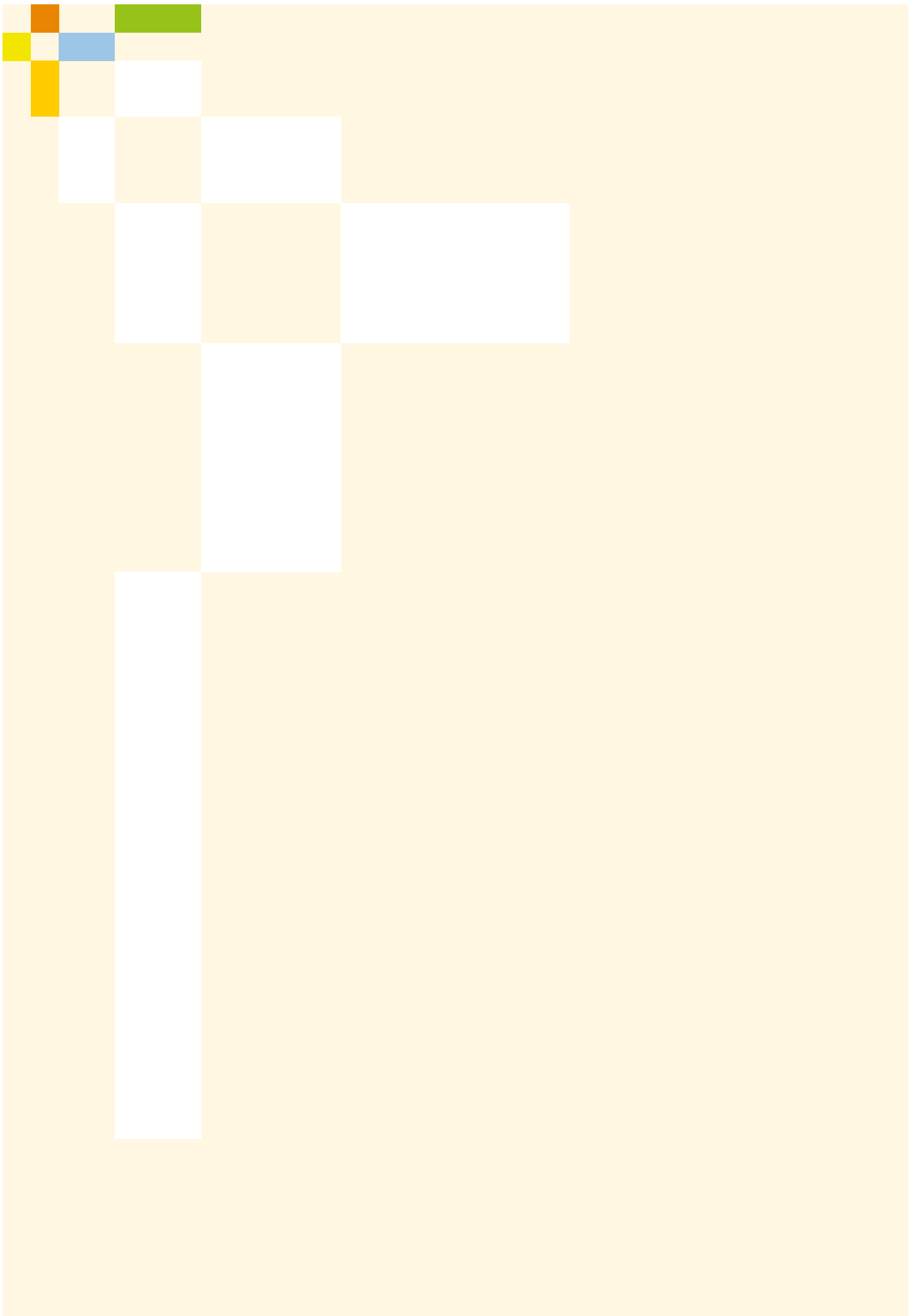




acatech IMPULSE

Resilience as a Goal for Economic and Innovation Policy

Henning Kagermann, Florian Süssenguth,
Jorg Körner, Anka Liepold,
Jan Henning Behrens



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The acatech IMPULSE series

This series comprises contributions to debates and thought-provoking papers on strategic engineering and technology policy issues. IMPULSE publications discuss policy options and are aimed at decision-makers in government, science, and industry, as well as interested members of the general public. Responsibility for the contents of IMPULSE publications lies with their authors.

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Foreword

Will we learn the lessons of the current SARS-CoV-2 pandemic and take proactive measures to prepare for future shocks of all kinds? Or, as on so many previous occasions, will we once again pass up the opportunity to learn, and allow resilience to drop off the radar as soon as the crisis is over?

Resilience is currently receiving a lot of attention in contexts ranging from the psychological resilience of individuals to the resilience of entire communities. However, there is no guarantee that this interest will be sustained, either in these areas or with regard to the resilience of economic structures. Government, science, and industry must act now to translate the current momentum into concrete joint initiatives that genuinely strengthen resilience so that we are better equipped to cope with the next crisis.

Accordingly, it is necessary to widen the debate on securing Germany's and Europe's long-term competitiveness. Resilience must take its place as a policy goal alongside the adaptation of individual industries to structural change, the question of technological sovereignty in the face of growing trade disputes,

and the key 21st century challenge of climate neutrality. However, there is no denying that this will add to the overall complexity and tensions between the individual goals, making things even more difficult for decision-makers.

Consequently, this three-volume study aims to provide guidance on how to strengthen resilience as part of the transformation of supply chains and value networks. The volume at hand, Volume 1, introduces the concept of resilience in an economic context and discusses general approaches to its implementation. The other two volumes build on this, taking an in-depth look at the challenges and opportunities of resilience in the healthcare industries and the automotive industry.

All three volumes of this acatech IMPULSE are based on a paper that was discussed with members of the German government in early 2021.

acatech would like to thank everyone involved for their invaluable contributions.

Prof. Dr. Dr.-Ing. E. h. Henning Kagermann
Chairman of the acatech Board of Trustees



Executive Summary

The SARS-CoV-2 pandemic has brought a new perspective to the innovation policy debate, which in recent times has focused mainly on structural change and technological sovereignty. It is also necessary to guarantee the **resilience** of economic structures in order to secure long-term **value creation and employment** and ensure that Germany and the European Union are **able to keep functioning during a crisis**.

Published in three volumes, this study addresses the **resilience of value networks and supply chains** (Volume I), as well as providing in-depth case studies of the **healthcare industries** (Volume II) and the **automotive industry** (Volume III).

Resilience is a key **enabler of self-reliance** in a world currently facing **three crises** with very different timescales, in the shape of the pandemic, simmering trade disputes and climate change.

There is one **fundamental error** that must be avoided in this context. Resilience has been debated before, during past crises. However, the importance attached to resilience invariably diminished markedly once the crisis was over, when **other priorities moved back up the policy agenda**. In many cases, this happened **before there was time to learn lessons from the crisis and take the measures** needed to make the relevant structures more resilient.

This **must not happen this time round** – decision-makers in government, science, and industry must **make the most of the current momentum**.

Crisis management teams, crisis plans, and accelerated processes must be established and rehearsed as soon as possible. **Continuous risk management** must become an inherent part of individual responsibility, permanently anchored in the decision-making structures of businesses, public authorities, and government, and thus also in **employees' minds**. This will also involve carrying out a critical review of **incentive structures** that make resilience initiatives unattractive to policymakers and businesses.

Volume I – Resilience as a Goal for Economic and Innovation Policy

The background discussions for these acatech IMPULSES identified a number of **general** supply chain and value network **resilience strategies** that can be pursued by government and industry (see Figure 1).

The **current pandemic** provided the **starting point** for **formulating general strategies** for strengthening resilience against **all kinds of crises**. The following general findings are examined in depth in the first volume:

1. While the SARS-CoV-2 pandemic has starkly exposed certain **weaknesses** with regard to resilience, it has also highlighted **huge potential for agility and innovation** within industry, the public authorities, and government. The ideas and experience needed to **develop resilience strategies** already exist – the next step is to create the conditions to enable their **systematic implementation**.
2. The **next crisis is unlikely to be another pandemic** and will therefore affect various industries and areas of society in different ways. Consequently, **resilience initiatives** should have a **broader conceptual approach** than is often the case today.
3. **Resilience** involves an **ongoing process** rather than a one-off effort. It does not aim to completely prevent all the negative impacts of a crisis. It means **making preparations** so that it is possible to **keep functioning during a crisis** and **recover rapidly** once it is over. The aim should be to create a **new state that is better than before** (“recover and re-imagine” rather than simply returning to the status quo).
4. The **main responsibility** for a business's resilience lies with **the business itself**. But resilience is not just in a business's own interest – it is also part of its **responsibility towards society and its employees**. **Government** can and must help businesses to strengthen their resilience, first and foremost by **creating favourable conditions**.
5. **Technological sovereignty** should **not** be confused with **autarky**. On the contrary, non-European actors should be actively recruited for projects within European regulations. Accordingly, discussions about promoting the **growth of globally competitive ecosystems** in strategic technology fields should aim to increase resilience by **diversifying** the global supplier landscape and strengthening Europe's own position on the global market.



Figure 1: Cross-sectoral priority areas (source: authors' own illustration)

6. Due to the **significant additional costs**, it only makes sense to **build up European production capacity that is independent of the market** in order to guarantee the supply of goods and services in a limited number of **basic public service areas**. Accordingly, the State should only introduce strict **resilience regulations** where this is essential for it to keep functioning or provide basic public services in crisis situations.

Volume II – Resilience in the Healthcare Industries: Quality and Security of Supply in Complex Global Value Networks

Reliable healthcare provision even during times of crisis and the **strong healthcare industries** needed to make this possible are clearly in the interests of both policymakers and the public. It should therefore be a policy goal to strengthen resilience by securing and **expanding value creation** in these key industries, especially in the case of new, highly innovative **medical devices** and **therapeutic approaches**.

The **challenges** associated with strengthening resilience in the healthcare industries include **structural factors** (cost structures, rigid regulatory environment, reimbursement system) that are conducive to the emergence of vulnerabilities in the supply and production chains for certain supply-critical products. **Inadequate infrastructure** and **complex regulations** have hitherto prevented the more extensive use of health data.

In the long term, close coordination and cooperation between government, science, and industry could help to achieve significant progress in strengthening the **resilience of supply chains**

and value networks against all types of shocks in the priority areas identified in Figure 2.

This would in turn strengthen the resilience of the healthcare system as a whole. A series of recommendations based on the lessons learnt from the current pandemic – also encompassing **wider aspects** such as **public communication** – were published in early 2021 in the acatech IMPULSE *The Resilience and Performance of the Healthcare System in Times of Crisis*.

The following **key messages** encapsulate the main insights from the discussions with experts on the **resilience of the healthcare industries**. These are explored in depth in Volume II:

7. Since **staffing and production capacity in the healthcare system** cannot simply be increased overnight when a crisis strikes, adequate **buffers should be permanently maintained** within the system. Once the **critical products** have been identified, government, science, and industry should draw up **options for implementing intelligent reserves of the relevant goods and production capacity**.
8. Stringent quality assurance and certification regulations place **tight constraints** on the **flexibility and responsiveness** of the healthcare industries in times of crisis. The pragmatic cooperation between private companies and public authorities during the pandemic has foregrounded **opportunities** to simplify and speed up certain procedures **without compromising safety**.



