# A Methodology for Future Scenario Planning


**Saskia Sardesai, Markus Stute, and Josef Kamphues**

**Abstract** The future is influenced by various possible developments and is hence difficult to predict. Still, each company or institution bases its vision and strategic progress on certain assumptions for the future. In order to prepare for various developments of the future, it is reasonable to consider different possible scenarios while building a future vision. Thus, this chapter focuses on the methodological approach for the generation of future scenarios showing what the surroundings for supply chains might be like in a time horizon until 2030. This integrates various political, economic, social, technological, legal and environmental influences and changes. The methodological framework required for generating scenarios is set by a combination of quantitative and qualitative scenario planning methodologies. Close coordination and collaboration between production and logistics guides the underlying scenario design to focus the context on supply chains. While considering trends described in Kalaitzi et al. 2020, this approach results in a set of macro scenarios, each describing a possible future development until 2030. The macro scenarios range from scenarios with progressive developments to regressing or stagnating evolutions.

**Keywords** Scenario planning · Trends · Supply chain management · Prediction

## 1 Introduction to Scenario Planning

Scenario planning is a proven approach to coping with uncertainties in today's rapidly changing world (DHL 2012). Since the 1950's, scenario planning has been used to help make public policy decisions—beginning with war game analyses at the Rand Corporation (Wilkinson and Eidinow 2008). Interest in the method has grown at the intersections of academia, the public and private sectors and policymaking.

Scenario planning forms a basis for learning through strategic conversation and it helps to build a consensus in terms of considering the probability of certain future

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developments (so called 'projections') (Wilkinson and Eidinow 2008). The methodology supports the creation of different scenarios in order to be prepared for various possible future developments. It results in a set of several scenarios in which each set claims a different probability level. Compared to the fixed results achieved by traditional methods, this methodology provides a set of possible ways forward while retaining uncertainty (Wilkinson and Eidinow 2008). Accordingly, it differs from other future research approaches, such as predictions and forecasts, as it integrates different combinations of future states, so called scenarios.

The methodology is specifically useful in the context of future statements with different levels of uncertainty. It provides a holistic and schematic overview to describe a possible future condition. Each resulting scenario details causal relationships between a set of projections of future developments. It describes a version of the future which originates from the current state of developments (Meinert 2014). The generated scenarios help organisations to react to changes, make decisions, be prepared for and adapt quickly to upcoming environmental changes and thus improve the quality of strategic thinking (DHL 2012). The methodology also allows public authorities to evaluate future developments e.g. to prepare for stocks of mouth and nose masks in case of pandemic events. Thus, the methodology helps organisations and public authorities to prepare for possibilities and to ensure innovative and flexible development (Amer et al. 2013).

Boerjeson et al. distinguish between three main scenario categories, namely predictive, explorative and normative. Predictive scenarios respond to the question "*What will happen?"*; explorative scenarios consider the question *"What can happen?"*; and the normative scenarios focus on "*How can a specific goal be achieved?"*. In addition, they can be classified according to the topic (i.e. global scenarios or problem specific) and its level of aggregation (e.g. macro or micro) (Amer et al. 2013).

The literature for the development of scenarios is diverse and wide-ranging and there are many definitions, typologies and methodologies (Enserink et al. 2013) with different utilities, strengths and weaknesses (Amer et al. 2013). In the underlying topic, the scenarios are intended to serve as an aid to policy planning within the logistics sector. In this case, the explorative long-term horizon within the definition of Boerjeson et al. is considered, aiming at the question: *"What can happen?"*. According to Boerjeson et al. this category is further differentiated into external and strategic scenarios. While strategic scenarios focus on internal factors, external scenarios address the development of external factors that cannot be influenced by an actor, e.g. a company or a political unit (Boerjeson et al. 2006).

## 2 Methodological Approach for Scenario Planning

With regard to the generation of scenarios, the approach used in this work is closely linked to a methodology proposed by Gausemeier and Plass (2014). The approach belongs to the category of quantitative approaches and uses a cross-impact and

consistency matrix to develop a set of scenarios. Being in line with the rational, objectivist school, a cross-impact analysis of future projections serves to identify correlations and causal impacts (Amer et al. 2013). It is complemented by qualitative methods to enhance the plausibility of the scenarios. The resulting scenarios represent macro-scenarios outlining the future industrial surroundings based on a trend analysis according to PESTLE dimensions (**p**olitical, **e**conomic, **s**ocial, **t**echnological, **l**egal and **e**nvironmental influences). The methodology applied here has the strong advantage of allowing several ways for the development of the future and of enabling the inclusion of complex future developments that result from different trends and perspectives. While integrating the complex surroundings, the methodology uses a powerful methodology to compress various future projections to select a few scenarios for a more detailed analysis (Gausemeier et al. 1995). The approach is separated into five different steps as shown in Fig. 1, where the approach as suggested by Gausemeier is compared to the applied approach.

The first step of the Gausemeier approach comprises a definition of the envisaged scope and timeline as well as the underlying decision-field-analysis. Step 2 conducts a scenario-field-analysis that identifies and describes major influencing trends within the decision-field. Step 3 clusters the trends to state future projections. Those projections are integrated into a cross-impact matrix to form future projection bundles and thus preliminary scenarios. Step 4 evaluates the consistency of the

