D3.2

### Cluster Interaction with SMEs to identify Needs and Challenges for Model Building



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Lead Responsible	Oliver Malmström
Contributing Partners	AID, ATIM, CU, ISL, LITC, PKTK
Contributing Authors	Dr. Aseem Kinra (ISL); Dr. Debarshee Bhardwaj (ISL)
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## List of Abbreviations

AI	Artificial Intelligence	ISL	Institute of Shipping Economics and Logistics
AIDIMME	a Metal-Processing, Wood, Furniture and Packaging Technology Institute	LITC	Latvian IT Cluster
ATIM	Advanced Technology in Manufacturing	MCN	Maritime Cluster Northern Germany
CU	Composites United e.V	PKTK	Polish cluster of Composite Technologies
ERP	Enterprise Resource Planning	SIEM	Security Information & Event Management
GTW	GreenTwin GmbH	SME	Small and Medium-size Enterprises
GWP	Global Warming Potential	WP	Work Package
IGCV	Fraunhofer IGCV		

## 1 Executive Summary

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This document is deliverable D3.2 “Cluster Interaction with SMEs to identify SME's Needs and Challenges for Model Building” of the ResC4EU project. It is a public document aligned with the Grant Agreement and created to support efficient project implementation.

Aim of the report for Task T3.2 is to **identify specific needs and challenges**, with a view to later compare them with possible advanced technologies that has a potential to help in overcoming the challenges. This document summarizes those needs and challenges.

The document names the **challenges** related to supply chain disruptions that can lead to delays in the transfer of goods and services. In addition, it also focusses on the **needs** of SMEs. By identifying their needs, alliance building (WP5) and matchmaking will be supported. The results of this deliverable are in line with the landscape of common advanced technologies developed in D3.1. According to this landscape the categories 1) data and storage, 2) software, 3) hardware and materials, 4) navigation and connectivity and 5) security have been comprised. Although this report does contain substantial data regarding navigation and connectivity (4), it does contain requirements relating to storage (1), software (2), hardware/materials (3) and safety (5).

The **methodology** consists of a comprehensive self-assessment as well as a survey consisting of five questions that were specifically prepared. Both instruments (surveys) are focussing on the question of this task “Identifying Needs and Challenges”. The self-assessment is gathering further data, that will support the model building (WP4). The clusters got in contact with their cluster members via their individual marketing channels (newsletter, mailings, social media and have spoken to their members in person or on the phone). The decision of choosing two complementary surveys enhanced the quality and quantity of the data.

The main findings of this deliverable are several challenges and needs. **Delivery issues** such as **availability** of spare parts or **flexibility** of suppliers are a particular concern at present. **Supplier dependencies** are of high importance, too. Companies are looking for alternative suppliers to increase flexibility. On the other hand, companies are seeking long-term cooperation with their suppliers. As with suppliers, **dependencies on certain customers** are also recognised as a risk. SMEs are reacting by diversifying their portfolio or target markets.

National or EU-**regulations** represent a substantial obstacle for many companies. Support services from the authorities could provide a remedy. The regulatory pressure is challenging for companies. National regulations concerning sustainability issues have been mentioned a few times. The repercussions of non-compliance can be substantial. Companies therefore attach great importance to compliance, while also expressing criticism of its complexity and knowledge requirements.

Critical single **components** or specific supply such as fuel or printed circuit are identified by the SMEs. However, this risk can be minimised by diversifying suppliers. Nevertheless, there is a possibility that product prices will increase in cases where there is a high level of dependency on individual raw materials.

**Trust and relationship** have an enormous significance regarding the supply chains. In comparison to the other challenges, this is more a soft skill. In contrast to portfolio diversification, for example, the capacity

to establish a trusting network cannot be easily reorganised. It is evident that either a high level of social skills is required, or further training measures are necessary. This provides an ample opportunity to develop additional instruments and tools for customer care or cultural competencies, for example.

According to the needs of the companies, **IT solutions** can strengthen their supply chain resilience. Both management solutions and tracking systems have been mentioned. As the data was collected prior to April 2025, before the USA adjusted its trade policy to impose tariffs, the tariff issue is not addressed. It is reasonable to assume that the outcome would have been different if the data had been collected after April 2025. IT solutions could also satisfy the need for optimization of internal processes, including digitalisation. Companies have difficulties to adapt their processes. This was not further described in detail. However, given the emphasis on digitalisation, the transition to digital process structures is the most evident option. The need for those IT solutions coincides with the landscape of common advanced technologies as developed in Task 3.1.

**Stability** is also a key for supply chain resilience. Companies are looking for stable partnerships and stable markets since stability means predictability.

In comparison to the **landscape of supply chain challenges and SME capabilities** developed in Task 3.1, many challenges have been encountered during the development of this deliverable. These include vulnerabilities such as the shortage of skilled labour, supplier issues, demand fluctuations or transportation delays for example. It also includes risks such as supplier dependencies, geopolitical instability or demand volatility. In line with Task 3.1, appropriate instruments have been identified to address the challenges raised by the cluster members (companies). This is the first step in linking the challenges and requirements with suitable technologies.

**Further findings of this deliverable are:**

- The main challenge for companies from the construction and mobility sector are delivery issues that affect delays
- Competition, price, infrastructure failures, recruiting and retaining of workers as well as limited number of suppliers are important vulnerabilities
- “Fuel” is a critical supply for the industrial eco-systems “Agri-Food” and “Mobility – Transport”
- “Electronical components” (printed circuit, for example) are critical for companies in the “Aero Space”, “Electronics” and “Energy renewable” segment mainly
- “Spare Parts” are critical in the industrial eco-system “Mobility-Transport”
- In general, the most critical products are smaller parts – most likely because of insufficient vertical range of manufacture
- Trust and relationship have an enormous significance regarding the supply chains (especially for the eco-system “Mobility – Transport”)
- The companies have diversified their customer base
- The majority has no information on the supply chains of their suppliers
- Sustainability issues as well as different location of the customers and the dependency on a few suppliers are challenging
- IT solutions like management solutions have the biggest chance to enlarge the resilience of the companies

## 2 Introduction

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### 2.1 Purpose of this document

This document is a deliverable D3.2 Cluster Interaction with SMEs to identify SME's Needs and Challenges for Model Building of the ResC4EU project.

Its purpose is to identify the challenges of SMEs that can cause supply chain disruptions and provide an overview of needs that have the potential to solve these challenges.

In the following chapters this document describes the results of the questions sets, that has been distributed to the cluster members. It also opens conclusions of the collected data.

#### Objectives of this deliverable are:

- To identify specific needs and challenges, with a view to later compare them with possible advanced technologies that has a potential to help in overcoming the challenges (in correlation with D3.3 Tech Savvies to meet the Needs of SMEs).
- Use the output of this deliverable to make the planned supply chain risk models and associated tools more practical for the SMEs (in correlation with D4.1 Risk and Alerts Framework for Multimodal Logistics and Supply Chain Resilience).