Build up strategic reserves of drugs and medical devices

- List of supply-critical products and raw materials
- Combination of physical stores, connected stocks and production reserves

Clarify role of European production capacity

- Round table for supply-critical products
- Strengthen Europe's position as centre for innovative drugs and medical devices

Improve staffing

- Revised tools for measuring staffing requirements
- CPD and attractive career opportunities
- Recognise European qualifications



Make approval procedures faster and more flexible

- Define faster procedures for crisis situations
- Fast-track procedures for innovative medical devices
- Maintain high quality standards

Reform incentive structures/ reimbursement models

- Mandatory multi-sourcing in discount agreements
- Payment for critical drugs such as antibiotics based on supply rather than use

Coordinate and pool existing research expertise

- National proof of concept platform to accelerate translation of highly innovative solutions
- European and international cooperation

Create a European Health Data Space and systematically digitalise the healthcare sector

- Secure platform for sharing health data
- Quality and interoperability standards
- Code of conduct and access to data for industry

Figure 2: Priority areas in the healthcare sector (source: authors' own illustration)

9. **Problematic dependencies** on a handful of mainly Asian producers exist for certain **supply-critical drugs and medical devices**. These dependencies make supply chains vulnerable to shocks and can create supply shortages even outside of crisis situations. **Changes to the incentive and reimbursement systems** could support supplier **diversification** and potentially also enable the development of **self-sustaining production capacity** in Europe.

10. The innovative use of **health data** offers not only systemic resilience benefits but also concrete patient benefits and value creation opportunities. **Better framework conditions and European infrastructures** such as GAIA-X should be implemented in this area as soon as possible, not least to **prevent dependence** on suppliers from other markets. High **cybersecurity** standards are particularly critical in the healthcare sector.

Volume III – Resilience in the Automotive Industry: Between Global Structures and Local Challenges

The extensive **changes** required to **strengthen the resilience** of **automotive industry** value networks and supply chains in the face of both long-term structural change and the immediate crisis call for **close cooperation** and a new culture of sharing information among the different market players and with science and policymakers.

In an industry characterised by globally fragmented value creation systems, greater supply chain transparency is a key requirement for greater resilience.

Figure 3 summarises the priority areas for strengthening resilience identified during the discussions. Volume III explores these areas in depth, with a focus on **batteries, microelectronics, and data**.

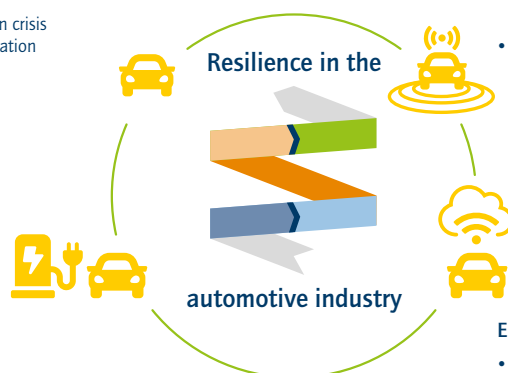


Increase flexibility

- Make production systems more flexible
- Review interpretation of competition law in crisis situations and for pre-competitive collaboration

Strengthen microelectronics in Europe

- Strengthen the ecosystem, e.g. through additional microelectronics IPCEI
- Expand Europe's semiconductor production capacity



Think circular for batteries

- Promote circular economy concepts
- Create supportive framework, e.g. recycling rates at the component level
- Regulatory sandbox for circular economy for batteries
- Monitor critical components and raw materials

Enable secure use of data

- Rapid implementation of European platforms
- Build trust, with government acting as mediator
- Strengthen cybersecurity

Figure 3: Priority areas for the automotive industry (source: authors' own illustration)

The discussions produced the following **key messages concerning the resilience of the automotive industry**:

11. **Reviewing the extremely restrictive standard interpretation of European competition law** and defining exemptions for **crisis situations** could improve the industry's ability to function in acute crises and facilitate **pre-competitive collaboration** on important strategic projects that permanently strengthen value network resilience.
12. Supply base **diversification for critical components** is key to ensuring the resilience of the German automotive industry, which is currently **heavily dependent** on Asian producers for **microelectronics** and **batteries**. In the medium to long term, other factors that can help to increase the resilience of value creation in strategic mobility sectors include **alternative materials research**, **substitution of scarce raw materials**, implementation of **circular economy principles**, and more generally the development of existing key automotive electronics technologies.
13. Policy support to **strengthen Europe's design, manufacturing** and – in the case of batteries – **recycling capability** should be maintained and increased. This will involve cooperating closely with industry to promote the **establishment of self-sustaining ecosystems**. Policymakers can provide support through regulatory sandboxes, IPCEI, and research factories.
14. **Control of the data streams and software** in and around the vehicle is also strategically important for resilient business models. **Rapid implementation of GAIA-X** and the **Mobility Data Space** is thus vital to ensuring that these key value creation factors remain in European hands. The establishment of a **cross-company data space** across the **entire value chain** would make a significant contribution to strengthening resilience.



The study comprises three volumes:



Resilience as a Goal for Economic and Innovation Policy
(Concepts and general approaches for implementing resilience)



Resilience in the Healthcare Industries: Quality and Security of Supply in
Complex Global Value Networks*
(Industry case study of principles discussed in Volume I)



Resilience in the Automotive Industry: Between Global Structures and
Local Challenges*
(Industry case study of principles discussed in Volume I)

*The full-length text of this volume is only available in German

Interviewees

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In addition to carrying out a review of the specialist literature and other studies, the acatech Secretariat conducted a series of exploratory interviews on the resilience of supply chains and value networks with 86 experts from science, industry, government, and civil society. In the interviews, the lessons learnt from the current SARS-CoV-2 pandemic provided the starting point for a discussion of how to strengthen the general resilience of economic structures against all kinds of shocks.

The interviews were conducted between July and November 2020 and lasted an average of one hour. An open-ended discussion

format was chosen to support the exploratory nature of the interviews and capture the “undertones” of the responses. The views expressed in the interviews on general resilience strategies and on the resilience of the healthcare industries and automotive industry provided key input for the three volumes of this acatech IMPULSE. However, individual interviewees may have had different opinions on some of the questions.

The positions listed below were held by the respective interviewees at the time of their interviews. The text is interspersed with anonymous quotes from the interviews that illustrate some of the interviewees’ key views.

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1 Introduction

Resilience is the ability to contain the negative impacts of a crisis thanks to vigilant forward planning, **recover** rapidly, and learn the appropriate **lessons**. As well as **adapting** or recreating the relevant **structures**, this learning process includes **building** the relevant **skills** and ensuring their availability. Resilience is **not a new concept**¹. In the past, however, **interest** in resilience has tended to **wane** once a crisis is over, **before** appropriate measures to strengthen it have been implemented.

This cannot be allowed to happen again in the wake of the **SARS-CoV-2 pandemic**. In spring 2020, for example, partially uncoordinated border closures resulted in **disruption to essential production and supply chains**, causing shortages of individual goods such as medical protective equipment. This in turn directly **compromised the ability of governments** to combat the pandemic and its **economic impacts**. Closer **coordination** of the measures taken by European countries is thus vital, not least in order to maintain supply chains within Europe.

Once the crisis is over, the aim should be to **build back better**. This will call for a **broad dialogue** within and between government, science, industry, and the general public about the lessons learnt and how these **translate** into concrete **resilience measures**. This also applies to the **resilience of supply chains**² and **value networks**³, the **focus of this acatech IMPULSE**.

The **next crisis** will (in all probability) **not be a pandemic**. Accordingly, resilience strategies should be geared towards ensuring a general **capacity for action** and ability to adapt rapidly to the specific challenge in all manner of different, unforeseeable crisis situations. The **high degree of agility and flexibility** shown by many sectors of government and industry in dealing with the impacts of the pandemic is something that can and must be learnt from for future crises.

This acatech IMPULSE hopes to contribute to this learning process. It aims to introduce **economic resilience** concepts and discuss general approaches to implementing them, building on the experience of science, industry, and government in dealing with the current pandemic.

Chapter 2 begins by defining **the concept of resilience and placing it in the context of other** important economic and innovation policy **debates**. **Chapter 3** explains why **resilience** should not simply be regarded as a **specific response to the current pandemic** and should instead be understood and implemented in a **more general** manner. **Chapter 4** discusses potential **conflicts** between resilience and other objectives. This is followed by a **discussion of European crisis management** in **Chapter 5**. Finally, a number of **general resilience principles** are outlined in **Chapter 6**, while **Chapter 7** sets out various **cross-sectoral strategies** for strengthening resilience.

1 | See acatech 2014; Bertelsmann Stiftung 2017b; Fraunhofer ISI 2020; OECD 2016.

2 | **Supply chains** encompass all material and information flows across the entire value creation process, from raw material extraction and the various processing stages right up to the end consumer (authors' own definition based on Gabler Wirtschaftslexikon 2018b).

3 | The term **value network** reflects the trend towards the breakup and increased dynamism of conventional, predominantly rigid and linear value chains. In contrast to traditional value chains, the interaction and collaboration between the web of actors in a value network is more flexible, more dynamic, and in some cases also more automated. Value networks facilitate innovative service offers and enable multiple different ways of supplying and selling products and services (authors' own definition based on acatech 2020b, Gabler Wirtschaftslexikon 2018a).



2 Definition of resilience

Resilience is the ability to prepare for and cope with sudden and hard to foresee adverse events (shocks), and use the lessons learnt to adapt and improve the relevant systems. Resilience is not a static condition, it is a continuous process. In some sectors, there is a degree of overlap between resilience and technological sovereignty. It is also necessary to ensure that resilience measures are aligned with ongoing structural change processes.

There is **little consistency** in the **definitions of "resilience"** used in different debates and studies. For example, there are differences regarding whether structural change processes should be regarded as shocks, and how severe the disruption needs to be. What most definitions do have in common is that they **focus on the impacts on systems and processes rather than on the concrete cause** of the shock itself, since this is not always known.⁴

For the purposes of this acatech IMPULSE, **resilience is defined as follows:**

In the context of value networks, **resilience** refers to the **ability to prepare** for sudden/unforeseen **and in some cases unprecedented adverse events** with potentially catastrophic impacts, **avert** them as far as possible, **cope with them** if they cannot be averted, and **recover** rapidly from any damage caused. This includes the capacity to **plan for external shocks** and use the **lessons learnt** from a crisis to implement advance measures for managing future crises, thereby **creating more adaptable adapted systems**. Putting resilience into practice calls for cooperation between government, science, industry, and civil society.

This definition is based on the assumption that resilience includes a transformative element, i.e. that adaptive measures are taken after a crisis in preparation for future external shocks. Accordingly, it is better to visualise resilience as a spiral rather than a cycle – instead of returning the system to its original state at the end of a crisis, the aim should be to attain a new state that is more adapted and better than before (see Figure 4).