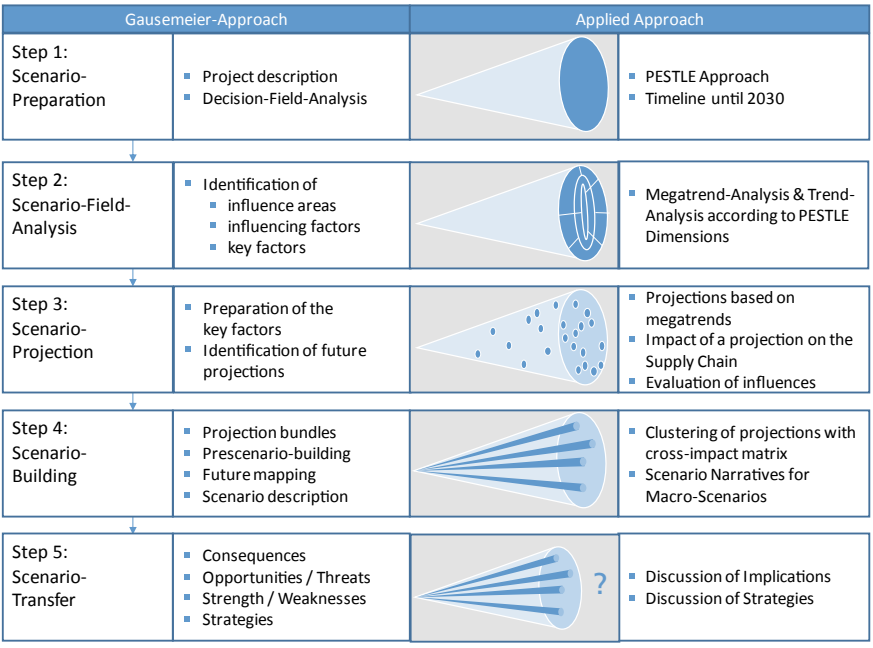


**Fig. 1** Application of the Gausemeier approach (own representation following Gausemeier et al. 1995)

scenarios via cross-impact analysis resulting in a set of final scenarios. As the cross-impact evaluation is a pure mathematical approach, a qualitative approach enhances the methodology with a validation of the plausibility of each scenario. Accordingly, experts are invited to evaluate the probability of occurrence of each scenario and its impact on the supply chain. Finally, a storyline for each macro scenario details the scenario settings and conveys the differences of each scenario to the decision-making units. While reflecting on the impact of each scenario, conclusions have to be drawn on how to prepare for, or even influence, different alternatives. Step 5 is dedicated to scenario transfer that aims at developing appropriate strategies for each scenario.

As the first two steps (scenario preparation and field analysis) are described in Kalaitzi et al. (2020), the following sections detail step 3 (scenario projection) and parts of step 4 (scenario building). Sardesai et al. (2020) refines the scenario narratives and impact of each scenario on supply chains. Barros et al. (2020) provides the methodological approach for scenario transfer and supply chain strategies for each macro-scenario.

## 3 Scenario-Projection–Conception of Future Projections

The creation of future projections relies on previously identified trends and mega-trends. The six PESTLE dimensions set the framework and form subsections, each incorporating several so-called 'descriptors' (Gausemeier and Plass 2014). Descriptors express a neutral form of future topics and are characterised by diverging future projections. Future projections express a certain future state of a descriptor and describe possible circumstances that companies and societies might face. Most commonly, a descriptor comprises a positive, negative and neutral future projection.

The development of future projections for the descriptors is a decisive step in the scenario planning as they create the structural components for the upcoming scenarios. The significance and quality of the scenarios depend on it, and thus ultimately the success of the entire scenario project, too. Generally, future projections have to contain plausible future states and it is necessary to consider extreme but possible developments. At the same time, it is essential that each projection remains reasonable and conceivable, in the sense that a projection can be futuristic but needs to rely on valid arguments or requires justification by means of statistical developments (Gausemeier and Plass 2014). Careful attention has to be paid to the distinctness of the projections to ensure that the subsequent consistency check leads to reasonable combinations of projections and consistent scenarios. Hence, the projections have to fulfil the following criteria:

- Plausibility—a projection needs to be plausible to the scenario team.
- Dissimilarity—all projections have to be distinct from each other.
- Completeness—a set of projections within a descriptor has to provide a comprehensive set of possible developments.
- Relevance—each projection requires a check regarding its future relevance.

- Information content—each projection needs to add further value to the set of projections within a descriptor.

Table 1–Table 6 list the different descriptors and future projections that result from the underlying field analysis (see Kalaitzi et al. 2020; Daus et al. 2018). The projections are separated according to the six PESTLE dimensions.

**Table 1** Overview of the resulting projections for the political dimension

| Political dimension | | |
|---|---|---|
| Political setting | Political concord in Europe | We experience a politically stable environment in Europe. States at the border region and trade partners are living in peace (Stiftung 2018) |
| | Constant development in Europe | The number of terrorist attacks is slowly decreasing due to stronger security enforcements (Stiftung 2018; EUROPOL 2017) |
| | Governmental collapse in Europe | Social unrest and conflicts characterize everyday life throughout European countries. Frequent strikes occur and terrorist attacks hinder economic growth (Stiftung 2017b) |
| Trade policies | Protectionism | We experience a policy of protecting domestic industries against foreign competition entailing a rise in trade policies such as tariffs, import quotas (de Kluyver 2010) |
| | Free trade | We experience a policy of open trade, not discriminating against imports from and exports to foreign competitors. Countries are interested in making trade as easy as possible (World Economic Forum 2016b) |
| Confederation | Contended Union | Asian, Latin American and other countries form state unions. EU Member States act as a single political, economic area promoting free movement of goods, services, capital and people (World Economic Forum 2016b) |
| | Unstable confederations | Some countries push for change and express their discontent with the confederation. Free movement and trade agreements remain (Stokes 2016) |
| | Fragmentation | The EU is going into crisis and several countries are leaving the confederation (Stiftung 2017a) |