It will also boost the matchmaking activities planned for WP5 Building Alliances between Tech Savvy and Traditional SMEs.

### 2.2 Document structure

This document is divided into five sections:

**Methodology:** Describing the methodology of data collection.

**Challenges:** Describing the results of the comprehensive self-assessment which contains several questions regarding knowledge about the individual supply chain, vulnerabilities, risks<sup>1</sup> and disruptions.

**Needs & Solutions:** Contains only a few questions on challenges, needs, preliminary products and global warming potential. The survey supplements the self-assessment with these questions. It contains two simplified and, compared to the self-assessment, more general questions on needs and challenges to emphasise the most important topics. As the survey was completed by directly and specifically contacting companies (e.g. by telephone), it complements the type of interaction and therefore increases the number of responses.

**Discussion:** Contains implications for both policymakers and industry leaders

**Summary:** Summarizing the results of both the self-assessment and the survey.

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<sup>1</sup> Risk is the measure of the potential for events having adverse (negative) effects on the organization's objectives. Gredal, P., Panyi, Z., Kinra, A., & Kotzab, H. (2017). What hinders the implementation of the supply chain risk management process into practice organizations. *Dynamics in logistics* (pp. 151–161). Springer.

### 2.3 Targeted group

This document is classified as **public**, means for members of the Consortium including Commission Services and for the public. This report will help understanding the challenges and needs of the companies from different industrial eco-systems. It also describes vulnerabilities for single eco-systems.

This document has been created for the ResC4EU project partners. Understanding of challenges will help the project partners building the model in D4.1 Risk and Alerts Framework for Multimodal Logistics and Supply Chain Resilience.

### 3 Methodology

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ISL developed the self-assessment methodology in Task 4.1 with significant contribution and support from MCN and FHG. MCN provided the questions online in Task 3.2. The EU survey tool had been used for this approach. The comprehensive self-assessment can be accessed through the following link: <https://ec.europa.eu/eusurvey/runner/ResC4EU-Self-Assessment>. The content of the self-assessment was discussed with all clusters, that are taking part in the project as well as with ISL.

The EU survey management platform (see <https://ec.europa.eu/eusurvey/home/welcome>) is selected by MCN and ISL to ensure secure, scalable, and accessible survey data collection by MCN as part of T3.2. The link to the ResC4EU survey is shared with SMEs covering all 14 industrial sectors.

Regular meetings held by MCN with cluster representatives facilitates the distribution and completion of the self-assessment.

The self-assessment consists of six parts:

- PART 1: Information about your firm
- PART 2: Information about your firm's Supply Chain
- PART 3: Your firm's vulnerabilities
- PART 4: Supply chain capabilities
- PART 5: Your firm's supply chain performance
- PART 6: Your firm's supply chain resilience

The data collection via the EU survey tool is based on initial parameters on capabilities<sup>2</sup> (Pettit et al., 2013, Ivanov, 2018a)<sup>3</sup> and vulnerabilities<sup>4</sup> (Pettit et al., 2013), which includes the needs and challenges, developed in T4.1 (ISL supported in developing survey items for assessing supply chain resilience<sup>5</sup> (Fiksel, 2006, Ivanov 2018a)<sup>6</sup> using a dual-layered approach, integrating literature insights and practitioner feedback, ensuring relevance, accuracy). The different capabilities and vulnerabilities are listed in the Annex (Table 9). The last two parts of the self-assessment evaluated the effectiveness of the company's current or potential performance in anticipating and overcoming disruptions in the supply chain and the company's resilience.

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<sup>2</sup> Capabilities refer to attributes such as skills, resources, competencies, and capacities that enable an enterprise to anticipate and overcome disruptions.

<sup>3</sup> Pettit, T. J., Croxton, K. L., & Fiksel, J. (2013). Ensuring supply chain resilience: development and implementation of an assessment tool. *Journal of business logistics*, 34(1), 46-76.

Ivanov, D. (2018). *Structural dynamics and resilience in supply chain risk management* (Vol. 265). Berlin, Germany: Springer International Publishing.

<sup>4</sup> Vulnerabilities refer to weaknesses, gaps (complexities) within an organization's operations that make it more susceptible to disruptions, risks, or negative impacts

<sup>5</sup> Resilience is the capacity of an enterprise to survive (withstand), adapt and grow (recover) in the face of turbulent change (disruptions) to meet customer demand and target performance

<sup>6</sup> Fiksel, J. (2006). Sustainability and resilience: toward a systems approach. *Sustainability: Science, Practice and Policy*, 2(2), 14-21.

The self-assessment is available since December 2024. The link to the survey has been sent out to all cluster members. In addition, the self-assessment has been promoted in working groups, events, via email, social media etc.

The self-assessment has been distributed by each cluster (CU, AIDIMME, ATIM, PKTK, LITC and MCN) to the companies in their network. In sum, 15 companies have taken part in this self-assessment.

With a total number of 7 (47%), Latvia has the most responses, followed by Germany with a total of 5 (33%), Spain 2 (13%) and Austria 1 (7%).

The self-assessment includes specific questions regarding the companies (industrial eco-system, industry segment, size of company, type of product etc.). It also collects data about their supply chain (critical supplier and customer).

According to the company data, the size of the firms varies between 0-9 employees (9 companies), 10-49 employees (3 companies), 50-199 employees (2 companies) and over 2000 employees (1 company). The company size in relation to the industrial eco-system is heterogeneous (see Table 1).

**Table 1 – Company size in relation to the industrial eco-system**

Industrial eco-system	Company size
Aero Space & Defence; Digital	0-9
Aero Space & Defence; Electronics; Renewable Energy	10-49
Agri-Food	0-9
Construction	0-9
Construction	50-199
Electronics; Mobility - Transport	10-49
Electronics; Retail	0-9
Energy intensive industries	50-199
Energy intensive industries	More than 200
Energy renewables; Mobility - Transport	0-9
Mobility - Transport	0-9
Mobility - Transport	0-9
Mobility - Transport	10-49
Retail	0-9
Retail	0-9

To increase the outreach and collect as much data as possible, a **survey** was conducted in addition to the self-assessment. The survey supplements the self-assessment with questions regarding preliminary products and global warming potential. It also includes two more general questions on the needs and challenges.