Resilience can be broken down into **five phases**:

- Prepare
- Prevent
- Protect
- Respond
- Recover and Re-Imagine

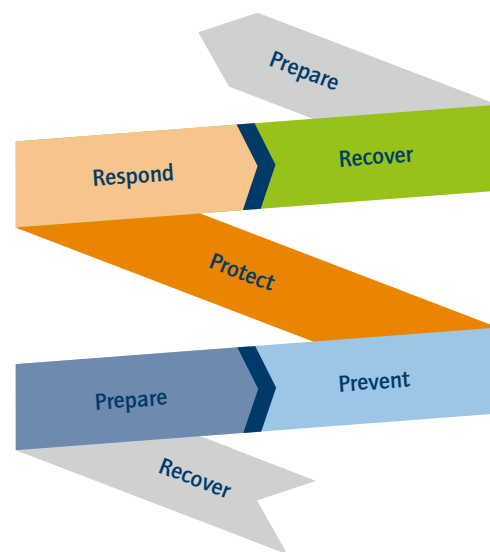


Figure 4: The resilience spiral (source: authors' own illustration)

Forward planning and preparation for each phase are only a part of what makes a successful resilience initiative. According to the experts, a high degree of **agility in the relevant structures and processes** is equally important (see also Box 2).

It is thus clear that **resilience is not a static condition** – it is a **process** involving **continuous** implementation of the appropriate measures.

It is also important not to **misconstrue** resilience as a means of **completely preventing the negative impacts** of shocks – it is not possible to guarantee full protection against every type of shock event. Instead, resilience aims to **mitigate the impacts** and enable a **rapid recovery** in a skilful manner before, during and after a shock.

4 | See acatech 2014; Bertelsmann Stiftung 2017b; Bundesakademie für Sicherheitspolitik 2016; FhG 2020a; Fraunhofer ISI 2020.

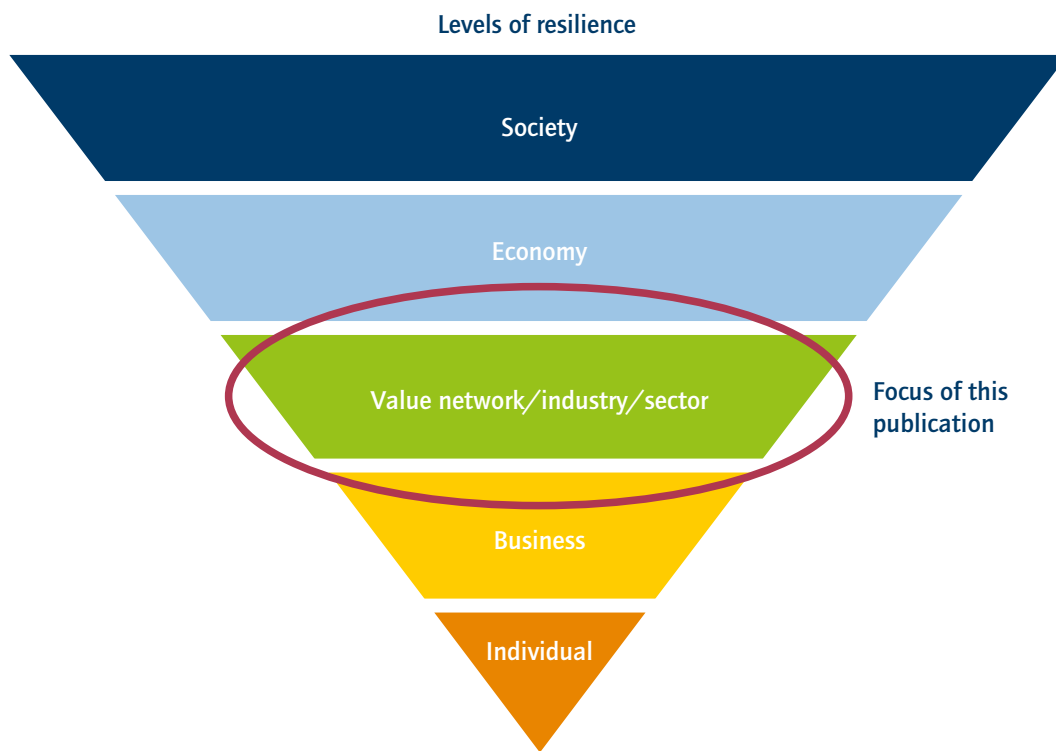


Figure 5: Levels of resilience (source: authors' own illustration)

Resilience can exist at **different levels** (see Figure 5), ranging from the psychological resilience of individuals at one end of the spectrum, to the resilience of entire societies at the other.⁵

This acatech IMPULSE focuses on the **resilience of value networks**. It should be stressed that the decision to investigate this particular aspect does not imply that the other levels of resilience are any less important. Moreover, the measures and strategies discussed in this publication are also relevant to the **adjacent levels**, i.e. the resilience of individual businesses and of the economy as a whole.

2.1 Resilience in the context of other current economic and innovation policy debates

During the current pandemic, the **concept of resilience** has gained currency in economic and innovation policy debates on

securing value creation and competitiveness. It has become clear that there is some **overlap** with other **key strategic debates**, especially **technological sovereignty**⁶ and adaptability to **structural change processes** (see also Figure 6). This acatech IMPULSE only references these other two debates where there are synergies or conflicts with resilience.

Technological sovereignty refers to the freedom to **independently choose** which technologies to use. In combination with the capacity to test and evaluate the alternatives, technological sovereignty directly **strengthens resilience** in some areas such as battery production and data use.

Conversely, resilience is undermined by the threat of access to certain technologies being withdrawn – for example due to unforeseen political conflicts (see also Chapter 3). However, this link between resilience and technological sovereignty should not be misconstrued as a **plea for complete autarky**, as explained for example in the acatech IMPULSE on *Digital Sovereignty*⁷ with reference to digital technology. From a resilience perspective,

5 | See LIR Mainz 2020.

6 | See acatech 2021a.

7 | See *ibid.*

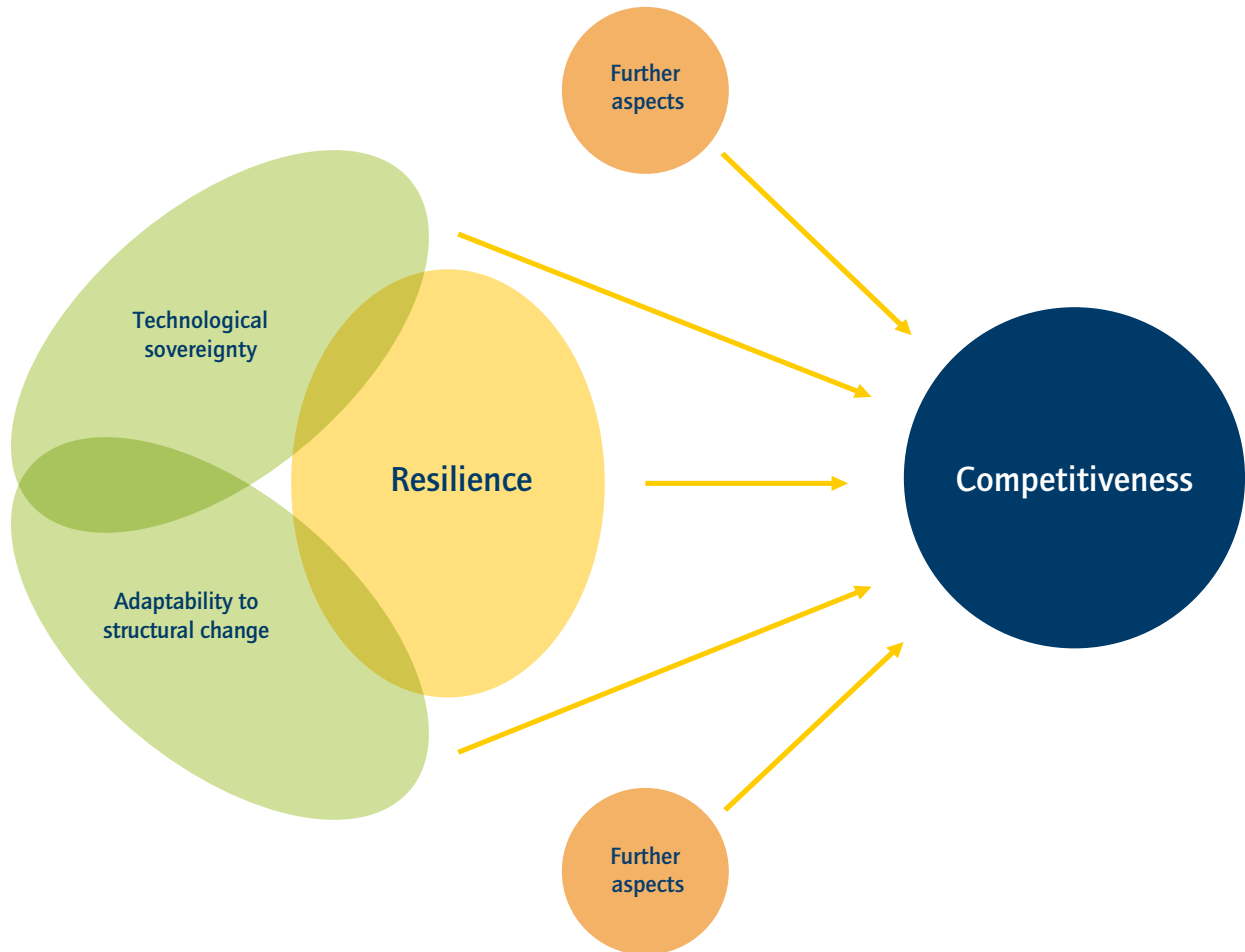


Figure 6: How does resilience fit in with other objectives? (source: authors' own illustration)

too, the experts regard self-determination and freedom of choice as the key objectives of technological sovereignty, rather than isolationism and complete self-sufficiency.

Similarly, although resilience is by definition largely concerned with unpredictable short-term events, it **cannot be considered in complete isolation from long-term structural change** (such

as the increasing use of electric vehicles) – it is important to avoid an “either-or” approach. Ideally, resilience measures should always form an **integral part of adaptation to structural change processes**. This means identifying new vulnerabilities arising from structural change as early as possible and implementing appropriate countermeasures.

3 The challenge: vigilant preparation for the unexpected

When the next crisis occurs, as it must, it is unlikely that it will be a pandemic. In view of the many different types of potential shock, it is vital for government and businesses to establish structures that are resilient to crises of all kinds and can be rapidly adapted to the current shock when a new crisis occurs. Nevertheless, forward planning for industry-specific crisis vulnerabilities is also necessary so that businesses can continue to operate and ensure security of supply for the general public.

Resilience involves preparing for shocks **without knowing exactly when** they will occur or **what form** they will take. For example, two thirds of those interviewed for the 2019 Supply Chain Resilience Report thought that cyberattacks would pose the greatest threat to supply chains in 2020.⁸ A global pandemic was not perceived as an acute threat in 2019.

Conversely, the **current resilience debate** is quite understandably **too focused on pandemics**, even though it is highly unlikely that the next major crisis will be another pandemic.