**Table 2** Overview of the resulting projections for the economic dimension

| Economic dimension | | |
|---|---|---|
| Global trade shift | The pendulum shifts | Global market demand and trade shifts specifically to Asia. It is projected that new emerging economies such as Mexico and Indonesia will be larger than the UK and France by 2030 (WTO 2017) |
| | Steady Titans US and Europe | US and Europe manage to keep export trading volume high, and heavily invest in education and new technologies (PwC—Price Waterhouse Coopers 2015) |
| Global corporate structures | Think global, act local | An increase in wages in previously low-wage countries, and cost of shipping and custom fees, make local production attractive again. Companies follow market demand and primarily offer and source local products (Menon 2014) |
| | Rise of born-global firms | Digitalisation helps SMEs and start-ups to participate on a global level. Born-global firms are innovative in all areas of value creation, both technological and non-technological (Weerawardena et al. 2007) |
| Digital economy | Pure traditional economy | People object to digitalisation and accept limited online functionality due to privacy. Traditional physical goods such as hardcopies of books are preferred (Brynjolfsson and Kahin 2000) |
| | Traditional economy persists | The traditional way is upheld due to fear of data misuse and legal and political concerns limit development. Even though traditional business needs to cooperate with online platforms (such as for food delivery services or fashion), customers continue to e.g. eat and shop the conventional way (Laudon and Traver 2014) |

(continued)

**Table 2** (continued)

| Economic dimension | | |
|---|---|---|
| | Platform economy | Expanding digital economy B2B by developing more collaborative platforms enabling an easy share and utilisation of resources (hubs, terminals, etc.) (PwC—Price Waterhouse Coopers 2017b) |
| Financial innovations | Bank and Fintech collaboration | The rise of Fintech companies transforms bank institutions and other sectors. Start-up companies compete with traditional banking by focusing on digital processes and innovation, thus enabling better customer interactions (PwC—Price Waterhouse Coopers 2017a) |
| | A world without banks | Smart ledgering enables a new kind of trading. It is possible for each individual to create their own virtual currency. Transactions are secured via new technologies, e.g. blockchain. Using secure web services, devices submit financial transactions autonomously (Karathodorou; Fintechnews Singapore 2016) |
| | Big 5 are the banks of the future | Trusted third party services develop their own digital currencies, taking over the "traditional" currencies. E.g., the big five IT companies offer their own currencies to facilitate seamless payment between both people and devices (Shah et al. 2016) |

**Table 3** Overview of the resulting projections for the social dimension

| Social dimension | | |
|---|---|---|
| Demographic change | Ageing population and acceleration of disparities | Due to longer and healthier lives in developed countries, a significant increase in older populations can be assumed (Krys and Fuest 2017) |
| | Awareness of inequalities and wealth redistribution | New forms of solidarity, social engagement and civil participation develop within society supporting fast integration of migrating young people (Krys and Fuest 2017) |
| Urban living | Smart regions | Some people leave the cities to live in the countryside. While people continue to work in cities, they look forward to a break in the countryside (Zelt et al. 2017) |
| | Smart cities | Smart cities with free Wi-Fi in all public spaces, where children learn how to program apps in elementary school, goods are delivered to homes within hours, and e.g. street lighting is provided on demand (Zelt et al. 2017) |
| Consumption patterns | Much and cheap | We experience a throwaway society in which people focus on convenient and mass products (Kharas 2017) |
| | Consumption awareness | Customers receive detailed information about products they buy. An ecological mind-set determines consumption and products within other sectors like transportation (Kharas 2017; Eurostat 2016) |
| | DIY Society | Motivated by increased consumption awareness, a perceived lack of quality from available offerings and the need for customisation, people become strongly involved in the production process (Wolf and McQuitty 2011) |

(continued)

**Table 3** (continued)

| Social dimension | | |
|---|---|---|
| | Individualised consumption | A transition towards small scaled households affects the quantity sizes demanded and the way products are requested, purchased and consumed in each household (Agriculture and Agri-Food Canada 2010) |
| Customer orientation | Individualism—focus on variety | Personalised purchases are offered in categories like holidays, clothing and furniture. Companies postpone their production until the latest point possible to allow individual customisation (Deloitte 2015) |
| | Collectivism—focus on the crowd | Social networks strongly influence buying behaviour and hence, companies have to adapt quickly on a large scale (Frank et al. 2015) |
| Knowledge-based economy | Investments equalize the labour market | The investment in new production structures and new facilities partly equalizes low skilled job opportunities lost due to autonomisation (Lorenz et al. 2016) |
| | Rapid changes cause unemployment | Several industry sectors are affected by autonomisation, which leads to a high overall rate of unemployment, a loss of seven million jobs in transportation alone is predicted (Lorenz et al. 2016) |

**Table 4** Overview of the resulting projections for the technological dimension

| Technological dimension | | |
|---|---|---|
| Digital transformation | Rapid advancement of digitalisation | The overall technological development evolves fast in an open manner and enables small and multinational companies to profit from products and services that are increasingly personalised, data-intensive and context-aware (World Economic Forum 2016a) |
| | Obstacles restrain digital transformation | Performance improvements through digital transformation seem obvious, but can seldom be verified and lack proof of evidence (Bouee and Schaible 2015) |
| | Digital stagnation | Only a few companies attempt to promote digital transformation further but are struggling with a lack of compliant regulations and political support (Bingley et al. 2016) |
| Autonomous systems | Dynamic development of autonomous technologies | Cyber-physical systems enable efficient communication and control by transferring and exchanging data in real time. An increased exploitation of these technologies leads to a highly automated, autonomous environment (Bingley et al. 2016) |
| | Innate reluctance to accept autonomous technologies | Since an autonomous technology requires suites of expensive sensors, the average cost of this technology remains high. In addition, regulations prevent the full exploitation of their potentials (Omohundro 2014) |
| Alternative energy generation, storage and usage | Established electrification technologies and green systems | New power grid solutions and grid transformations overcome technological limitations. This enables a smart grid environment with distributed energy generation and powerful storage systems (Howell et al. 2017) |

(continued)