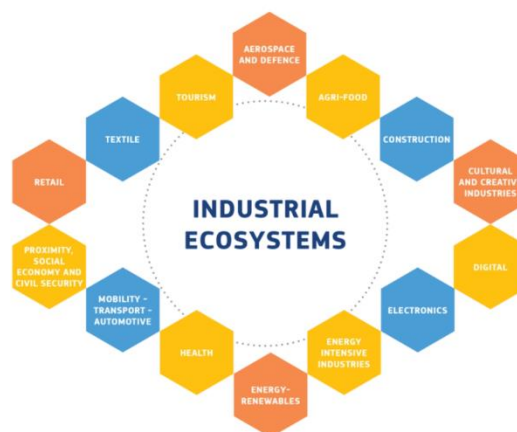
**The survey consists of the following questions:**

- 1) What are the challenges for your supply chain?
- 2) What do you need to enlarge the resilience of your supply chain?
- 3) Do you know the production steps and production sites of your preliminary products?
- 4) Do you know the GWP of the preliminary products in relation to the individual production sites?
- 5) Under what conditions would you enter your own GWP or energy values in a database in order to be able to carry out an analysis and optimization of the GWP?

Aim of the survey was to reach out to companies who did not have the time to complete the self-assessment. Therefore, the clusters (AIDIMME, ATIM, CU, LITC, PKTK and MCN) conducted direct interviews with selected companies in their network. The selection of those companies had been done by each cluster.

For this purpose, back-to-back meetings have been conducted with LITC, CU, ATIM, AIDIMME, PKTK, ISL, IGCV, GTW and MCN. The project partners discussed the data collection on SMEs challenges, the procedures and progress. The mentioned project partners developed the question set to collect the data on SMEs challenges. The clusters have done 59 interviews directly with different sector companies via phone or in direct dialogue.

In the following chapters both challenges and needs will be described for the different industrial eco-systems, as presented in Figure 1.



*Figure 1 – Industrial eco-systems*

## 4 Challenges

The companies that have conducted the self-assessment are working in different industrial eco-systems – mainly in the Aero-Space, Agri-Food, Electronics, Mobility, Retail and in the Energy intensive-industries, as well as some companies having overlapping industries (see Table 2). The industry segments are different accordingly. The following segments have been mentioned: agriculture, energy storage system, engineering surveying, floristry store, furniture, locksmith, maritime industry, shipping, shipping and all types of power generation, subsea technology, supply chain digitalisation, transport, wholesale / retail, woodworking industry.

**Table 2 – Industrial eco-systems of the participants of the self-assessment**

	<b>Aero Space &amp; Defence</b>	<b>Agri-Food</b>	<b>Construction</b>	<b>Electronics</b>	<b>Energy intensive industries</b>	<b>Mobility - Transport</b>	<b>Retail</b>
<b>1</b>	Aero Space & Defence; Electronics; Energy renewables	Agri-Food	Construction	Electronics; Mobility - Transport	Energy intensive industries	Mobility - Transport	Retail
<b>2</b>	Aero Space & Defence; Digital		Construction	Electronics; Retail	Energy intensive industries	Mobility - Transport	Retail
<b>3</b>					Energy renewables; Mobility - Transport	Mobility - Transport	

Considering the industrial ecosystem of the 59 companies that have been interviewed by the six clusters, the survey includes responses from companies of almost all 14 industrial eco-systems (see Table 3).

**Table 3 – Number companies per industrial eco-system**

<b>Industrial eco-system</b>	<b>Number of companies</b>
Mobility, Transport, Automotive	11
Aerospace and Defence	6
Construction	10
Renewable Energy	1
Energy- intensive Industries	11
Agri-food	2

Textile	3
Health	4
Cultural & Creative Industries	2
Electronics	3
Tourism	3
Retail	1
Digital	2
Proximity, Civil security, Cyber security	0

According to the question “*What are the challenges for your supply chain?*” the results are different (see Table 4). Since 59 companies have been interviewed and the most of them have more than one challenge with their supply chain, their answers have been clustered. Based on this sorting, the answers can be divided into 25 categories (see Table 4).

**Table 4 – Challenges of the companies according to the survey (Company frequency in brackets)**

Delivery Issues	Market and transaction issues	Organisational and human issues	Supply issues	Information technology and issues related to supply chain processes		
Reliability (18)	Price/ costs (16)	Fixed contact person (1)	Alternative Suppliers (11)	Ineffective Software (2)	Business management (calculating opportunities) (2)	Depth of production (and location) (1)
Speed (5)	bureaucracy/ regulations (18)	Generational Change/ Staff (2)	Unknown supplier (3)	Quality Management (of materials/ products) (2)	Complex Process (1)	Cyber Security (1)
Availability (of spare parts/ raw materials) (15)	Market (4)	Relationship (6)	Products in stock (3)		Missing Information (customs-related) (1)	Sustainability (regarding components) (2)
Flexibility (1)	Geopolitical Instability (3)		Dependency from Transport (2)		Monitoring (of components/ inventory) (2)	Forecast (of demand etc.) (3)

In the following chapters, there are several references to the self-assessment rating system, which ranges from 1 (extremely irrelevant) to 7 (extremely relevant)<sup>7</sup>. The ratings provide an objective assessment of capabilities and vulnerabilities.

#### 4.1 Challenge- Delivery Issues

The main challenge is focussing delivery issues such as **reliability**, which includes the compliance with delivery times. 18 companies mentioned this during the survey. These answers are similar to the answers regarding “**Speed**”, “**Availability**” and “**Flexibility**”. While “**Reliability**” is considering delays in general, “**Availability**” is focussing on delays because of missing spare parts. In the context of business, the terms “**speed**” and “**flexibility**” are often used to describe the ability to respond quickly and adapt to changes in a timely manner. These qualities are particularly important in dealing with **delays**, as they allow for effective management of resources and the ability to make adjustments in real-time. The answers to all these generic terms are therefore close together. The most companies with those challenges are from the construction and mobility sector.

#### 4.2 Challenge- Bureaucracy/Regulations

“**Bureaucracy/ regulations**” has been mentioned by 18 companies, too. It covers both EU- and national regulations. “**Geopolitical instability**” was frequently mentioned in this context. It can be assumed that this is partly due to the sanctioning of certain countries. Uncertainty regarding the future direction of countries can also play a role - China was mentioned here, for example. Especially this has a strong connection to “**market**” and “**price/cost**”. Concerning the price, fluctuations have been mentioned several times. These fluctuations represent uncertainties for companies and the market. “**Market**” describes uncertainties regarding the demand. The market may be volatile which represents a challenge. This is similar to the answers regarding “**Forecast**” which describes the limited resources for demand forecasting. Those market and transaction issues have been responded from companies of all industrial eco-systems.

**Regulatory pressure to reduce emissions** is also having a significant impact. “*We maintain low levels of CO<sub>2</sub> emissions.*” has an average rating of 5,3. “*We maintain low waste production and high recycling rates in all our processes.*” even has a rating of 5.6. This means the companies have capabilities concerning sustainability. It also emphasises the pressure to implement the regulatory requirements. Failure to comply with these regulations could result in fines for companies. EU Fuel Maritime is a prime example of this.

