Scenarios for the logistics services industry: A Delphi-based analysis for 2025 ☆

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ABSTRACT

The logistics services industry will be significantly affected by future developments throughout the world. Therefore, developing future scenarios is an important basis for long-term strategy development. Nevertheless, research exposes that there is a lack of awareness among logistics researchers and practitioners about future scenarios. In this paper, we apply scenario planning and present the findings of an extensive Delphi-based scenario study on the future of the logistics services industry in the year 2025. The major contribution of our research is the development of probable and unforeseen scenarios of the future which may provide a valuable basis for strategy development in the logistics services industry.

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1. Introduction

The future of the logistics services industry will be faced with many obstacles as well as opportunities. The industry is currently experiencing strong growth rates, but is also confronted with major challenges in an increasingly complex and dynamic environment. Intensifying globalisation, stronger competition, higher customer demands and resource scarcity are just a few of the factors that lead to a more turbulent and uncertain environment. Given the potential negative impact of these factors, an analysis of future requirements is required to foster innovations in logistics in order to maintain competitiveness and the ability to adapt to changes (Halldórsson and Kovács, 2010, p. 5; Flint et al., 2005, pp. 113–114; Soosay and Hyland, 2004, p. 41; Darkow et al., 2006). Scenario planning has been identified as one of the most appropriate approaches for long-range planning and to support decisions in uncertain situations (Courtney et al., 1997, p. 78; Schoemaker, 2002, pp. 47, 48; Phelps et al., 2001, p. 223-224; Powell, 1992, p. 551). The positive impact of its adoption has been proven empirically. In a broader sense, 30 or more studies have examined a positive relationship between long-range planning and corporate performance over the past four decades (see e.g. Ansoff et al., 1970; Miller and Cardinal, 1994; Rhyne, 1986).

Recently, an increasing number of authors have also high-lighted the high value of scenario planning for logistics, primarily due to the rapid changes in the competitive environment and the fast-paced growth of the logistics industry (see e.g. Piecyk and McKinnon, 2009; Boasson, 2004, p. 47; Spekman and Davis, 2004, p. 428; Waters, 2007a, p. 142; Burbank and Ways, 2004; Shapiro, 2004). Nevertheless, an extensive literature review, as well as empirical research, demonstrates that scenario planning has not been widely used in logistics as yet, both in logistics research and industry practice (Darkow and von der Gracht, 2006).

In this paper, we develop scenarios that describe potential long-term developments of the logistics environment and thereby support logistics executives in developing long-term strategies. These scenarios can support and guide managers in defining strategies contingent to potential future developments or in testing the robustness and appropriateness of strategies that are already in place. The first step in scenario planning is to systematically develop consistent and plausible scenarios. We present the results of an extensive expert-based scenario study on the future of the logistics services industry in 2025. Two specific research questions directed the design and execution of our study:

(1) How will the macro-environment (political/legal, economic, socio-cultural, and technological structure) of the logistics services industry change by 2025?
(2) How will the micro-environment (industrial structure) of the logistics services industry change by 2025?

Scenario development was based on a two-round Delphi survey with 30 CEOs and strategy experts of the top 50 logistics service providers in Germany. In order to do so, projections were structured according to PEST-analysis (political, economical,

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socio-cultural, and technological conditions related to research question 1) (see Wilson and Gilligan, 2005, p. 123) and Michael E. Porter's "Five Forces Model" (Porter, 1979) (related to research question 2). These projections include aspects such as the global energy consumption, resource scarcity, labour shortage, the role of emerging and developing countries, urbanisation, demographic change, social responsibility, global warming, digitisation, global networks, and large-scale outsourcing. The experts which participated in the Delphi study assessed each of these projections in terms of the probability of occurrence, the potential impact on the industry and their desirability. Based on these assessments and numerous verbal specifications and comments from the participants, different scenarios were developed. *Probable* scenarios for the future of the logistics services industry in 2025 were developed based on 12 projections with high probabilities of occurrence and consensus among experts; these included, for example, projections about the diminishing economic gap between emerging markets and developing countries and the still unresolved energy supply problem to foster globalisation. Furthermore, we examined *surprising or unexpected* scenarios, so-called discontinuities, with a low probability of occurrence but with a high impact on the industry; these include, "fabbing", terrorist attacks, and the spread of pandemics.

The remainder of our paper is organised as follows: we begin with a review of the literature relevant to our research, followed by a description of the research methodology. Subsequently, we present our findings with respect to probable scenarios and unforeseen events. Finally, we conclude by delineating various implications and further research avenues.

2. Literature review

The application of scenario planning to the business environment is a relatively new phenomenon (Bradfield et al., 2005, p. 810). Scenarios are typically defined as internally consistent, plausible, and challenging narrative descriptions of possible situations in the future, based on a complex network of influencing factors (Gausemeier et al., 1998, p. 114; van der Heijden, 2005, p. 114).