**Table 4** (continued)

| Technological dimension | | |
|---|---|---|
| | Ongoing electrification and alternative energy endeavours | Green systems used for power generation, energy storage and transportation, such as hydrogen power cells and biomass, are gradually applied in industrial and social sectors (McKinsey 2010) |
| Decentralised connection of information and physical devices | Dominance of global players | Only global players have significant resources, global data sets and institutional know-how to harness for their digital transformation (DHL Customer Solutions and Innovation 2016) |
| | Start-ups and SMEs take up business | Many small and medium-sized enterprises (SMEs) and start-ups attack traditional markets, due to the democratisation of technology, increased access to funds and a rising entrepreneurial culture (Coleman et al. 2016) |
| Disruptive production technologies | Continuous exploitation of disruptive technologies | Suppliers of disruptive technologies experience exponential growth rates. Existing technologies are improved and additional solutions are developed in a rapid and continuous manner (Jiang et al. 2017) |
| | Coexistence of conventional and disruptive technologies | Conventional technologies and disruptive technologies coexist in industry. A widespread implementation of disruptive technologies is missing due to high associated costs, lack of expertise and uncertainty of quality (Bingley et al. 2016) |

**Table 5** Overview of the resulting projections for the legal dimension

| Legal dimension | | |
|---|---|---|
| Consumer Protection Laws | Promotion of laws and full product transparency | Safety and approval regulations for new products are in place and constantly monitored. For cross border transactions, the required general legislation has been adopted and consumers' personal data are strictly protected in the EU (PwC—Price Waterhouse Coopers 2011) |
| | Legislation is lagging behind dynamic market development | Arising trends (e.g. sharing economy, digital market) lack legislative clarity and are still key priorities for regulations and consumer protection laws in Europe (Rhodes 2017) |
| Intellectual property laws | Full security for inventors and data providers | Secure peer-to-peer data networks allow regulated data transfer supported by politics, businesses and research (Mittal et al. 2017) |
| | Low confidentiality for data and market participants | Comprehensive data exchange via conventional business platforms, especially with potential competitors, is a challenge since core data and business secrets are exposed and liability regulations are missing in case of infringement (PwC—Price Waterhouse Coopers 2016) |
| Social and environmental regulations | Comprehensive regulatory framework | Standards exists on how frameworks and reports for setting regulations are communicated. New legislator decisions facilitate business and set decisive, easy to implement regulations in terms of corporate responsibility (CR) and sustainability (Governance and Accountability Institute 2016) |
| | Heterogeneous regulations | Standards and widely accepted regulatory frameworks are missing in Europe as well as worldwide (Ceniga and Sukalovaba 2015) |

**Table 6** Overview of the resulting projections for the environmental dimension

| Environmental dimension | | |
|---|---|---|
| Climate impact | Our environment is recovering | Rapid improvements in energy efficiency and a greater share of zero- and low-carbon energy supply reduce and maintain global warming at an environmentally acceptable rate (European Commission 2016). The number of natural disasters stabilises and even declines slightly. Incidents of pandemics or epidemics and general infectious diseases appear less frequently (WHO 2004) |
| | Our environment on the brink | Rising atmospheric $CO_2$ concentration and rising temperatures reach new peaks as time passes. Crucial signs for continued climate change (Schwartz et al. 2014). The frequency of pandemics and epidemics increases along with the deterioration of the environment. Natural hazards like floods and hurricanes become very common and support the spread of epidemics |
| Environmental resource management | Countering resource depletion | Improvements to the collection, treatment and recycling of waste, particularly of electronics and plastics at end of life, contribute to circular economy endeavours (European Commission 2018) |
| | Rise in depletion of natural resources | Ever-increasing global population, economic growth and demand for resources from affluent consumers contribute highly to severe ongoing depletion of resources (Krys and Fuest 2016) |

## 4 Scenario Building—Creation of Scenarios

The major challenges in scenario building comprise, on the one hand, the evaluation of the credibility of different combinations of projections and, on the other hand, the aggregation of coherent combinations of projections to a scenario. To overcome these challenges, the scenario building technique within scenario planning contains powerful tools to identify contextual challenges and opportunities. The technique highlights the implications of possible future systems and projects consequences of choices or policy decisions (Amer et al. 2013).

The tools and methods of scenario building evaluate possible combinations of future projections. Each resulting set of future projections forms a scenario. This can result in a high number of different scenarios, some of them with a low credibility of interrelation. Such contradictions are referred to as inconsistencies (Gausemeier and Plass 2014). This implies that a scenario has a tendency to implausibility in cases of a high number of inconsistent future projections. It is therefore necessary to evaluate the consistency of each scenario as it acts as a decisive factor for its credibility.

There are several methodologies to evaluate the consistency of a scenario. The simple consistency analysis itself has certain constraints and practice has demonstrated that a simple consistency analysis does not sufficiently limit the spectrum of possibilities. To further restrict the spectrum of possibilities, Theodore Jay Gordon and Olaf Helmer developed a Cross-Impact Analysis (Gordon 1994), later extended as a Cross-Impact Balance Analysis (CIB). Similar to a consistency analysis, a CIB assesses the relationships between the factors in pairs. In contrast to the consistency analysis though, a CIB does not assess the concurrence of two future projections, but the direct effect that the occurrence of one future projection has on the other. A CIB therefore works with causal information (Weimer-Jehle 2009) and utilises qualitative insights of the individual relationship between the factors of the network thus constructing consistent images of its overall behaviour (ZIRIUS 2020). The scenario technique is one of the typical applications of CIB.