#### 4.3 Challenge- Customer Dependencies

11 of the 15 participants named their **critical/ main customers**. Some companies even named three critical/ main customers. It is striking that some of the customer names are general descriptions of industry segments, but they vary greatly. As an example, one company names three critical/main

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<sup>7</sup> The rating system ranges from 1 (not very relevant) to 7 (extremely relevant). 0 means “Don’t know”. All questions and the average rating can be seen in table 10 (see annex).

customers from the areas of "Research institutes", "Offshore oil and gas", "Renewable energy". The companies have therefore **diversified their customer base**.

According to the responses on "Our products/services are sold to customers in a variety of **geographic locations**." higher investments in the handling of various supply chains (customs, etc.) can be assumed. This also emphasises the importance that companies place on this capability.

#### 4.4 Challenge- Supplier Dependencies

**Supplier dependencies** have been mentioned in both the self-assessment and the survey. It is noticeable that no participant of the self-assessment is familiar with the supply chain of their critical customers or critical suppliers. This means that the knowledge of the supply chain is very limited.

According to the self-assessment 8 out of 15 participants have named their most critical suppliers and the products that are critical. **The following have been mentioned:** Fuel (3x), printed circuit boards, tubes, locks and cylinders, Board, Spare parts, cooling cap, cooling input, electronical components (3x), Fittings, equipment (tractor, parts) (2x), motor vehicle parts and accessories, cell carrier, Washbasin, seeds, motor vehicle parts and accessories, connectors and small equipment.

According to Table 5 "**Alternative suppliers**" also contains all answers to existing dependencies on a few suppliers. According to the responses, this issue is affecting approximately 20% of companies. An analysis of responses to the question, "We depend on limited number of suppliers," emphasises the assumption that supplier dependency is of high relevance for SMEs. While this is a critical vulnerability, the fact that companies are aware of the risks can be regarded as a demonstration of capability. In addition to this dependency, **knowledge regarding their suppliers is missing**.

**Table 5 – Critical supplier and its products in relation to the industrial eco-system**

Industrial eco-system	Product #1	Product #2	Product #3	Product #4	Product #5
Aero Space & Defence; Electronics; Energy renewables	tubes	electronical components	electronical components	electronical components	connectors
Agri-Food	fuel	equipment (tractor, parts)	seeds	equipment	small equipment
Electronics; Mobility - Transport	printed circuit boards	cooling cap, cooling input	cell carrier		
Energy intensive industries	board	fittings	Washbasin		
Mobility - Transport	fuel	fuel	motor vehicle parts and accessories	motor vehicle parts and accessories	
Mobility - Transport	Spare parts				
Retail	locks and cylinders				

## 4.5 Challenge- Products

While “fuel” is critical for at least two industrial eco-systems (Agri-Food, Mobility – Transport), “**electronical components**” (printed circuit, for example) are critical for two companies in the Aero Space, Electronics and Energy renewable segment. “**Spare parts/ motor vehicle parts**” are critical in the industrial eco-system Mobility – Transport. In general, the most critical products are **smaller parts** – most likely because of insufficient vertical range of manufacture.

## 4.6 Challenge- Relationship

Further data was collected on capabilities, vulnerabilities, performance and resilience. “*We trust each other on the accuracy of information.*” has a very high relevance (rating of 5,9). “*We are sincere to each other relationship with the partners and keep promises to each other.*” has an average rating of 5,6 and hereby underlines the meaning of **trustful relationships**. This means that trust and relationship have an enormous significance regarding their supply chains. It is particularly noteworthy that companies operating within the industrial ecosystem entitled Mobility – Transport have assigned a significant degree of importance to the relationship. The lowest rating is 4 (neutral) and belongs to service provider.

In Table 6 “relationship” describes the coordination and management of relationship to the suppliers of the SMEs. It includes a trustful relation as well as knowledge about the quality of the supply.

Further data was collected on capabilities, vulnerabilities, performance and resilience. “*We trust each other on the accuracy of information.*” has a rating of 5,9. “*We are sincere to each other relationship with the partners and keep promises to each other.*” has an average rating of 5,6 (on a scale of 0-8) and hereby underlines the meaning of trustful relationships. This means that trust and relationship have an enormous significance regarding their supply chains. It is particularly noteworthy that companies operating within the industrial ecosystem entitled Mobility – Transport have assigned a significant degree of importance to the relationship. The lowest rating is 4 and belongs to service provider.

**Table 6 – Rating of the question “We are sincere to each other relationship with the partners and keep promises to each other” in relation to the industrial eco-system**

Industrial eco-system	Rating
Aero Space & Defence; Digital	4
Aero Space & Defence; Electronics; Energy renewables	6
Agri-Food	6
Construction	4
Construction	5

<sup>8</sup> The rating system ranges from 1 (not very relevant) to 7 (extremely relevant). 0 means “Don’t know”. All questions and the average rating can be seen in table 5 (see annex).

Electronics; Mobility - Transport	5
Electronics; Retail	4
Energy intensive industries	no response
Energy intensive industries	no response
Energy renewables; Mobility - Transport	7
Mobility - Transport	7
Mobility - Transport	7
Mobility - Transport	7
Retail	5
Retail	6

#### 4.7 Challenge- Price and competition

The information about “*Our products are challenged by frequent **competitive innovations and price competition***” is relevant according to the participants, too. With an average rating of 5,2 it is the result of global competition on the market. According to the self-assessment it is the vulnerability with the highest rating. Due to recent developments in the area of US customs policy, it is likely that this has intensified further. Price and competition will therefore remain the biggest challenge for small and medium-sized companies in the foreseeable future.

#### 4.8 Challenge- Infrastructure Failures

Vulnerabilities concerning “***Infrastructure failures, such as power outages or transportation network breakdowns could impact our ability to operate in our unit.***” have a rating of 5. This means that risks are recognised, or at least specific weaknesses are known. Companies are sensitised to such disruptions. If they have not already done so, it is likely that companies are working on developing defence mechanisms and procedures to counteract this.

#### 4.9 Challenge- Recruiting

According to the data collected by the clusters, **recruiting** and retaining highly skilled workers is difficult. This is not very surprising since “labour and skills shortages are on the rise in all EU Member States”. 63 percent of small and medium-sized businesses cannot find the talent they need<sup>9</sup>. The deliverable of task 3.1 have identified this topic as one of the main challenges, too.

<sup>9</sup> European Commission, 20. March 2024, [Tackling labour and skills shortages in the EU - European Commission](#)

#### 4.10 Influence on the valuations

It is likely that the lower the calculated average rating, the lower the rating of each participant. However, the dispersion of the answers also appears to have a major influence. Both high and low ratings can occur simultaneously. According to table 7, the companies from the Agri-Food and Construction industry gave a low rating, while companies from the Aero-Space and Mobility industry submitted a high rating. This suggests that the **industrial eco-system (among other aspects) influences the capabilities** etc. However, two companies from the Retail industry gave opposite answers. Since both companies are located in the same region, have the same size etc. the **type of product seems to affect the rating**, too. The company that qualified the question “We have regular interchange of information among suppliers, customers, and other external sources.” as not very relevant (1) is a locksmith. The company with the high rating of 7 is a Floristry store.