Because it is not possible to say what shape the next crisis will take, it is important to have a **clear overview** of all potential forms

of disruption and **develop concrete plans for different types of crisis**. Functioning production and supply chains are key to **guaranteeing security of supply**.

"You need to recognise the shock, but you shouldn't be shocked by it."

It is also necessary to treat resilience as an ongoing challenge because we are increasingly living in a **VUCA world**.

VUCA is an acronym for **Volatility, Uncertainty, Complexity and Ambiguity**. It describes the **challenges** facing businesses and society as a whole in a world that has become more vulnerable to crises due to phenomena such as digitalisation and globalisation.⁹ As a result thereof, **businesses will need to become more resilient** in order to cope with increasingly frequent unforeseen crises.

"The world will become more volatile. There will be more shocks, and their impacts will be more severe. We need to find solutions to this."

Resilience is about coping with **external shocks** rather than the internal challenges of particular industries and systemic weaknesses. Box 1 provides an overview of the different **types of potential crises**.

8 | See BCI 2020.

9 | See Unkrig 2020.



Box 1: Overview of crisis types

Potential shock events can be **caused** by **natural phenomena, human beings** or **technology**. For analytical purposes, conceivable shock events can be broken down into **seven** broad **categories**. Specific events may come under several different categories at once or move between categories as they unfold.¹⁰

Highly **improbable crisis events that are often difficult to anticipate** and have **severe impacts** are referred to as **“black swan” events**.¹¹ Many of the interviewees classify the current SARS-CoV-2 pandemic as a black swan (compared to other, regional epidemics) due to the global spread of the virus and its drastic economic impacts.

- **Natural phenomena:** Examples include floods, earthquakes, and heat waves. The risks for particular regions are usually known. Protective measures such as dams are often already in place, but are not always sufficient. Infrequent and highly destructive natural phenomena such as once-in-a-century flooding or volcanic eruptions can have particularly dramatic impacts on the affected region. These can only be mitigated by extremely expensive defences.
- **Technology failure:** This category includes crises that have been caused intentionally, such as cyberattacks, and accidental technology failures caused by factors such as material stress.

- **Threats to public health:** Bacteria and viruses can cause regional disease outbreaks, as in the case of Zika and Ebola, or global outbreaks, as with SARS-CoV-2. The combination of specific safety measures to protect the workforce and public uncertainty about the future of the economy can often have a negative impact on production and supply chains.
- **Social threats:** Social movements such as the Arab Spring protests or ethnic groups fighting for independence can trigger regional crises. Depending on the size of the movement and how its campaign unfolds, this type of crisis event can seriously disrupt the region's economy for several years.
- **Political threats:** Almost all companies operate in several different markets and/or source components from other parts of the world. Political crises such as wars or coups can threaten the functioning of production and supply chains, for example through the physical destruction of plants or the disruption of production due to a shortage of personnel.
- **Trade disputes:** Geopolitical conflicts can sometimes cause arguments that spill over into trade disputes between individual countries or entire regions. Supply chains can be seriously impacted when import and export bans or high tariffs are imposed on certain goods.
- **Economic shocks:** The stability of the financial markets is vital to the real economy. Stock market crashes such as the one during the 2008 financial crisis have a severe impact on the global economy.

The McKinsey Global Institute produced a similar classification¹² in a study of the **resilience of different value creation systems** that analysed how **vulnerable** certain key industries are to **different types of risk**.

With regard to **technology-intensive sectors**, the study found that a **pandemic** “only” has particularly severe impacts in **a few industries** such as the aerospace, transport equipment, and automotive industries, whereas it hardly affects other sectors at all. On the other hand, **many** technology-intensive industries are **extremely vulnerable** to shocks such as **trade disputes or cyberattacks** (see Figure 7).¹³

What Figure 7 does not show is that the exposure of a given industry can in some cases vary significantly depending on which part of the world is affected by the crisis (and which manufacturers are located there). This is particularly true of local natural phenomena such as flooding.

The diverse nature of the potential shocks means that the **lessons learnt** from the current **pandemic** should only be treated as a starting point when analysing this topic. It is essential for businesses and government to develop and pursue **broad-based resilience strategies that are also effective against other types of crisis event**. This will require them to engage in **proactive crisis management, even during crisis-free times**.

10 | See ESYS 2017.

11 | See Taleb 2013.

12 | See McKinsey Global Institute 2020.

13 | The table below focuses on technology-intensive industries and does not include other sectors that were in some cases badly affected by the pandemic, such as catering, textiles, and tourism. See McKinsey Global Institute 2020 for the impact on other industries.



Figure 7: Exposure of selected technology-intensive industries to different types of risk (extract from original table; source: McKinsey Global Institute 2020)



4 Conflicts between resilience and other objectives

During crisis-free times, resilience is often overlooked compared to other objectives such as short-term cost optimisation or high regulatory standards. It is important to address these conflicts in order to ensure that any progress with regard to resilience is sustained over the longer term. Resilience must be firmly and above all permanently anchored as an economic and social goal in the relevant incentive systems, structures and institutions, and in people's minds. If we do this, we will be able to fall back on resilience when the next crisis comes along, rather than wishing we had done more to strengthen it.

The following sections discuss some of the conflicts between resilience and other objectives.

4.1 Resilience and efficiency

Efficiency and resilience may appear to be at odds with each other if only crisis-free times are considered. However, a **long-term perspective** that takes the cost of crises into account reveals **significant overlaps**.

Today's supply chains are optimised for cost and time efficiency. While concepts such as **just-in-time** and **just-in-sequence** significantly reduce inventory costs, they always entail the risk of production being brought to an immediate halt if supply chains are interrupted due to the threat of border closures and other crises (see Box 1). From a long-term perspective, therefore, maintaining a certain level of inventory contributes to resilience, even if it does entail short- and medium-term costs.

At the level of entire value networks, **multi-sourcing** can help to make supply chains and production processes **more resilient**

and – in the long term – **more efficient**.¹⁴ In practice, however, incentive structures that fail to take resilience into account often prevent this principle from being implemented. As far as the purchasing company is concerned, maintaining additional suppliers means more work. Moreover, procurement officers are usually judged on short-term cost savings rather than on the extent to which they strengthen long-term supply chain resilience.

One **approach to solving** this dilemma would be to create **incentives for managers** that specifically **increase the weighting of a company's medium- to long-term success**. This would be a particularly effective way of encouraging **publicly listed companies to adopt a longer-term strategy**. Some of the interviewees say that shareholders often put too much pressure on management to deliver short-term gains at the expense of long-term resilience.

Privately-owned **medium-sized enterprises**, many of which have a **strong local tradition in a particular location**, are at a significant advantage in this regard. Some of the interviewees say that medium-sized enterprises often adopt a long-term perspective when judging their success as a company and setting their goals. This causes them to act in a way that helps to strengthen resilience throughout entire value networks.

Improving access to patient capital can also help to embed long-term thinking and action more strongly within companies. Some countries have launched programmes and initiatives with this specific aim, for example the Long-Term Stock Exchange (LTSE) in the US and the British Patient Capital Programme. The development of a new co-investment platform for direct investment is another useful approach.¹⁵

It is also important to **develop resilience metrics** in order to make it clear **which resilience level** is being referred to and how **resilience can be measured** at this level. For example, while there are **clear indicators** for measuring and monitoring efficiency, this dimension is currently missing from the resilience debate. To put it more graphically, **we need to put a price tag on inadequate resilience**.

"The exclusive focus on monthly return on investment isn't a law of nature. We can give more weight to resilience if we want to."

14 | See VDMA/IfW 2020.

15 | See acatech 2019.

4.2 Resilience and regulation

Germany's performance during the **different phases of the pandemic so far has been mixed**. It did relatively well in the **spring and summer of 2020**, even compared to its European neighbours. Extensive relief schemes initially led to widespread confidence among government, industry, and the general public that the country was taking appropriate and systematic measures to bring the pandemic under control.¹⁶ **In the autumn of 2020**, however, the **number of cases rose** rapidly again in Germany, as in other countries, resulting in **new and in some cases drastic restrictions**. Meanwhile, some of the widely publicised relief payments continue to experience major delays, posing a severe threat to the survival of many businesses, especially smaller ones. These events demonstrate that crises can also present serious challenges for government regulation. In some cases, it is necessary to reinvent the regulations in question so that their processes are faster and more flexible in crisis situations.

In this context, both the experts interviewed for this publication and various studies make the point that **too much regulation** can **inhibit** economic actors' **ability to adapt** in an acute crisis situation.¹⁷ Accordingly, the experts advocate **regular scrutiny of regulations to determine whether they are effective** and whether **scrapping or amending** certain regulations could enable greater flexibility for efficient crisis management.¹⁸

There was general approval regarding the flexibility of government decision-making during the pandemic in areas such as employment law and research funding programmes in the health-care sector. Several interviewees from businesses highlight the positive, flexible and pragmatic cooperation between company management, works councils and the trade unions in dealing with the crisis. Nevertheless, there are some aspects where the interviewees **call for greater policy and administrative flexibility** in order to enable an even faster response in the event of a shock.

This is illustrated by the **regulations governing production processes and the market approval of new products**. In most cases these regulations are appropriate and necessary, not least in order to guarantee product quality and safety. In some instances, however, the relevant processes can be very time-consuming and complex. As a result, the regulations can sometimes prevent the adoption of creative, flexible and less time-consuming processes

that are still safe. This applies to the regulations for converting production facilities or certifying suppliers in the healthcare industry, for example.¹⁹

4.3 Resilience and degree of political centralisation

Over the course of the pandemic, it has become apparent that both highly centralised systems – such as China – and decentralised systems such as German federalism have their **strengths and weaknesses** when it comes to tackling a crisis of this nature.

China and to some extent also **South Korea** have taken a highly centralised approach to combatting the pandemic. In both of these countries, strict digital contact tracing and the rapid imposition of centrally decreed lockdowns in the worst hit regions led to measures being implemented faster and more effectively than in other parts of the globe. However, long-term, centrally decreed interventions of this type are unthinkable in Europe due to the **restrictions** that they impose on **civil liberties**.²⁰

The pandemic has once again highlighted **several benefits of Germany's federal system**. For instance, it allowed specific regional circumstances to be taken into account when implementing the relevant decisions. In situations like this, federal systems are in principle an excellent way of combining central decision-making structures and lines of communication with flexible, decentralised systems.

Nevertheless, the interviewees think that there is **room for improvement** with regard to **overall coordination**, especially between **federal and state governments**, in order to minimise the uncertainty and extra workload for businesses in terms of compliance with the relevant requirements.

In future, it will also be important to **improve the thematic concentration of government contact points by establishing a crisis intervention centre**. This will ensure that responsibilities can be quickly identified in the event of an acute crisis and will provide a central point of contact for those affected. Crisis coordination at European level is discussed separately in Chapter 5.

16 | See BMF 2020; SVR 2020.

17 | See Bertelsmann Stiftung 2017a.

18 | See acatech 2021b; 2021c.

19 | See acatech 2021c.

20 | See Altakarli 2020.