Depending on the method used, the impact assessment is either carried out along with an evaluation of probabilities, or, similar to consistency analysis, by qualitative assessments on an ordinal scale. Mathematical simulations or calculations support the evaluation process which has given cross-impact analysis the reputation of oversized mathematisation among qualitatively oriented scenario analysts. Still, the mathematical approach facilitates the implementation in a tool such as the CIB tool developed under the leadership of Dr. Weimer-Jehle at the University of Stuttgart. The tool is available on an open source basis, in order to benefit from the advantages of this methodology (see https://www.cross-impact.de/english/CIB_e.htm).

## 4.1 Evaluation of Impacts of Future Projections via the Cross-Impact Matrix

The methodology of the Cross-Impact Matrix, as part of the CIB, is based on a matrix that plots the future projections, once in the ordinate and once in the abscissa. The evaluation of the impact between two future projections takes place in a group of experts who evaluate and assess the direct impact between two future projections. The group of experts should consist of people with a diversified background to ensure a broad view on the evaluation of the projections. As an example, the evaluation can consider the following scale:

**−2 = strong impeding influence**, i.e. future projection A1.1 has a strong inhibiting influence on the future projection A2.1. A common occurrence in a scenario has to be argued.
**−1 = moderate impeding influence**, i.e. future projection A1.1 has a moderate inhibiting influence on future projection A2.1.
**0 = neutral or independent influence**, i.e. the respective future projection does not affect the other.
**1 = moderate supporting influence**, i.e. future projection A1.1 has a light supporting effect on future projection A2.1. Both future projections may well occur in a scenario.
**2 = strong supporting influence**, i.e. the future projection A1.1 has a strong supporting effect on future projection A2.1. If future projection A1.1 occurs in a scenario, future A2.1 can also be expected to be in the same scenario.

In contrast to the consistency analysis, the CIB matrix must be filled in completely in order to be able to express the causality of the relationships (Weimer-Jehle 2006, 2008). An extract of the CIB matrix is shown in Fig. 2 along with the applied procedure.

It is recommended to invite several expert groups to evaluate the Cross-Impact Matrix in order to ensure objectivity. Resulting matrices can be consolidated by using a scaling up mechanism. This means that the target matrix consists of the sum of the individual judgement matrices. By comparing two matrices, this extends the range of judgement to −4 to 4. Scaling-up has no influence on the later evaluation, but allows a differentiated evaluation.

## 4.2 Development of Future Scenarios with the Cross-Impact Balance Analysis

The CIB uses an inductive approach to form different sets of scenarios. The consistency analysis is the core of the CIB procedure. The method assesses the plausibility of the combined future projections within a scenario. Based on the output of the

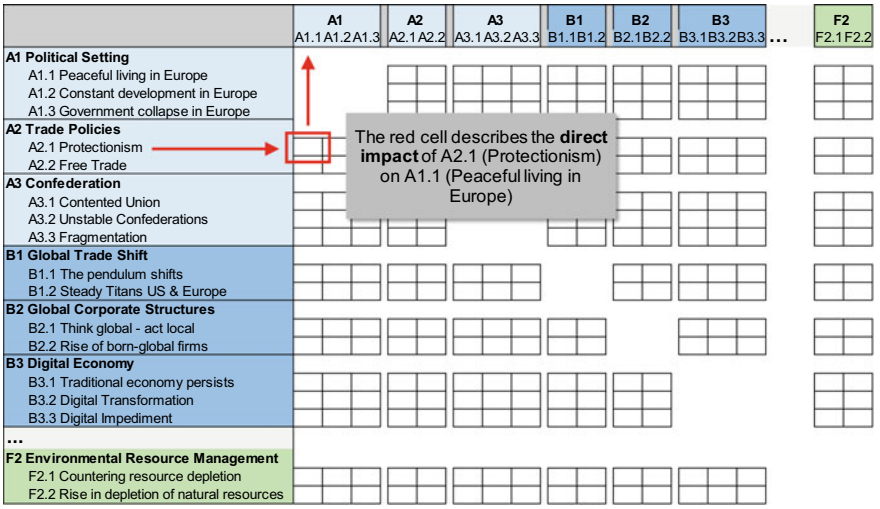


**Fig. 2** CIB matrix to support judgements

cross-impact matrix and its impact balances, all consistent clusters of future projections are considered as suitable scenarios (Gausemeier et al. 1988). For this purpose, all possible scenario sets are evaluated according to their consistency and their logical fitness. The general procedure taken within the Gausemeier approach is shown in Fig. 3.

In order to achieve consistent and plausible scenarios, impact scores serve to conduct consistency and plausibility checks in the CIB. They are calculated for each future projection by selecting the rows (future projections) that belong to the analysed projections of one descriptor bundle and then calculating the column sum.

The impact scores of a descriptor define its impact balance. As an example, Fig. 4 shows three descriptors with two future projections each. The figure reflects two scenarios; each scenario includes one future projection of each descriptor. Within Fig. 4, the scenario in each table is highlighted in grey. Scenario 1 is represented by 'Free Trade', 'High Capability' and 'Digital Impediment'. Scenario 2 consists of the future projection 'Free Trade', 'High Capability' and 'Digital Transformation' (instead of 'Digital Impediment'). In Scenario 1, the impact score for 'Free Trade' is calculated by adding the numbers at the vertical intersection with 'High Capability' and 'Digital Impediment', $0 + (-1) = -1$. In Scenario 2 though, the impact score for 'Free Trade' results in $0 + 1 = 1$ (please refer to encircled numbers within the figure).