**Table 7 – Rating of the question “We have regular interchange of information among suppliers, customers, and other external sources.” in relation to the industrial eco-system**

Industrial eco-system	Rating
Aero Space & Defence; Digital	6
Aero Space & Defence; Electronics; Energy renewables	7
Agri-Food	1
Construction	2
Construction	4
Electronics; Mobility - Transport	6
Electronics; Retail	4
Energy intensive industries	no response
Energy intensive industries	6
Energy renewables; Mobility - Transport	5
Mobility - Transport	5
Mobility - Transport	7
Mobility - Transport	6
Retail	1
Retail	7

## 4.11 Challenges in relation to the industrial eco-system

By focussing the industrial eco-system, the challenges are as follows:

**Mobility, Transport and Automotive:** The main challenge is reliability. Delays to shipments are particularly critical. The availability of spare parts and raw materials is as important as the associated costs. There is high pressure to minimise shipment costs wherever possible. Reducing supplier dependencies is also important.

**Aerospace & Defence:** Reliability of suppliers and processes are of high interest for the aerospace segment. The establishment of redundant supplier networks is just as important in this segment as it is in the mobility sector.

**Construction:** Within this industrial eco-system, Reliability is the most important challenge. In this eco-system, companies are subject to significant pressure from bureaucracy and regulations. The reduction of costs as well as the diversification of their suppliers are challenging, too.

**Renewable Energy:** Reliability concerning delays, availability of components as well as cost-related issues are important for companies in this industry.

**Energy- intensive Industries:** Those companies have main challenges concerning reliability issues such as delays in material delivery. Bureaucracy and regulations are also a major hurdle for companies in this area. Further challenges are availability of components and spare parts, geopolitical instabilities, supplier relationships and a lack of redundant suppliers.

**Agri-Food:** Reliability, costs and bureaucracy is challenging in this industrial eco-system, too. Market-related issues such as price/demand fluctuations and geopolitical instabilities are further challenges.

**Textile:** Securing raw materials and keeping costs down are two of our main priorities. Volatile markets and supplier dependencies are further challenges to be addressed.

**Health:** This ecosystem is facing challenges due to regulations and strict rules (IATA has been mentioned by a Spanish company), which are resulting in slow procedures. Furthermore, reliance on suppliers from outside Europe is proving to be a challenge.

**Cultural & Creative Industries:** Companies within this industrial eco-system are challenged by delivery issues and market issues such as demand volatility.

**Electronics:** This industrial eco-system has the most different challenges (together with the mobility sector). Building good supplier relationships, the diversification of the suppliers and the availability of components must be mentioned here. Ineffective/ manual business management and forecasting inability are further challenges.

**Tourism:** The most frequently mentioned challenges were a lack of alternative suppliers and strict regulations (which reduce business opportunities), followed by market related issues (demand fluctuations) and relationship (difficulties in managing supplier relationships).

**Retail:** Delays and price fluctuations can have a negative impact on this eco-system. In addition, companies face challenges in establishing trusted relationships with suppliers and accurately forecasting demand.

**Digital:** This industrial eco-system has different challenges. Some of them are less redundant supplier, delays or issues with the quality management of products.

#### 4.12 Summary of the challenges

Ultimately, it can be summarised that reliability is of high interest for SMEs. Hereby, reliability has different dimensions.

- 1) Reliability as a matter of delivery issues. The primary objective of companies is to prevent delays and ensure that planning is executed efficiently and effectively.
- 2) Reliability as a matter of stable market.
- 3) Reliability as a matter efficient and stable relationships.

In general, reliability is an integral component of effective planning and therefore of extremely high relevance for all companies.

Regulations are both sophisticated and resource-demanding for companies. The demand to enlarge the number of suppliers is a cornerstone to strengthen the supply chain resilience. Companies are aware of this. However, it seems to be either challenging to find potential suppliers or their prices, delivery times etc. are having a negative effect on the competitiveness. **Trust** between the companies is a particularly high priority. Sustainability<sup>10</sup> issues as well as different location of the customers are challenging.

The industrial eco-system does not have the main influence on the relevance of a specific capability. Instead, the relevance depends on several factors. One of them is the product, for example.

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<sup>10</sup> Warmbier, P., Kinra, A. and Ivanov, D. (2022), "Supply chain sustainability and resilience-relationship and congruent capability analysis based on paradox theory", IFAC-PapersOnLine, Vol. 55, No. 10, pp. 311-316  
Warmbier, P., Kinra, A., Ivanov, D.: Supply chain sustainability and resilience under uncertainty: paradoxes and responses. In: Academy of Management Proceedings 2023 (2023).

## 5 Needs and Solutions

Several needs are mentioned by the companies (see Table 8). As can be seen in table 4, the needs are very much in line with the challenges. This means that the gaps in the resilience strategy and possible solutions have been identified.

*Table 8 – Needs of the companies according to the survey (number of responses in brackets)*

Supply issues	Delivery Issues	IT issues	Organisational and human issues	Market and transaction issues And issues related to supply chain processes
transport service providers (2)	<b>Reliability (3)</b>	Tracking price and components (4)	<b>Staff (4)</b>	<b>Regulations (3)</b>
<b>Storage (3)</b>	<b>Stability (3)</b>	IT (9)	<b>Support (2)</b>	<b>Money (3)</b>
<b>Multiple Suppliers (23)</b>	<b>Availability (2)</b>		<b>Relationship (6)</b>	<b>Process (4)</b>

### 5.1 Need of multiple suppliers

By far the most frequently mentioned answer was “**multiple supplier**”. A total of 23 (out of 59) companies, predominantly from the construction and mobility sectors, but also from the aerospace, defence and renewable energy industrial ecosystems, have identified dependencies on a small number of suppliers as being of critical importance. In addition, some of them mentioned that they would like to have further suppliers in Europe, instead of Asia etc. This leads to the conclusion that companies have recognised the risks of geographically large supply chains and perceive them as significant.

Next to this, supplier **stability** is also very relevant. As some products have a lifetime of several years or even decades, spare parts must be available in the future. In the maritime industry, it is not unusual for a ship to be in service for 25 years or more. Consequently, shipowners have a strong incentive to ensure the continued availability of these components, even in the long term. The reliability of suppliers is therefore very important. A stable network is essential for effective planning, ensuring security, and accurately calculating costs. It also prevents unforeseen expenses that may arise from switching suppliers. Therefore, stability is a matter of planning capabilities and cost-efficiency, and thus a matter of reliability.