4.4 Resilience: straddling local and global value creation

The interviewees think that the current calls for **deglobalisation and reshoring** of value chains to Germany and Europe should be **viewed critically** from a resilience point of view:²¹

- **Global risk spreading** is only possible if production and supply chains are also distributed globally.
- Active promotion of shorter global supply chains **can actually contribute to certain shock events** such as trade disputes. As an exporting country, Germany is particularly vulnerable to such events.

From a strictly business perspective, there are good reasons for the current international division of labour. These include **cost structures**, unattractive **regulatory frameworks** in Germany and/or Europe, and **proximity to the relevant markets**.

The interviewees feel that it only makes sense to **move away** from the global division of labour if one or more of the following **criteria** are met:

- **Protection of key future technologies:** In order to protect value creation and jobs, it may make sense for Germany and Europe to actively strengthen or reshore the value networks of technologies that will be vital to future business models.
- **Critical security of supply for the population in emergency situations:** A guaranteed supply of certain products and services (e.g. certain drugs) is of critical importance for the population in the event of external shocks. As a rule, security of supply for these products and services is more important than being able to produce them profitably.²²

Nevertheless, the experts recommend that resilience strategies should also have a fundamental focus on **strengthening the competitiveness of Germany and Europe**, in particular by building and **strengthening regional value ecosystems and clusters of excellence** centred on leading-edge technologies, Industrie 4.0 and new business models. While these will require technical

and financial support during their establishment and transitional phases, the medium-term goal should be for them to be commercially self-sustaining.

Furthermore, although these value ecosystems should be developed at a regional level, i.e. in Germany and Europe, that is by no means to say that they should be exclusively European- or German-owned. **Non-European owners** can provide **access to global resources** that can be drawn on in the event of a local crisis. More generally, they are also an important source of **expertise and capital**, and they offer a **means of accessing non-European markets**, especially for start-ups.²³

4.5 Resilience and innovation

Efforts to strengthen supply and value chain resilience (especially if focused on the short term) can **hold back long-term innovation** in science and industry and thus inhibit future competitiveness. This happens when organisations needing to respond swiftly and effectively to a crisis cut their budgets for long-term projects, often leading to a reduction in R&D investment. The overall **picture** in this area is very **mixed**.

For example, an ad hoc survey of 250 industrial enterprises carried out by the Federation of German Industries (BDI) found that many R&D projects in sectors such as the automotive industry had been **halted or cut back due to the current crisis**.²⁴

Three-quarters of businesses who took part in a survey of 3,500 SAP user companies conducted by the German-speaking SAP user group (DSAG) said that they are planning to **reduce IT investment in Germany** because of the economic crisis.²⁵ On the other hand, companies in Switzerland report that the SARS-CoV-2 pandemic is actually causing them to step up their digitalisation efforts, and that they therefore have no plans to cut their IT budgets for the coming year.²⁶ The recently published innovation survey of the Leibniz Centre for European Economic Research (ZEW) found that **small and medium-sized enterprises (SMEs)** in particular **planned to significantly cut spending on innovation in 2020 and 2021** due to the **coronavirus crisis**.²⁷

21 | See VDMA/IfW 2020.

22 | See acatech 2021c.

23 | See acatech 2019.

24 | See BDI 2020.

25 | See Handelsblatt 2020.

26 | See DSAG 2020.

27 | See ZEW 2021.

Conversely, **R&D is actually increasing** in sectors that are playing an especially important role in combatting the crisis, such as the **pharma and biotech** industries.²⁸ Moreover, a survey of over 27,000 companies carried out by the Stifterverband between March and August 2020 found no significant change in overall R&D spending, although the figures varied widely from one industry to another.²⁹

In the short term, it is usually unproblematic for an individual company to cut back on its R&D activities during a crisis in order to **maintain business continuity**. In the medium to **long term**, however, **companies need to innovate in order to remain competitive**, and this requires high levels of R&D.

28 | See acatech 2021c.

29 | See Stifterverband 2020.



5 European crisis management

It is often not possible for nation states to achieve resilience on their own. However, the conditions and structures do not currently exist for a rapid, effective and coordinated response to external shocks at the highest European level, for example in the shape of an established crisis management team. The existing EU agencies and institutions lack the resources and/or authority to perform this role effectively.

The current SARS-CoV-2 pandemic has demonstrated that **Europe** is often the only sensible **frame of reference for resilience measures**, since many measures cannot be implemented effectively at national level. However, the interviewees identify a number of issues with the European crisis management system that could also cause problems in other types of crises. These include:

- **A lack of rapid, effective, and coordinated EU crisis management:** It took too long to find adequate European-level responses to a rapidly spreading pandemic.
- **Inadequate communication:** Effective communication and sharing of the relevant information among the actors are key to any resilience strategy.³⁰ However, communication of the impacts of the current pandemic and the measures to tackle it has hitherto been extremely inconsistent within Europe. This has resulted in confusion and in some cases contradictory information regarding the organisation of the movement of goods within Europe. Similarly, information about regional changes in measures to combat the pandemic (such as the rules for incoming goods at ports or district-level travel restrictions) has in some cases been reported in the press before it was communicated by the responsible authorities.

- **Ad hoc border closures within Europe:** Even within Europe, a number of borders were closed during the first wave of the SARS-CoV-2 pandemic in spring 2020. Moreover, a repeat of this situation threatened to occur at some borders in early 2021. Although things quickly improved in 2020 (for example thanks to the establishment of green lanes at border crossings), the border closures **cast doubt on international solidarity during a crisis**, causing lasting damage to trust in global trade.

"The border closures within the EU were a shock for us. From one day to the next, workers and goods could no longer cross national borders. We cannot allow this to happen again in a second wave or in future crises."

In some quarters, this de facto **lack of crisis coordination** was considered to have **accelerated the crisis**.

There is no denying that some **EU-level initiatives and institutions** are performing important roles in the **current SARS-CoV-2 pandemic**, for example the Emergency Response Coordination Centre (ERCC) and the European Centre for Disease Prevention and Control (ECDC). There are also a number of EU advisory bodies such as Scientific Advice for Policy by European Academies (SAPEA) and research agencies such as the Joint Research Centre (JRC) that are carrying out scientific research into the pandemic and feeding the relevant findings into the policymaking process. The report "Improving pandemic preparedness and management" is one example.³¹

Nevertheless, the institutions, agencies and/or advisory bodies referred to above currently lack the **resources and/or authority** to respond adequately to (public health or other) crises on the scale of the current SARS-CoV-2 pandemic. At present, there is a **lack of effective European crisis response structures** for enabling the **coordination, consolidation, and rapid agreement of (crisis) decisions at the highest EU level** so that they can subsequently be implemented by adequately resourced authorities at lower levels (see Chapter 7).

30 | See Brinkmann et al. 2017; EU-KOM 2020b.

31 | See Group of Chief Scientific Advisors to the European Commission et al. 2020.

The European Commission's new **Strategic Foresight Process** is an important step in the right direction. For the first time, it focuses on Europe's capacity for resilience in a wide range of different fields and should serve as a compass for EU policymaking.³² Better coordination has also been promised for the healthcare sector, for example through the **HERA incubator** announced in February 2021.

This initiative aims to **bring together science, industry and public authorities in a targeted manner** and leverage more resources, among other things in order to provide **incentives for the development of vaccines against new variants** and **ramp up production capacity**.³³

32 | See EU-KOM 2020a.

33 | See EU-KOM 2021.



6 General principles for strengthening resilience

Both businesses and public authorities can make use of general principles in order to strengthen their resilience. These include prudence (active risk management), diversity (e.g. in the supply and production chains), and redundancy. Another particularly important general principle is agility. Agile processes, structures and decision-makers make it easier to respond to a crisis. However, agility is only effective if it is accompanied by flexibility.

There are a number of **general principles** that can help to strengthen the overall resilience of businesses, organisations, public authorities, and value networks. These include:³⁴

- **Prudence:** active and methodical risk management, including careful and regular analysis and – where possible – elimination of the weaknesses and dependencies in one’s own processes, as well as the development and rehearsal of contingency plans

- **Redundancy:** creating a buffer by duplicating products/ processes, maintaining stocks, and making use of the swarm principle
- **Diversity:** in terms of the geographical spread of supplier sources (multi-sourcing), production facilities, product portfolios, and the people who form part of the organisation itself
- **Adaptability:** flexibility and scalability in processes and procedures, coupled with an openness to new strategies and solutions
- **Modularity:** a better overview and easier replaceability of components and processes
- **Responsiveness:** rapid and targeted responses enabled by early detection of disruption (using digital solutions such as Industrie 4.0), employing simple triggers to activate complex response mechanisms (bootstrapping)
- **Hybrid (digital/analogue) solutions:** e.g. solutions that combine or make it easy to switch between digital and analogue working

Figure 8 illustrates how **implementing these principles** before, during and after a shock can deliver a long-term **comparative advantage**.

Agility – in other words, agile processes, structures and decision-makers – is another general principle that can help to strengthen resilience (see Box 2).

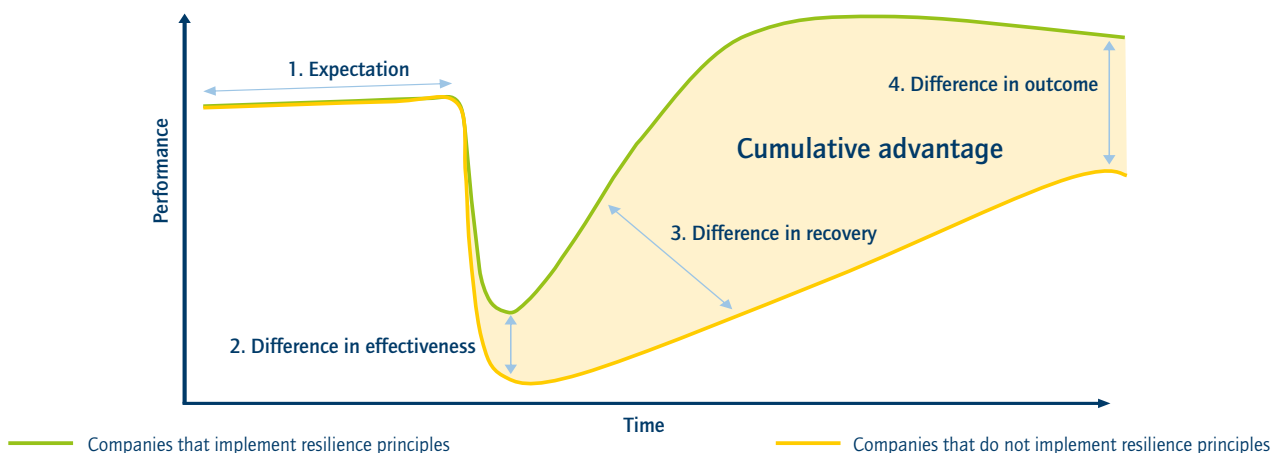


Figure 8: Benefits of general resilience principles (source: authors’ own illustration based on BCG Henderson Institute 2020b)

34 | See BCG Henderson Institute 2020a; 2020b; McKinsey Global Institute 2020.