In accordance with the CIB consistency principle, the scenario set has to represent the maximum impact score within an impact balance. Hence, for a consistent scenario, the chosen future projections have to achieve the maximum impact score within each descriptor. Within Fig. 4, the future projections of each scenario are highlighted with a black arrow on the top of the impact score ('Free Trade', 'High

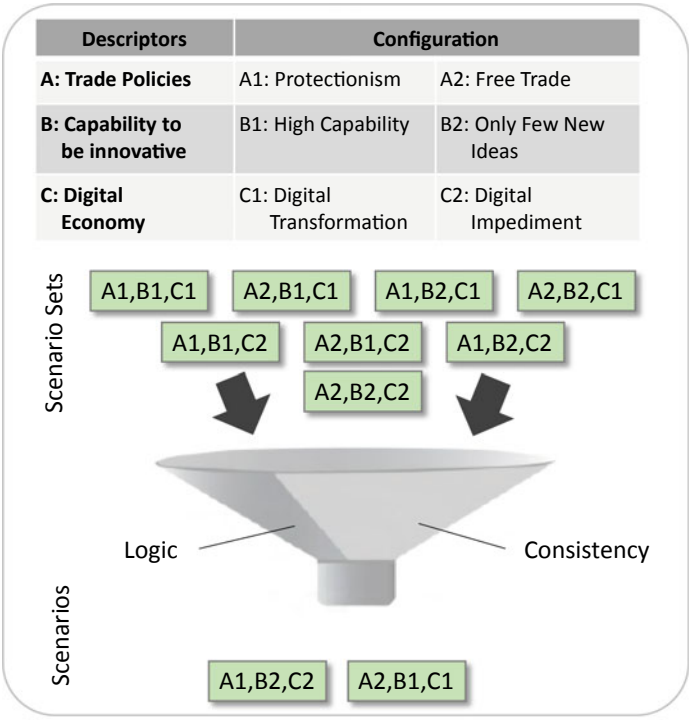


**Fig. 3** Achievement of consistent projection bundles

Capability' and 'Digital Impediment' for Scenario 1, 'Free Trade', 'High Capability' and 'Digital Transformation' for Scenario 2). The maximum value of each descriptor is highlighted with a black arrow below the impact score ('Protectionism', 'Only Few New Ideas' and 'Digital Transformation' for Scenario 1, 'Free Trade', 'High Capability' and 'Digital Transformation' for Scenario 2). Once all arrows point to the same projection, the scenario counts as consistent. This is the case in Scenario 2 (lower table in Fig. 4), where all maximum values of the impact scores correspond to the projection within the scenario set. On the contrary, according to CIB, Scenario 1 is considered as inconsistent as none of the scenario assumptions fits to the maximum impact balances.

The CIB offers various evaluation options for determining consistent scenarios. Scenario 2 considered in the example above applies "strong consistency". This option returns only those scenarios in which the scenario assumption corresponds to the highest impact score in any case (Weimer-Jehle 2008). To increase the diversity of the resulting scenarios in order to cover a wider scenario space, it is also possible to loosen the consistency principle and to allow for a certain inconsistency value while retaining the validity and plausibility of this scenario (Weimer-Jehle 2018).

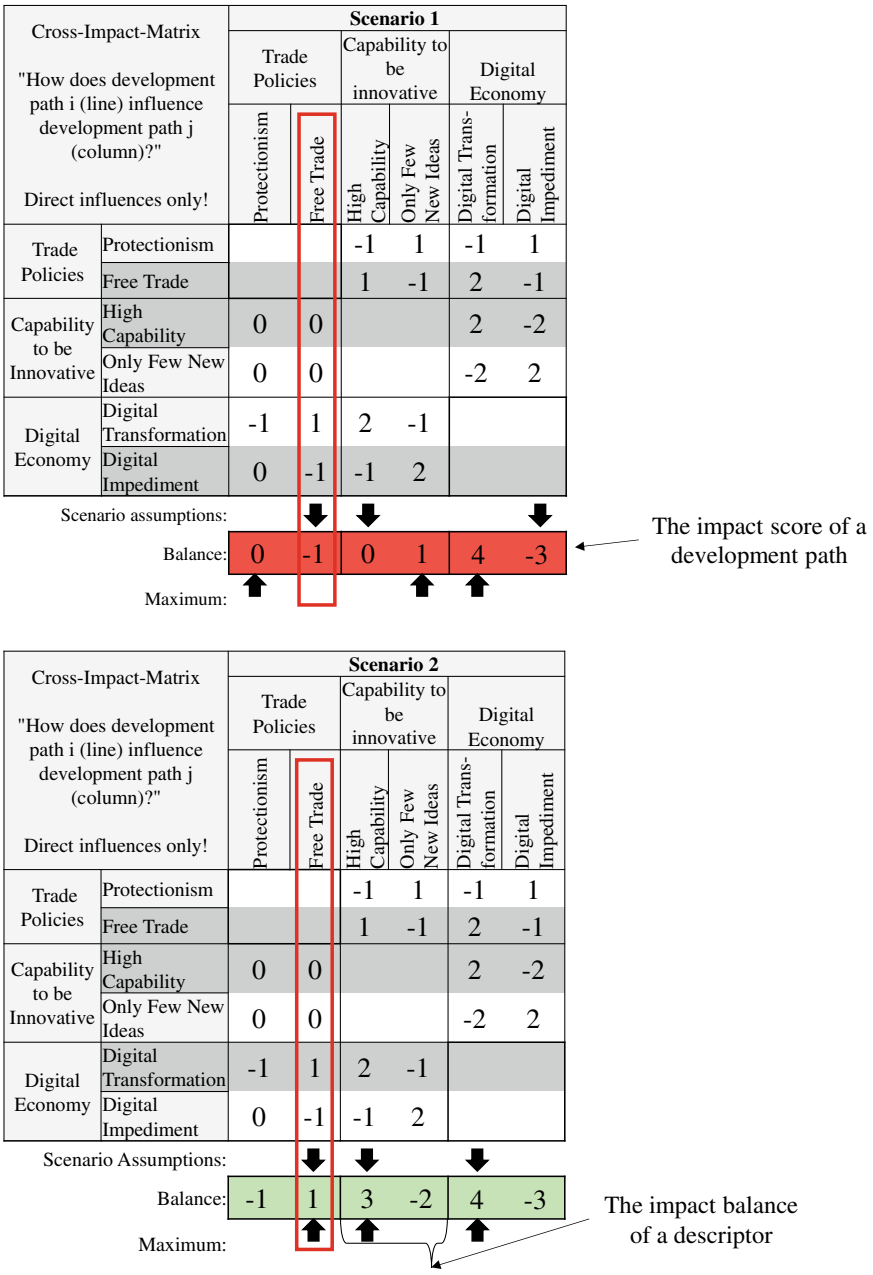


**Fig. 4** Example CIB consistency calculation

Its simple comprehensibility and its potential to work through a complex network of interdependent factors make consistency analysis an attractive compromise between simplicity and analytical depth.