In general, **delivery issues** and **availability** of spare parts plays a fundamental role.

## 5.2 IT solutions

Many responses are related to **“IT” solutions**. These data are very important because they specify the technology requirements. The companies are requiring efficient **management solutions**, mainly. The solutions should be used for:

- SIEM & Security Guidance
- Modern ERP-system that supports the electronics industry
- administrate the workflow and booking process
- their supply needs on the transit map
- bookings and logistics
- warehouse and order management
- accurate calculations and to talk directly to suppliers
- creating a database of available materials, including mechanical, chemical, and processing properties
- Data/information to assess risk and respond

Furthermore, there are four responses regarding **“tracking systems”**. Of course, they are covered by IT solutions in general. However, as they were mentioned separately, they are clustered alone:

- to have an IT solution that gives real-time product prices and stock of all suppliers
- for procurement, it would be great to track the critical components and their prices
- to track the truck to know where it is and therefore calculate precise arrival times
- to track orders, optimize production, and improve communication with customers and suppliers

It is primarily companies from the tourism and construction sectors that have referenced these solutions, respectively, in light of the inherent challenge. Further responses were from the agri-food, electronics and retail industries.

## 5.3 Further needs

The responses clustered by **“relationship”** covers all data regarding the importance of a good network. The companies are willing to enlarge their network. This includes suitable partners and long-term cooperation. Of course, by strengthening their network the companies want to attract new clients. Cooperation with local authorities is also important. Companies are seeking assistance from local authorities due to the complexity of the **regulations**.

In general, processes are challenging because of regulations as well as the internal structure of the company. Therefore, the **optimization of internal processes**, including **digitalisation** is important for the industry. Technologies as well as consulting by specialized companies could solve this problem. Authorities could support this by adapting regulations or enabling support services.

The companies are currently seeking to **recruit** new employees on a national and international level. Consequently, companies must explore alternative or new ways to recruit potential employees. Another option to consider is the use of **efficiency-enhancing technologies**, which can help to mitigate the shortage of skilled labour. This objective could be realised through automation or the integration of

robotics. The use of AI, virtual reality, augmented reality, additive manufacturing or exo-skeletons, for example, is also a possibility.

## 6 Discussion

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The ResC4EU Task 3.2 findings, derived from both the self-assessment and survey of European SMEs across diverse industrial ecosystems, highlight critical structural and operational challenges and needs in SME supply chains. These insights carry direct implications for both policymakers and industry leaders seeking to foster supply chain resilience within the European industrial landscape.

### 6.1 Policy Implications

#### 1. Strengthening Regional Supply Networks:

The heavy reliance on non-European supplier points to the need for incentives supporting supplier diversification and nearshoring. The EU Critical Raw Materials Act and Industrial Strategy Update provide useful frameworks for reducing strategic dependencies (European Commission, 2023)<sup>11</sup>. As observed in both the self-assessment (Table 4) and survey (Table 6 and 8), a recurring challenge is the heavy reliance on a limited number of suppliers, particularly from outside Europe. Survey responses revealed that 23 companies highlighted the need for multiple suppliers, especially within Europe, indicating vulnerabilities due to global dependencies. This aligns with policy frameworks like the EU Critical Raw Materials Act and the Industrial Strategy Update.

#### 2. Supporting SMEs in Managing Compliance and Bureaucracy

Survey findings (Table 4) show bureaucracy/regulations as one of the top challenges (18 companies), pointing to the need for clearer, more streamlined compliance requirements. The self-assessment additionally reflects mixed capability ratings related to risk management and regulatory handling, suggesting a policy gap in providing SMEs with practical tools and advisory support. These and findings can be reflected from other regulatory compliances as well that are currently active in Europe.

For example., the Act on Corporate Due Diligence Obligations in Supply Chains (Gesetz über die unternehmerischen Sorgfaltspflichten in Lieferketten) came into force on 1 January 2023 in Germany. The law regulates the responsibility of German enterprises to respect human rights in global supply chains. This includes, for example, protection against child labour, the right to fair wages, as well as environmental protection. The people in the supply chains, enterprises and consumers benefit from this (Federal Minister of Labour and Social Affairs. (2023).)<sup>12</sup>.

The European Union entered the Directive on corporate sustainability due diligence (Directive 2024/1760) into force in July 2024 (European Commission, 2024)<sup>13</sup>. The Directive increases the risk management, resilience and competitiveness (European Commission, 2024)<sup>14</sup>.

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<sup>11</sup> European Commission. (2023). Critical Raw Materials Act.

<sup>12</sup> Federal Minister of Labour and Social Affairs. (2023). [Supply Chain Act - BMAS](#)

<sup>13</sup> European Commission. (2024). Directive on corporate sustainability due diligence

<sup>14</sup> European Commission. (2024). [Corporate sustainability due diligence - European Commission](#)

### 3. Keys to resilient supply chains - OECD policy toolkit: Increasing supply chain resilience

Both the survey and the self-assessment (see Table 10 in Annex) highlight a lack of knowledge about tools related to top supplier networks and production processes, especially concerning environmental metrics like GWP. Only 6 out of 59 companies knew the GWP for preliminary products (see Table 11 in Annex). This gap reinforces the importance of policy-driven initiatives promoting supply chain mapping, data disclosure and standardised environmental reporting frameworks and tools.

The OECD provides a toolkit for resilient supply chains. It supports policy makers with tools to navigate decision-making processes relevant to building supply chain resilience. With this tool policy makers can support the private sector's efforts by creating a stable, transparent and predictable framework for business to operate in<sup>15</sup>.

## 6.2 Industry Implications

### 1. Prioritising Supplier Diversification and Redundancy and Risk Management:

The self-assessment (Section 4, Table 4) clearly identified critical dependencies on specific products (fuel, spare parts, electronic components) across ecosystems such as Agri-Food, Mobility-Transport and Aerospace. This vulnerability was echoed in the survey where 'multiple suppliers' was the single most frequent resilience need (23 mentions, Table 8). It underscores the strategic importance for SMEs to build supplier redundancy and explore nearshoring. Companies must diversify suppliers and actively manage risks, as research shows multisourcing improves resilience (Ivanov & Dolgui, 2021)<sup>16</sup>.

### 2. Corporate measures to improve supply chain resilience

IT management solutions were identified as key needs by 9 survey respondents (Table 8), focusing on workflow, tracking, risk management and real-time data. The self-assessment results also indicate low digital maturity scores (see Section 4's vulnerability assessment), particularly in areas like real-time information interchange. These findings collectively point to IT and digital transformation as pivotal enablers for resilience. Companies improve their supply chain resilience by expanding digitization programs and implementing structural changes to their networks (McKinsey & Company, 2022)<sup>17</sup>.