Scenario planning consists of two main parts: first, scenarios are developed through a systematic process of picturing and rehearsing future situations; second, strategic planning is based on the outcome of scenario development (Bishop et al., 2007, p. 6; Lindgren and Bandhold, 2003, p. 27). The major contributions of scenario planning include thinking in alternatives, enhancing a planners' perception, and offering a structure for dealing with uncertainty (van der Heijden et al., 2004, pp. 142–144).

Varum and Melo (2010) have recently presented results of an extensive bibliometric study on scenario planning publications in scientific journals. Furthermore, an analysis of the various scenario foci revealed that a large portion (36%) concentrated on individual companies, followed by territories (approximately 9%) and specific industries (approximately 7%). However, the most striking result of Varum and Melo's (2010) research was that 70% of all scenario articles were published after the year 2000, which confirms a substantial increase in academic research in this field recently.

Based on existing literature, we can identify different schools of thought in scenario planning: important representatives of these different schools are the Global Business Network (see Schwartz, 1998), the Stanford Research Institute (see e.g. Ralston and Wilson, 2006), and the Wharton Business School (see Schoemaker, 1991; Schoemaker and Mavaddat, 2002). More

specifically, the schools have either an intuitive-creative approach or a mathematical–logical approach to develop a scenario.

Provides an overview of the most relevant literature on scenario planning that is specifically related to logistics. In this table, we only list articles with a minimum time horizon of 5 years and an empirical approach (e.g. through expert interviews or surveys) to data gathering. The different research contributions are classified by type, focus, planning horizon in years, methodology, and content.

The overview of relevant articles for logistics reflects the general trend in publication patterns, as revealed by Varum and Melo (2010). The number of publications has steadily increased for years. In terms of the planning horizon, we can observe a concentration of papers that considers either a range of 8–10 years or a planning horizon of more than 20 years. This development reflects the need for a more profound and systematic approach to manage long-term planning in the volatile and uncertain environment of the logistics services industry. The trend towards globalisation has steadily increased with the effect that supply chains have become longer and more complex (Ballou, 2004, p. 15).

Recent research identified three major trends relevant for the logistics industry: outsourcing of logistics services; more severe competition; and differentiation or competitive advantages achieved through the added value offered to the customer (Grant et al., 2006; Waters, 2007b). Grant et al. and Waters expect that companies will go on to focus on their core competences. As in the course of cost reduction and flexibility improvement, the vertical integration will further be reduced. On the other hand, the regional scope of production is still expanding. Therefore, information and goods flows have to be synchronised on a global level, leading to high complexity in the system. Managing these systems efficiently is one of the major challenges for the logistics services industry and reflects the need for long-term planning and scenario planning.

In general, scenario publications often have a quantitative focus, building on oil price development, GDP (gross domestic product) growth or transport volumes (see e.g. European Community, 2004; Stead and Banister, 2003; Sviden, 1988). Many scenarios actually include forecasts through trend extrapolations of historical data. A few publications exhibit a qualitative focus, i.e. scenarios based on a narrative description of the future (see e.g. Institute for Mobility Research (ifmo), 2002, 2005). This may be due to the fact that most of the scenario studies were intended to serve as a basis for decision makers in public policy. Especially in logistics, scenario planning often focuses on macro-environmental aspects, such as infrastructure, roadwork, transportation markets, and policies (see e.g. Piecyk and McKinnon, 2009; European Community, 2004; Stead and Banister, 2003). In the PROTRANS project, funded by the European Commission, scenarios were developed with a focus on intermodality in the European logistics services industry. Two models for the focused field of intermodal transportation were developed, which were considered in a best, average and worst case simulation (Protrans, 2003). Hardly any studies exist which consider industry scenarios to support decision making in companies (see e.g. Bergman et al., 2006). Furthermore, many studies follow a classical, functional understanding of logistics, i.e. transportation, handling, warehousing (see e.g. Duin et al., 2005; English and Keran, 1976; European Community, 2004), and scenario research so far has not focused on the logistics services industry taking a holistic, supply chain perspective into consideration.

Our research is a first step in closing this research gap. We develop future scenarios that logistics service providers can use as a basis and starting point for strategy development. We integrate

Table 1
Most relevant results of literature review on scenario planning in logistics. Description: 18 identified literature sources that link scenarios and logistics.