## *4.3 Resulting Set of Scenarios*

In the underlying case, around 63 million possible projection bundles had to be evaluated. For the consistency check conducted by the CIB tool, several consistency criteria were defined in order to reduce the range of solutions. This has resulted in twelve consistent scenarios. Two of the resulting scenarios show an overall progressive development. Foremost, a stable political and economic environment characterizes these scenarios (Aspirant and Proceeding). Regressive overall development characterizes two further scenarios represented by a politically and economically unstable situation, as well as lagging legislation and poor environmental conditions (Escapism and Endanger). All other scenarios can be classified in between, they show mixed developments. Figure 5 displays the scenarios and the configuration of the projections.

## *4.4 Validation and Selection of the Scenarios*

After the quantitative method of locating consistent scenarios has been carried out, it is necessary to validate the scenarios qualitatively to increase their interpretability and validity. Following the methodology, it is necessary to evaluate the probability of occurrence of a scenario and its impact strength on the decision field. In the underlying case, the evaluation assesses the impact strength of the macro scenario setting on supply chains. The latter evaluates the potential pressure for changes on current supply chain settings.

An expert-workshop is chosen to fulfil this qualitative task. Again, with regard to the topic concerning the creation of future scenarios, it is recommended to select experts with a diverse background and from different industrial sectors. A discussion round between the experts helps to formulate scenario narratives. The results of the evaluation of the scenarios are then transferred into a probability-impact-matrix thus displaying the overall distribution of the scenarios. Figure 6 shows the result for the probability and impact evaluation of the retrieved scenarios.

The outcome of the assessment serves to refine the results of those scenarios which are probable and plausible and necessitate a change to future supply chains. As recommended in the literature, the number of scenarios has to be restricted to allow thorough further analysis with detailed scenario narratives. Bradfield et al. (2005) recommend a scenario set of three to six scenarios using a quantitative approach combined with expert judgements. The final number of selected scenarios is highly dependent on the number of future projections considered and their uncertainties (Amer et al. 2013).

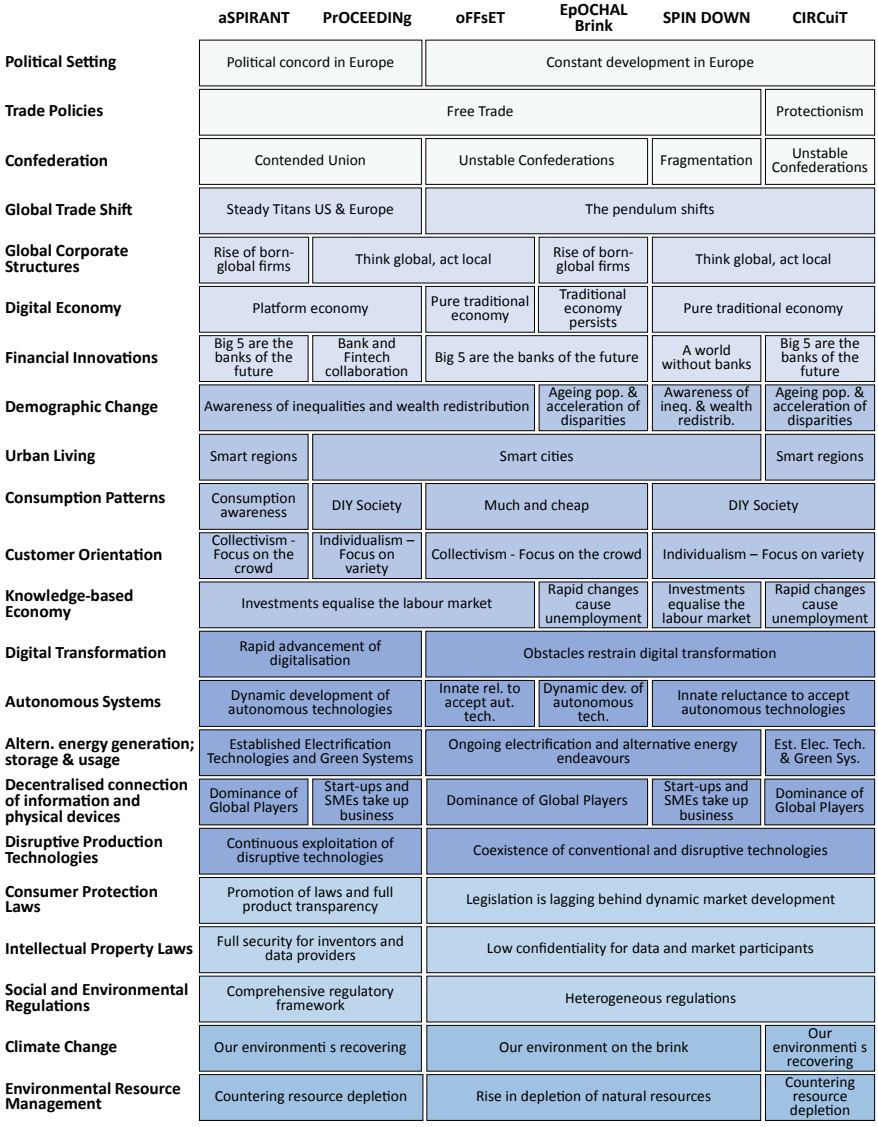


**Fig. 5** Overview of the twelve selected scenarios

As displayed in Fig. 6, the assessment resulted in six scenarios that force a strong to medium change on the supply chain (impact factor > 3) and have a rather high probability (>35%).