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<sup>15</sup> OECD. [Resilient supply chains | OECD](#)

<sup>16</sup> Ivanov, D., & Dolgui, A. (2021). A digital supply chain twin for managing the disruption risks and resilience in the era of Industry 4.0. *Production Planning & Control*, 32(9), 775-788.

<sup>17</sup> McKinsey & Company. (2022). [Supply chain disruption and resilience | McKinsey](#)

## 7 Summary

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In sum, both the self-assessment and the survey have complemented each other regarding the variety of challenges. The most important topic seems to be the **delivery issues** such as **reliability** of suppliers and the corresponding supply chain **relationships**. Companies from the construction and mobility eco-system are challenged by delivery issues that affect delays. **Availability** and **Flexibility** are also issues of high priority. Availability includes spatial (global-wide) as well as temporal dimension.

The experience the companies made during the last crisis with regards to supply chain disruptions is long-lasting as the most companies are looking for **redundant suppliers** – especially within Europe. The limited number of suppliers is an important vulnerability predominantly for the construction, mobility, aerospace and defence and renewable energy industrial ecosystems. They classify dependencies on a small number of suppliers as critical.

Further important vulnerabilities are **competition, price, infrastructure failures, cyber-attacks and recruiting** and retaining of workers.

Furthermore, some companies have diversified their product portfolio to decrease the impact of volatile **markets**. Companies have also recognised the risks of geographically extended supply chains and are therefore trying to concentrate their supply chains in Europe.

**Knowledge** is an important factor to strengthen resilience. The majority stated that they have no information on the supply chains of their suppliers. Data concerning the GWP of the preliminary products is missing, too. In general, the knowledge about the supply chain is very limited. In Germany, awareness of supply chains is slightly more prevalent due to the provisions of the Supply Chain Act (Act on Corporate Due Diligence Obligations in Supply Chains). According to the Supply Chain Act, large companies are obliged to prepare a sustainability report. This approach improves the information situation. At the same time, it leads to greater administrative effort - an argument that many companies criticise. **Bureaucracy** must be adapted according to the responses. Perhaps the companies are overwhelmed by the existing regulations. Assistance by local authorities is a potential way to support them.

In general, **critical supply** are smaller parts. Companies from eco-system “Mobility – Transport” are challenged by missing spare parts. Electronical components are critical in the Aero Space, Electronics and Energy renewable eco-systems mainly. Fuel is critical for the industrial eco-systems “Agri-Food” and “Mobility – Transport”.

From a technological perspective, **IT solutions** probably have the biggest chance to enlarge the resilience of the companies. Efficient management solutions to avoid double-bookings etc. as well as tools for optimisation and monitoring are very promising. Especially companies in the industrial eco-system “tourism” and “construction” are looking for those solutions.

The challenges, that are mentioned in the Mapping of relevant Advanced Technologies of the ResC4EU project, were confirmed during this data collection. However, the challenges were broken down further and assigned to the individual eco-systems. Some challenges such as regulation of processes affect all eco-systems. However, others are weighted differently (depending on the eco-system). The advanced technologies

The challenge “**supplier dependency risks**” and “**supplier failures**” mentioned in the Mapping of relevant Advanced Technologies have been identified by several interviews. Companies considered those supplier dependencies and added reliability, flexibility and availability. These factors are mutually dependent. While dependency on certain suppliers represents a susceptibility to disruption, the availability of spare parts is also due to a critical number of suppliers.

The volatility of **markets** could also be linked to the need for forecasts.

## 8 Annex

**Table 9 – Capabilities and vulnerabilities according to the self-assessment**

<b>Capabilities</b>
1. Flexibility in Sourcing: Ability to quickly change inputs or the mode of receiving inputs
2. Flexibility in Order Fulfilment: Ability to quickly change outputs or the mode of delivery
3. Capacity: The ability to change manufacturing processes or adapt to new products, mix, or volumes efficiently
4. Efficiency: Capability to produce outputs with minimum resource requirements
5. Visibility: Knowledge of the status of operating assets and the environment
6. Adaptability: Ability to modify operations in response to challenges or opportunities
7. Anticipation: Ability to discern potential future events or situations
8. Recovery: Ability to discern potential future events or situations
9. Dispersion: Broad distribution or decentralization of assets
10. Collaboration and trust: Ability to work effectively with other entities for mutual benefit
11. Security: Defense against deliberate intrusion or attack
12. Financial strength: Capacity to absorb fluctuations in cash flow
13. Digital capabilities: Skills, technologies, processes, and resources that enable an organization to effectively leverage digital technologies
14. Risk Appetite and Culture: Ability to recognise, assess, and address risks and uncertainties in the supply chain
15. Social sustainability: Ability to ensure social sustainability of employees during production and delivery of products and meeting the requirements of stakeholders
16. Ecological sustainability: Ability to ensure ecological efficiency and sustainability during production and delivery of products and meeting the requirements of stakeholder.
<b>Vulnerabilities</b>
1. Turbulence: Environment characterized by frequent changes in external factors beyond company's control
2. Deliberate Threats: Intentional attacks aimed at disrupting operations or causing human or financial harm

3. External Pressures: Influences, not specifically targeting the company, that create business constraints or barriers
4. Resource Limits: Constraints on output based on availability of the factors of production.
5. Sensitivity: Importance of carefully controlled conditions for product and process integrity
6. Connectivity: Degree of interdependence and reliance on outside entities
7. Man-made Vulnerabilities: Vulnerabilities resulting from human activities or accidents

**Table 10 – Industrial ecosystems of the participants of the self-assessment**

Question	Rating
10.4 We trust each other on the accuracy of information.	5,91666667
2.1 We maintain a low rate of workplace incidents and accidents.	5,69230769
10.3 We are sincere to each other relationship with the partners and keep promises to each other.	5,61538462
3.1 We maintain low waste production and high recycling rates in all our processes.	5,58333333
2.2 Our employees report high levels of job satisfaction.	5,41666667
3.2 We maintain low levels of CO2 emissions.	5,38461539
1.1 We meet the expected quality of our supply chain partners.	5,30769231
1.2 We can deliver products within the desired lead time.	5,25
3.1 Our products are challenged by frequent competitive innovations and price competition.	5,23076923
9.3 Our products/services are sold to customers in a variety of geographic locations.	5,15384615
7.2 Infrastructure failures, such as power outages or transportation network breakdowns could impact our ability to operate in our unit.	5
4.2 We depend on limited number of suppliers.	4,92307692
4.5 We have difficulty recruiting and retaining highly skilled workers.	4,92307692
9.1 Our key inputs are sourced from a decentralized network of suppliers.	4,91666667
1.3 We have satisfactory sales growth and can earn our expected profit.	4,84615385
4.1 Our labor productivity is very high and we consistently produce high-quality products with little waste.	4,75