Box 2: Enabling agility through flexibility

Agility is the ability of organisations and people to respond flexibly to unforeseen events and new challenges. Agility involves a proactive rather than purely reactive response to change.³⁵ **Agility** can be enabled by **organisational and regulatory leeway**, and helps to **maintain operations and innovation** in acute crisis situations. The following three examples show how agility helps to cope with a crisis:

- **A flexible workforce** can mean greater staff availability in an acute crisis. This is illustrated by the fact that many white-collar workers were able to rapidly switch to **mobile working** from home without any major adjustment issues. Many workers were also willing to temporarily move to **other departments**, for example because there was no work in their own department. It is vital that those affected should have a say in decisions of this nature. This requires self-determined flexibility, the involvement of employee representatives, and a **corporate culture** that demands and supports **employee responsibility, lifelong learning, and digital skills**.³⁶
- Some actors in German science, industry, and government already have **agile decision-making structures** that enabled the rapid establishment of **crisis management teams** in many companies, for example. Moreover, the government SARS-CoV-2 relief schemes were and continue to be an important instrument, especially for many small businesses and self-employed sole traders. Most of the experts interviewed praise the rapid and comparatively uncomplicated

launch of these schemes. However, the subsequent steps of applying for and paying out the relevant funds are in some cases still suffering from significant delays, and many companies complain that this is threatening their survival. It is clear that another key requirement for agile decision-making structures is effective **communication and information sharing** between the different actors.³⁷

- Agility can also make it easier for **new actors to respond rapidly and appropriately to new market requirements**. Examples include the “Give a Breath Challenge” launched by Munich RE and the Fraunhofer-Gesellschaft for ideas for treatment of COVID-19, and the rapid conversion of some manufacturing facilities to production of masks and sanitizer.³⁸

The interviewees emphasise that it is vital to **maintain** this heightened **spirit of agility** and the concrete structures that enable it **once the crisis is over**. However, this is not just a task for the relevant organisations – they will also require the necessary (regulatory) flexibility.

Consequently, ideas based on the lessons learnt from the crisis should be identified **as quickly as possible in discussions** between government, science and industry and **translated into concrete measures**. One example of this is the “Work4Germany” fellowship programme, which brings together private sector experts and government ministries with the aim of learning from each other and reinventing processes, structures, and methods. The programme focuses on concrete projects and challenges within a limited timeframe.³⁹

35 | See Bendel 2019.

36 | See BDA/Microsoft 2020; DGB 2020; Mierich 2020.

37 | See Brinkmann et al. 2017; EU-KOM 2020d.

38 | See Munich Re 2020.

39 | See Work4Germany 2020.

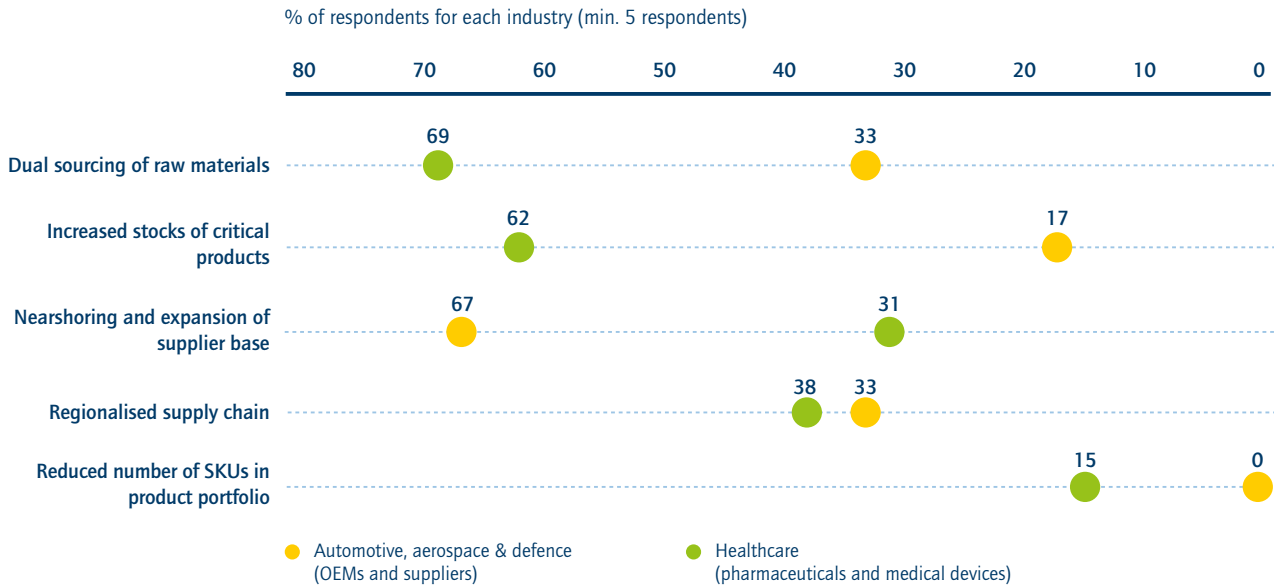


Figure 9: Survey of measures taken to strengthen resilience in different industries (source: authors' own illustration based on McKinsey Global Institute 2020)

Concrete **implementation** of the general principles will call for a **mix of general and individual solutions** that will vary depending on the sector and shock scenario. Figure 9 shows the most common resilience measures adopted in response to the SARS-CoV-2 pandemic according to representatives of leading companies in two different industries.

Box 3 describes some existing examples and **best practices** relating to how resilience can be **researched, evaluated, and strengthened** in science and industry.

Box 3: Concrete resilience measures

The following are some of the projects that are already focusing on measuring or strengthening resilience in general or in specific fields:

- **Fraunhofer Resilience Evaluator (FReE):** The FReE tool aims to help enterprises assess their business units' resilience more accurately. Potential natural and anthropogenic shocks are taken into account. The tool allows enterprises to carry out a quantitative assessment of the resilience of their business units, facilities, and systems.⁴⁰
- **DHL Resilience360:** "Resilience360" is a product that DHL offers its customers to help them minimise supply chain risks. This cloud-based platform enables real-time supply chain visualisation, tracking and monitoring. The tool acts as an early warning system, identifying potential supply chain problems and risks. This ensures that companies have enough time to initiate the relevant countermeasures, thereby reducing costly supply chain disruption.⁴¹
- **Manual on pandemic planning for businesses:** The Federal Office of Civil Protection and Disaster Assistance provides free, publicly available manuals offering expert advice geared primarily towards helping companies prepare for and respond to pandemics. Aimed in particular at SMEs that lack the capacity to develop their own pandemic response plans, the manuals provide checklists for businesses and help them to identify and implement strategies that will deliver swift and effective results. These guidelines can also assist with other types of shock scenarios and help companies to strengthen their resilience by integrating (better) risk management into their existing processes and procedures.
- **RADAR – Data Driven Environmental Scanning:** Funded by the Federal Ministry of Education and Research (BMBF), the RADAR research project aims to develop an environmental scanning system that can analyse large volumes of data in order to detect the relevant signals, trends, technologies, disruptive changes, and new relationships in a company's environment in real time.⁴² The research project also includes a "risk radar" that helps businesses to adapt proactively to changes in their company environment caused by the SARS-CoV-2 pandemic.
- **Hybrid working practices enabled by remote maintenance:** The fact that people in factories often have to work in close physical proximity to each other has caused problems during the SARS-CoV-2 pandemic. Remote maintenance can help to protect employees' health and keep factories running. NavVis develops mobile indoor mapping systems that enable digital navigation of complex buildings and factory facilities. At the beginning of the SARS-CoV-2 pandemic, this technology was used to enable hybrid cooperation between remote and on-site experts when converting production facilities in Spain from napkin to face mask production.
- **Together for Sustainability (TfS):** Transparency can help to strengthen supply chain resilience. The Together for Sustainability platform provides companies in the chemical industry with access to information about compliance with environmental and social standards. For smaller companies in particular, it offers a way of obtaining detailed information about potential suppliers without necessarily having to carry out an audit themselves.⁴³ According to the experts, global suppliers who have continued to comply with minimum social standards have hitherto proven to be more successful at weathering the acute crisis caused by the SARS-CoV-2 pandemic.
- **BioMOTS – biological modelling of technical systems:** The Fraunhofer BioMOTS project has shown that biological protection principles can be abstracted and transferred to technical systems. Principles of wound healing and pain reflex response were systematically characterised for electric vehicles and transferred to a simulated battery system, significantly increasing its resilience.⁴⁴
- **NOLAN – scalable emergency logistics for urban areas:** This BMBF-funded public-private partnership aims to develop a holistic emergency logistics strategy that can be activated if private sector supply structures are disrupted during a crisis, so that the population still has access to a basic supply of essential necessities such as water, food and fuel.⁴⁵

40 | See FhG 2020b.

41 | See acatech 2016; DHL Supply Chain 2020.

42 | See radar 2020.

43 | See TfS 2020.

44 | See Fraunhofer EMI 2020.

45 | See BMBF 2018; Wiens 2019.



7 Cross-sectoral priority areas

In most industries, the main **responsibility** for strengthening supply and production chain resilience lies with **businesses themselves** – doing so is not only in their own interest but also part of their responsibility towards society and their employees. Nevertheless, **government** can and should help businesses to strengthen their resilience. Consequently, the relevant actors must engage in a **dialogue** to determine where government should establish **concrete standards**, where it should **directly support** efforts to strengthen resilience, and where it should create a **more favourable framework**.

Focusing on four priority areas, the following sections set out **concrete recommendations** for strengthening resilience that can be implemented across different industries (see also Figure 10).