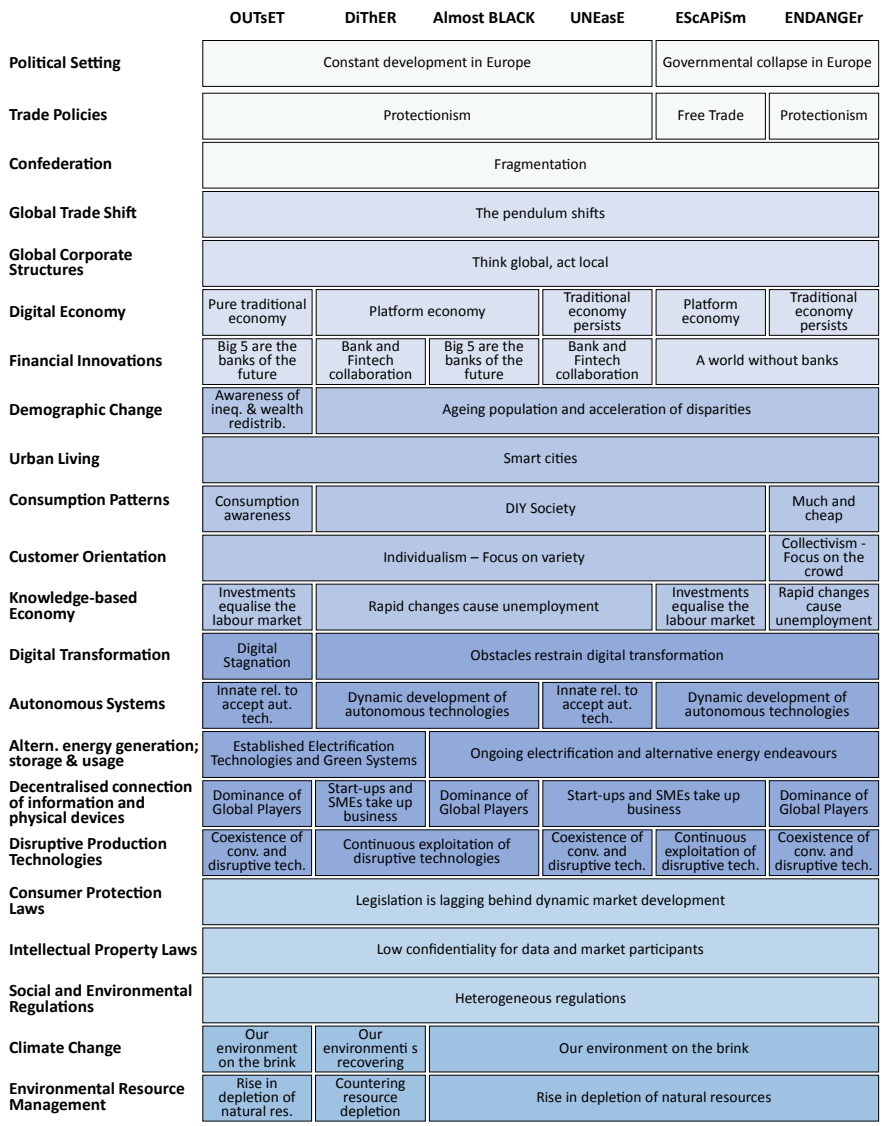


**Fig. 5** (continued)

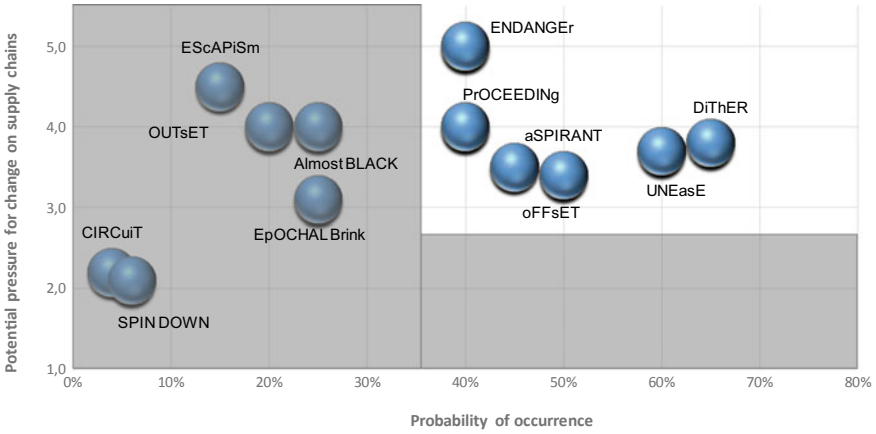


**Fig. 6** Overview of the assessment of the scenarios and scenario selection

## 5 Conclusion

Various methodologies can be applied to create future developments. This chapter describes a methodology that integrates quantitative and qualitative approaches. The applied methodology differs from a pure prognosis or forecast. Instead, it provides several possible future scenarios on how the macro surroundings for supply chains might look in a time horizon until 2030. This approach has the advantage that deduced policy decisions or company strategies consider possible changes in future conditions. This approach results in the selection of six validated scenarios that have a great impact on the design of future supply chains. From a managerial perspective, the results enable early preparations to be carried out for various potential development paths until 2030. Both countries and companies can benefit from this: since alternative plans are available on shorter notice, necessary measures to strengthen competitiveness can be initiated much earlier and in a more targeted manner.

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