5.2 We have regular interchange of information among suppliers, customers, and other external sources.	4,69230769
7.3 We recognize new business opportunities and take immediate steps to capitalize on them.	4,61538462
15.2 We uphold strict policies to protect human and labor rights across our supply chain.	4,53846154
1.4 We are cost effective.	4,53846154
12.1 We have significant financial reserves and insurance coverage to cover most potential needs.	4,5
1.3 Our supply contracts can be easily modified to change specifications, quantities, and terms	4,41666667
15.1 We have comprehensive policies and approaches to ensure workplace health and safety across our supply chain.	4,33333333
6.3 We continually strive to further reduce transportation lead-times for our products.	4,25
8.3 We take immediate action to mitigate the effects of disruptions, despite the short-term costs.	4,25
3.3 Environmental concerns influence how we design our products and/or conduct our operations.	4,23076923
4.3 Our suppliers have limited capacity.	4,23076923
1.2 Our import or export distribution channels face disruptions due to geopolitical turmoil or changing government regulations or sanctions.	4,16666667
4.2 Our assets and equipments are effectively utilized and are reliable with no limiting bottlenecks.	4,16666667
6.1 We excel at seizing advantages from changes in the market.	4,16666667
2.4 Cyber-attacks targeting our systems or networks could result in disruptions to our business and logistics operations.	4,15384615
6.2 Continuous information flow is critical to our regular operations.	4,15384615
2.4 We might be able to quickly change the routing and mode of transportation for deliveries	4,08333333
1.1 We depend on supplies and/or export markets that experience severe currency, price or demand fluctuations.	4
6.1 We are part of a globally distributed logistics and supply chain.	4

1.1 Our supplies can be used in multiple finished goods and our finished goods are modular.	4
1.2 Our products can be made by a variety of machines and workers.	4
9.2 Our production facilities, senior leaders and onsite experts and distribution/transportation channels may be dispersed at various locations.	4
12.2 We sell our products at a relatively high margin and diverse market.	4
14.2 We maintain a high level of awareness thorough training regarding supply chain risks.	4
3.2 Public opinion and other social or cultural changes can exert pressure on our operations and our ability to serve our markets.	3,92307692
13.1 We have effective policies and approaches to measure, assess and reduce carbon footprint across all operations in the supply chain	3,92307692
14.1 Our organization is willing to accept a significant level of risk in pursuit of its strategic objectives.	3,92307692
1.2 Our firm is able to evaluate the levels of risk facing our supply chain.	3,92307692
4.1 Our supply chain depends on large number of members (suppliers and customers) for each material/part/product.	3,90909091
4.4 We have limited production capacity and transportation capacity for distributing products.	3,90909091
13.2 We have effective policies and approaches for waste reduction and recycling of materials across all operations in the supply chain.	3,84615385
5.3 Our products/services are very delicate and require strict storage or handling controls to maintain their purity and/or integrity.	3,81818182
2.2 We might be able to delay production to be more responsive to demand.	3,81818182
8.2 We can deal with crises, including addressing public relations issues.	3,81818182
1.4 We have many alternative sources/suppliers.	3,76923077
11.2 We use stringent restrictions for access to facilities and equipment.	3,75
11.3 We have a high level of information systems security.	3,75
16.1 The procurement decisions are based on system data analysis.	3,72727273
1.1 Our supply chain system enables us to evaluate and deploy alternative solutions for our supply chain vulnerabilities constantly.	3,72727273

2.1 We can quickly vary and relocate outsourced storage, distribution (logistics and transportation), and other services.	3,63636364
2.1 Our products and services may be compromised by industrial espionage.	3,61538462
2.3 Our operations or products/services may face liability claims.	3,61538462
7.2 We have a formal risk identification and prioritization process and quickly recognize early warning signals of possible disruptions.	3,6
8.1 We can quickly communicate and organize a formal response team of key personnel, both on-site and at corporate level and have detailed contingency plans and regularly conduct preparedness exercises and readiness inspections.	3,6
7.1 In our production unit, industrial accidents such as fire or chemical spills could lead to disruptions.	3,54545455
1.5 Our operations are susceptible to a potential health pandemic affecting our employees.	3,53846154
6.2 We integrate innovative technologies and applications such as strategic gaming and simulations to create and test virtual scenarios for improving and adapting production and distribution/transportation operations strategy.	3,5
1.3 Our type of facilities or markets can be exposed to severe natural disasters such as earthquakes, hurricanes, floods, or wildfires.	3,41666667
10.1 We cooperate and employ collaborative demand forecasting techniques facilitated by transparent data flow between supply chain members, ensuring shared data accessibility to facilitate collaborative decision-making.	3,27272727
11.1 We employ layered defenses and do not depend on a single type of security measure	3,27272727
2.2 Our facilities or personnel and other operations (logistics- trucks and ships) can be targets of terrorism/sabotage (such as attack on Nord Stream pipeline) or impeded special interest groups	3,25
3.1 In case of emergency, we have reliable back-up utilities (electricity, water, communications, equipments, duplicate facilities etc.).	3,2
5.1 We have information systems that accurately track all operations and provide real-time data on location and status of supplies, finished goods, equipment, and employees.	3,18181818
16.2 The purchase orders are placed directly through ERP (Enterprise Resource Planning) systems based on the requirement.	3,18181818
5.1 Workers in our facilities or at our suppliers/ supply chain might have to sometimes operate in poor working conditions	3,09090909

5.2 Our suppliers or production facilities are geographically concentrated and/or co-dependent.	3,09090909
1.4 We might face unforeseen technology failures in our operations.	3
10.2 Our firm invests in facilities and equipment at suppliers' plants and is prepared to share risks with both suppliers and customers.	3
2.3 We have a sophisticated inventory management system that regularly computes both safety stock and cycle stock at all storage and retail locations.	2,90909091
7.1 We effectively use demand forecasting methods and closely monitor deviations to normal operations.	2,9
17.8 Our company uses sophisticated digital solutions to measure several matrices for assessing inventory level and performance.	2,9
16.3 We have smart work procedures (real-time online storage, monitoring, tracking and control) and big data analysis to manage our various operations.	2,8
3.2 In case of emergency, we have significant excess capacity of materials and labor to quickly boost output if needed.	2,77777778
16.4 Our company uses additive manufacturing in production.	2,36363636
16.6 Our company uses a digitally enabled global shipping platform to match individual shipping demand with unique logistics capabilities.	2
16.7 Our company uses Industry 4.0-based analytics techniques (machine learning/artificial intelligence) to consolidate deliveries for last-mile delivery.	2
16.5 Our company uses automated guided vehicles (AGVs) for moving materials in the warehouse.	1,57142857

**Table 11 – Number of responses regarding question 3 and 4 of the survey**

Question	Yes	No	Partly
Do you know the production steps and production sites of your preliminary products?	17	25	12
Do you know the GWP of the preliminary products in relation to the individual production sites?	6	31	9



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