7.1 Design more resilient production and supply chains

The current pandemic has exposed pre-existing weaknesses and bottlenecks in supply chains, value networks, and the underlying regulatory framework. These must be addressed in order to strengthen resilience, including the following specific points:

- **Supply chain transparency:** It is vital to identify weak points, linear dependencies, and other exposures to external shocks as early as possible so that appropriate countermeasures can be developed. Moreover, it is important to **go beyond Tier 1**. This can be achieved through the **digitalisation and automation of supply chains**. However, doing so will require robust digital infrastructures, including competition law compliant solutions for **sharing data** with external third parties (or corresponding changes in the interpretation of competition law). The data strategy adopted by the German government at the end of January 2021 is a significant step in the right direction. However, more detail is required, especially with regard to quantifiable targets and measures. It will also be important to establish a **trusted** form of **cooperation** with customers and suppliers across entire value chains that is not based solely on individual gain.
- **Supply chain diversification:** Once transparency has been established, it must be used to address critical supply and production chain vulnerabilities. In the medium term, strategies geared towards **diversification and multi-sourcing** (with several suppliers for each component wherever possible) can help to strengthen supply chain resilience. It will be necessary to strike a better balance between **resilience** and **cost and time efficiency**, since the current exclusive focus on efficiency makes supply chains vulnerable to shocks (see also Chapter 4). In order to spread the risk, it is also important to ensure a **geographical spread** of supply sources.
- **Inventory:** In **some cases**, maintaining **larger stocks** in inventory can play an important part in creating a resilient supply

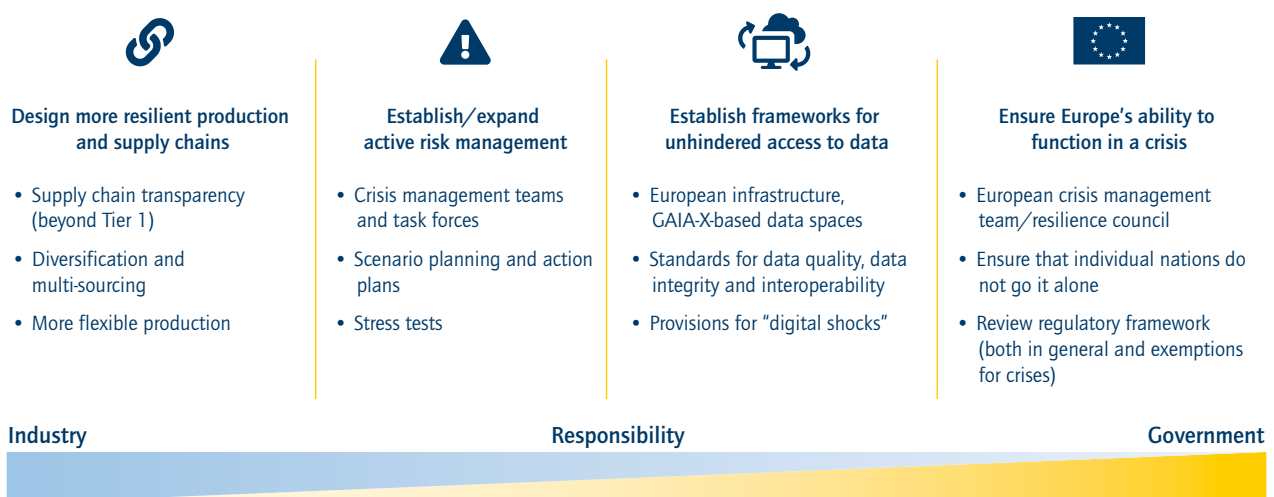


Figure 10: Cross-sectoral priority areas (source: authors' own illustration)

chain, although this will not be universally feasible in every industry and for every component. Rather than simply focusing on inventory levels, it is more important to establish an intelligent **planning and control system** that makes extensive use of digital solutions to **optimise** the resilience of the entire **material flow**. Border closures quickly expose the limitations of a strong and sometimes exclusive focus on just-in-time or just-in-sequence models aimed at eliminating inventory.

- **More flexible production:** Companies should ensure that their production chains are as flexible, scalable and modular as possible in order to strengthen their resilience to shocks and **increase the options available to the business**. The pandemic has highlighted certain **regulatory barriers** that make this more difficult. Any amendments to the relevant regulations must seek to **increase the flexibility and agility** of economic actors without diluting safety standards (e.g. with regard to product quality).
- **Support for SMEs:** Because they tend to have less rigid, rule-based processes and procedures, SMEs are often able to adapt their **cooperation with customers and suppliers more rapidly and flexibly** in crisis situations. However, their processes and procedures frequently **lack the level of digitalisation** needed to increase **supply chain transparency**. Industry associations and organisations can support them in this area by providing standardised, easily implemented guidelines.

7.2 Establish/expand active risk management

In order to maximise their resilience against future crises, it is essential – and indeed part of their responsibility towards society – for **businesses** and **government** to establish an **active risk management** system or strengthen their existing systems. In many cases, the SARS-CoV-2 pandemic has once again highlighted **just how important** this is. The mere act of continuously **evaluating, updating** (e.g. by including new threat scenarios) and **rehearsing the procedures to be followed in a crisis** can help to strengthen resilience and enable an appropriate response in a real emergency.

The following points are key to effective risk management:

- **Scenario planning:** Regular rehearsals of different crisis scenarios can help to identify weaknesses before a real crisis occurs and create familiarity with the relevant procedures.

Ideally, a **specific response plan** should be developed for each crisis event. In order to ensure the necessary level of detail, scenario planning **should also include suppliers and**, where relevant, **public authorities**. The Federal Office of Civil Protection and Disaster Assistance offers integrated risk management assistance, for example.⁴⁶ Scenario planning is also at least **partially transferable**, as illustrated by the fact that pandemic contingency plans developed in response to the 2009 H1N1 influenza (“swine flu”) pandemic helped some actors to respond more rapidly to the challenges of the SARS-CoV-2 pandemic. It is also important to take new risks such as emerging trade disputes into account.

- **Crisis management teams:** It is vital to **appoint** an agile and strong crisis management team with responsibility for making **strategic decisions** and setting out the framework for the entire company or government agency. The members of the crisis management team and its format and powers should be determined in advance, and its strategic directives should leave room for flexible, local measures.
- **Task forces:** Decision-makers with an in-depth understanding of **local** details and processes should be appointed to implement the strategic directives. These individuals should **have clearly defined responsibilities** during a crisis, such as monitoring supply chain problems or delivering emergency assistance. Their responsibilities and decision-making powers must be clearly defined to ensure a swift response if and when a crisis occurs.
- **Criticality testing:** It is important for businesses to **identify any critical dependencies** in their production facilities and establish **early warning systems** that provide **real-time** access to this information. Critical dependencies exist when production facilities are particularly vulnerable to shocks (such as natural disasters or trade disputes) and/or when there are one-sided regional concentrations (of suppliers). This type of information might prompt a business to initiate a reshoring/nearshoring strategy and/or to increase the geographical spread of particularly critical production capacity and sources of supply.
- **Best practices/action plans:** Industry associations can facilitate the **exchange** and dissemination of **industry-specific best practices**, providing SMEs in particular with faster access to concrete recommendations for specific crisis measures. They can also facilitate and moderate the development of general **requirements catalogues and action plans**. **Government agencies** such as the Federal Office of Civil Protection and Disaster Assistance and the relevant research institutions and associations should also be involved.



- **Stress testing:** Opinion is divided among the interviewees regarding the need for businesses to carry out mandatory resilience stress tests (along the lines of bank stress tests). Nevertheless, the majority of those interviewed recommend that companies should undertake **voluntary stress testing**. However, it is also felt that this is often adequately covered by scenario planning (see above).
- **Pooling resilience research:** By pooling existing resilience research in Germany, a one-stop shop could be created for government and industry. This would be especially valuable for SMEs. One possible model is the **German centre for risk management and resilience proposed by Germany's four non-university research organisations**.⁴⁷ Industry must be persuaded to commit to an institutional dialogue with this centre while interest in resilience remains high due to the current crisis.
- **Financial risk assessment:** The measures and strategies outlined above will call for the introduction or more accurate implementation of risk assessment and costing. This is vital so that appropriate reserves can be built up.

"To a large extent, resilience is just traditional risk management: identify and assess the risks, look for weaknesses in your own organisation and develop concrete action plans for certain scenarios."

7.3 Establish a (policy) framework for unhindered access to data

In the context of resilience, there are **three key goals** as far as access to data is concerned:

1. make better use of data **to strengthen resilience** (e.g. by digitalising supply chains),
2. use data to create **new, resilient business models** and
3. build resilience into the way that data is used and exchanged in order to **minimise vulnerability to shocks** affecting the digital sphere.

47 | See FhG et al. 2020.

48 | See EU-KOM 2020c; FAZ 2020.

49 | See EIT Digital 2020.

50 | See BMWi 2020.

51 | See Plattform Lernende Systeme 2020a; 2020b.

52 | See BMWi 2020.

Policymakers must establish a framework that supports these three goals:

- **From dialogue to pragmatic implementation:** In order to make better use of data, it will be necessary to establish **coordinated platforms and processes** such as data trust models for enabling the secure exchange of data throughout the supply chain. The **relevant actors** from science, industry, civil society, and the public authorities should be included in this process. It is important to **move forward as rapidly as possible** on this issue. Germany is already heading in the right direction with the Federal Government's new data strategy referred to in Chapter 7.1. This strategy should be fleshed out and systematically pursued in consultation with Germany's European partners. Coordination at **European level** is especially **important** in order to scale up the relevant solutions. The EU's current legislative initiatives in connection with the **European data strategy** (for example the Data Governance Act, Digital Services Act, and Data Act) provide an appropriate framework.⁴⁸

"If you want competitors to share data, you are going to need security, a contractual basis, and an independent trustee."

- **European infrastructure:** A European infrastructure for secure data use and sharing is key to ensuring Europe's **technological sovereignty** and avoiding dependency on technology companies from other economic areas.⁴⁹ **GAIA-X** employs a geographically distributed cloud infrastructure and a **federated** approach to the **organisation** of user ecosystems, with a hybrid structure that combines decentralised data clusters and central databases. This means that it is well placed to meet the key requirements for **resilience**.⁵⁰ Its geographical spread reduces vulnerability to shocks,⁵¹ while its federated structure enables the formation of industry-specific ecosystems that use GAIA-X's **harmonised standards** but still have the flexibility to **adapt them to their specific needs**.⁵²
- **A digital transformation that respects core European values:** It is important to ensure that the digital transformation strikes a **balance** between **enabling** more effective use of

data (either to add value or to strengthen resilience) and respecting certain **ethical and legal principles**. The concept of personal data sovereignty could serve as a guiding principle in this context.⁵³

- **Industry-specific data spaces:** There are already a number of promising initiatives geared towards optimising the use of data, facilitating data exchange, and enabling the development of digital business models. Industry-specific data spaces can help to **prevent** the emergence of **segregated data silos** within different industries. Examples include the planned **European Health Data Space**, the **Mobility Data Space**,⁵⁴ and the **International Data Space Association**.⁵⁵ It is important to move **from the conceptual stage to the practical implementation stage** as quickly as possible and feed the lessons learnt into other projects. In principle, the data spaces should also be **open to non-European actors**. The specific conditions regarding access for non-European actors or the use of European company data generated outside of the EU must strike a **balance** between allowing a **free flow of data** and maintaining **digital sovereignty**.
- **Standards for data quality, data integrity and interoperability:** The German government should promote **international harmonisation** of norms and standards for data quality, integrity, and interoperability. However, the regulatory framework should also **allow** a degree of **flexibility** so that it does not hold back continuous **innovation**.
- **Resilience against digital shocks (cybersecurity):** Architectures, infrastructures, platforms, and processes for secure data exchange and storage must be designed for **robustness in the face of different shock scenarios** (cyberattacks, failure of physical ICT infrastructure, etc.). Cybersecurity and the physical protection of digital infrastructures should be understood as a process that calls for constant vigilance on behalf of both government and the relevant companies. Further **research and development** in the field of cybersecurity is thus essential (in the new cyber agency, for example). **Government agencies** (such as the Federal Office for Information Security – BSI) should in general play a more active role in accelerating the widespread implementation of innovations in this field throughout industry and the public administration. It is especially important to provide practical guidance for SMEs. **Regular auditing** and strengthening of resilience could be directly included in the **terms of use**. Moreover,

infrastructures and applications should be subject to **different security requirements depending on the criticality** of the processed data.⁵⁶

7.4 Strengthen Europe's ability to function in a crisis

As the current SARS-CoV-2 pandemic has demonstrated all too clearly, the **ability to keep functioning in a crisis** is also very much a **European-level issue**. When a crisis occurs, matters relating to security of supply, border checks, and regulations cannot be resolved solely at national level. However, the current crisis has also highlighted many areas where there is **scope to strengthen Europe's role as a rapid, effective and appropriately empowered crisis manager**. The following measures can help to achieve this goal:

- **Establishment of a new European crisis management team:** The EU should establish a **structure for a central crisis management team** that could spring into action **at a moment's notice** in the event of a crisis, regardless of the nature of the underlying shock. In addition to the **key decision-makers**, the crisis management team should include **experts** in fields that are relevant to the current crisis. While the crisis management team should act in accordance with clearly defined **"if-then" processes** for different scenarios, it should also have **extensive, direct decision-making authority for dealing with crises**. The make-up and structure of the crisis management team should be determined during crisis-free times, and the relevant procedures should be regularly rehearsed. **Specialist task forces** that report to the crisis management team could be created to provide a **targeted** response to different aspects of acute crises. The crisis management team and the extensive decision-making powers conferred upon it should be enshrined in the basic treaties of the European Union and approved by all the member states. While this means that its establishment will be a **medium-term project**, it is important to harness the current momentum in order to **get things moving as soon as possible**.
- **Establishment of a European resilience council:** The establishment of a new **European resilience council** would help

53 | See acatech 2020a; Micheli et al. 2020.

54 | See acatech 2021b; 2021c.

55 | See Plattform Lernende Systeme 2020b.

56 | See *ibid.*



to anchor resilience **at a central level** and bring together **interdisciplinary expertise** in this area. In a crisis situation, the council should be empowered to make **rapid** and **effective recommendations** for all the **member states**. It should also ensure that **resilience** is **continually** taken into account in European economic and industrial policy. A resilience council could be **established** relatively **quickly** and could **potentially advise the European crisis management team** described above.

- **Ensuring open borders within Europe:** Solutions must be found to **prevent border closures within the EU during future crises** and enable the continued movement of people and goods. Failure to do so can trigger secondary effects that often exacerbate the impacts of a crisis. This point should also

be taken into account by the new European crisis management system discussed above.

- **Regulatory flexibility in the event of a crisis:** In order to ensure that businesses and other (e.g. healthcare system) actors can continue to function during a crisis, **amendments** to the relevant regulations – such as **shorter procedures and exemptions** – should be drawn up in advance so that they can be brought into force as and when necessary. However, these amendments must not be allowed to compromise safety. Resilience measures should also be more strongly anchored in the European Commission's Better Regulation guidelines.⁵⁷ The new EU Foresight Process described in Chapter 5 takes these aspects into account for the first time and is an important step in the right direction.

57 | See EU-KOM 2015.

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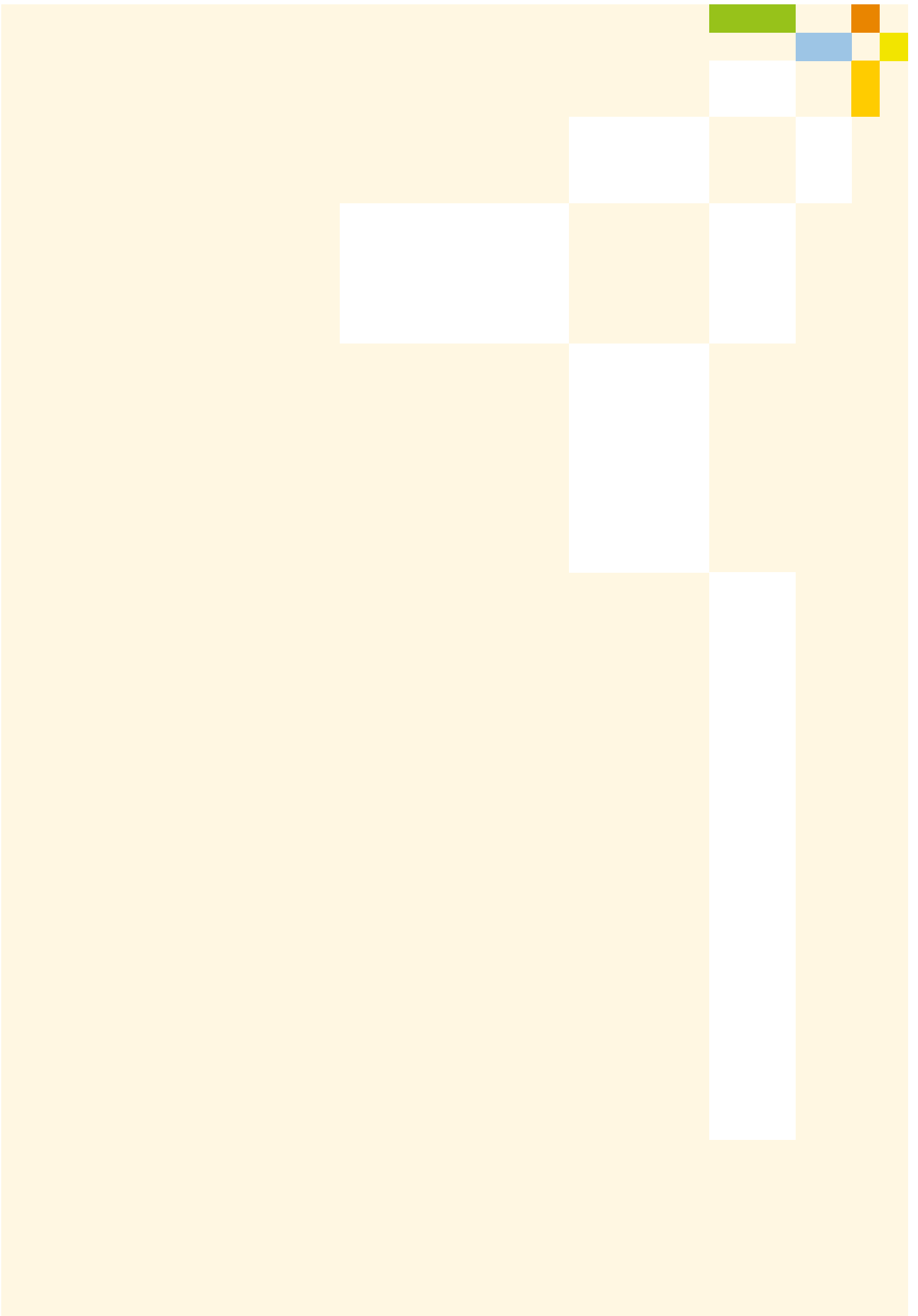
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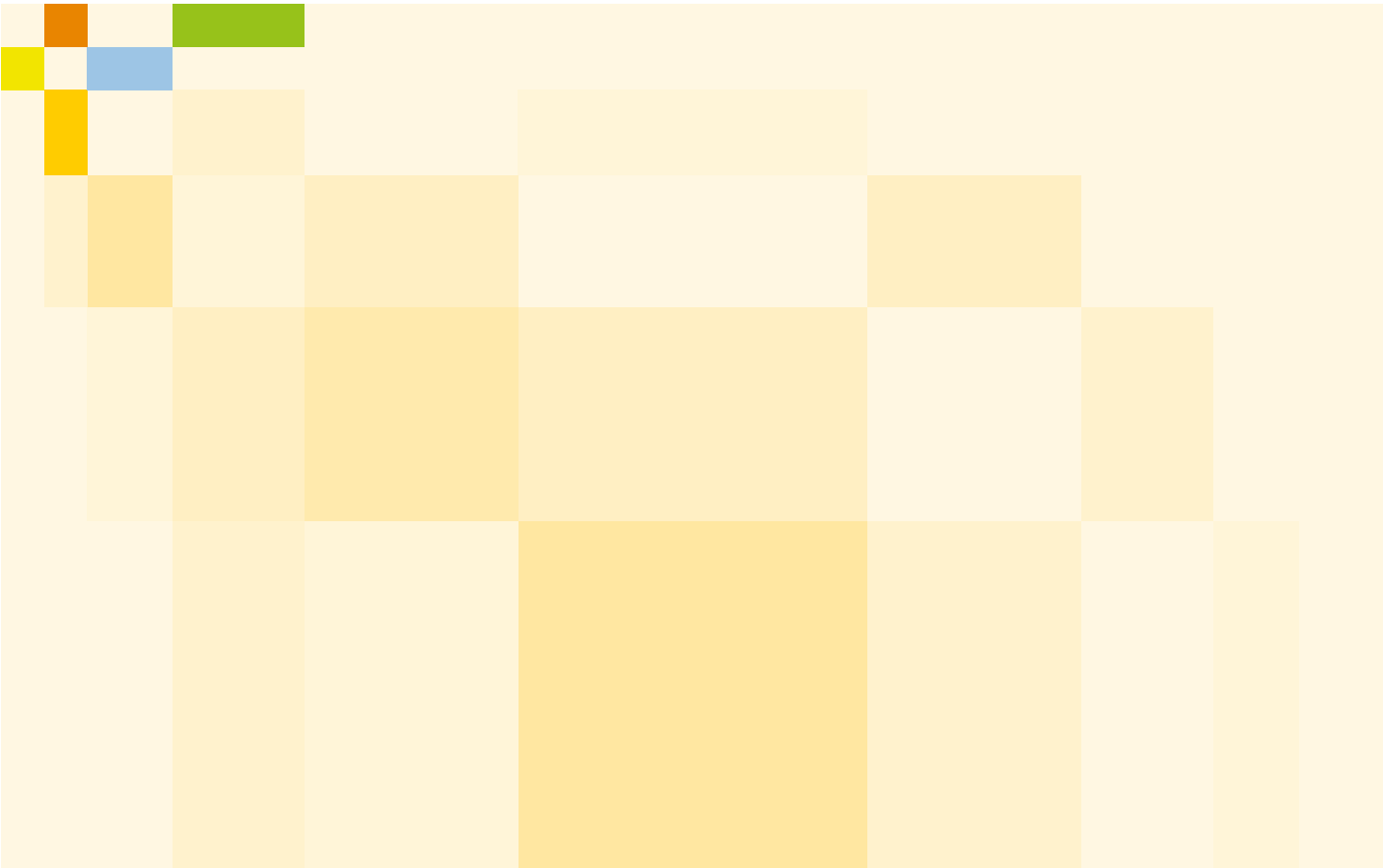
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As an essential requirement for successfully coping with shocks, resilience tends to receive more attention in times of crisis. However, this interest is generally quick to dissipate once the crisis is over. To prevent this from happening in the current SARS-CoV-2 pandemic, resilience must be permanently anchored in the minds of decision-makers and in the structures of government and industry. Resilience should also be incorporated into the design of supply chains and value networks, where it should be given equal weight to other goals such as efficiency. While the lessons learnt from the current pandemic provide a useful starting point, it is important to avoid focusing too narrowly on potential future pandemics – resilience means preparing for all types of shocks. Moreover, resilience is a continuous process that seeks to actively develop and improve structures rather than simply returning to how things were before the crisis.

This acatech IMPULSE summarises the key challenges involved in strengthening the resilience of supply chains and value networks, and identifies strategies that can be used by government, science, and industry to improve the resilience of economic structures against all kinds of shocks.