Author(s) (year)	Type	Focus[a]	Horizon in years	Research details
English and Keran (1976)	Journal article	A	25	Forecast of passenger/cargo traffic and technology Delphi-based scenarios (23 experts on air traffic and technology)
Gray and Helmer (1976)	Journal article	A	30	The use of futures analysis for transportation research planning (focus on transport, but also broad range of societal issues) Delphi-based scenarios (46 experts evaluated 263 developments in 17 influence areas)
Robeson (1988)	Journal article	A	8	The future of business logistics, prioritised list of expected trends in distribution, ranked by importance and impact Comparison of two Delphi-based scenario studies of the Council of Logistics Management (1983/1987), 76 logistics managers surveyed in 1987 study
Sviden (1988)	Journal article	A	50	Future information systems for road traffic Delphi-based scenarios (120 professionals, researchers, and informed generalists; 31 participants in second Delphi round), mainly qualitative research (experts' visions)
Cooper (1994)	Report	A	8	Logistics futures in Europe Delphi-based scenarios (200 logistics experts from six countries)
Lynch et al. (1994)	Journal article	A	30	Long-range forecast of logistics in Canada Development of 26 small Delphi-based scenarios (20 experts from logistics industry)
Perry (1996)	Journal article	A	10	Implications for design and management of logistics systems in the 1990s based on future economic and technological projections Two surveys among logistics managers (first sample of 6000; second sample of 120)
Gausemeier et al. (2001)	Journal article	A	10	Paper on an internal scenario study of Deutsche Bahn (2000); researches the future of the courier, express, and parcel markets and develops four market scenarios as well as four technology scenarios Scenario management (Heinz Nixdorf Institute), involved project team of 13 experts
Institute for Mobility Research (ifmo) (2002, 2005)	Report	A	20	The future of mobility Scenario approach of Geschka & Partner Consultancy, expert-based scenarios (over 80 experts involved)
Sodhi (2003)	Journal article	M	–	Proposes a concept for combining strategic supply chain planning and scenario planning
Stead and Banister (2003)	Journal article	M/A	15	Outline of a systematic and logical framework for the development of policy scenarios Three scenarios on sustainable mobility in the EU supported by a survey and interviews
Boasson (2004)	Thesis	M	–	Examination of methodological applicability of scenario planning to supply chain context
European Community (2004), see also Giorgi (2004)	Report	M/A	16	Foresight for transport; clarification of pathways through which external and/or policy variables impact on transport and mobility Delphi-based scenarios (94 experts from transportation and mobility)
Singh (2004)	Working paper	A	15	Review of the leading opinions on the future of supply chains Working paper of the SC2020 project (MIT-Zaragoza Logistics Program) Review and synthesis of 46 publications, and composition of a list of key drivers
Duin et al. (2005)	Book section	A	8	The future of RFID applications in logistics Takes expert views as basis, analyses and simulates the RFID integration into the supply chain until 2013 by software support (causal cross-impact analysis)
Bergman et al. (2006)	Journal article	M/A	10	Case study on scenario development in the Finnish electrical engineering and electricity distribution industry for the coming decade Two-day scenario session with 13 participating organisations/institutes
Garvin and Levesque (2006)	Case Study	M/A	20	Harvard Business School Case on scenario planning activities at United Parcel Service Two scenario sessions in 1997 and 2004 to define the Corporate Charter and mission statement, to identify the key themes and insights, and to create a discussion platform
Piecyk and McKinnon (2009)	Journal article	A	10	Carbon Footprint of Freight Transport in UK Delphi-based scenarios (100 logistics experts)

[a] Focus of publications: M (Methodology), A (Application), M/A (Mix).

the Delphi technique into scenario planning for expert-based scenario development. The Delphi rounds are based on evaluating potential developments until 2025 within the macro-environment and the logistics market structure, as suggested by our two research questions. The research objective is to develop qualitative-oriented industry scenarios while maintaining a holistic, supply chain perspective on the logistics services industry.

3. Research methodology

Scenario development focuses on the micro- and macro-environment of the industry. As indicated in the introduction, we used the PEST-analysis (see Wilson and Gilligan, 2005, p. 123) and Michael E. Porter's five forces model (Porter, 1979) to investigate the future of logistics services. The following two research questions were addressed: "How will the macro-environment (*p*olitical/legal, *e*conomic, *s*ocio-cultural, and *t*echnological structure—PEST) of the logistics services industry change by 2025?" and "How will the micro-environment (industrial structure) of the logistics services industry change by 2025?" We base our research on the multi-stage process proposed by Bood and Postma (1997, p. 634).

The development of Delphi-based scenarios is an approach that has been explicitly recommended by numerous authors because the Delphi process is easy to integrate into the scenario development process and Delphi delivers valuable, valid, and reliable data for scenario construction (see e.g. Kameokaa et al., 2004, pp. 584, 595; Loveridge, 1999, p. 10; Rikkonen, 2005). The Delphi method attempts to systematically develop expert opinion consensus about future developments and events which are formulated as projections, i.e. short and concise future theses. It is a judgmental forecasting procedure in the form of an anonymous, written, multi-stage survey process, where feedback of group opinion is provided after each round (Delbecq et al., 1986, p. 83; Linstone and Turoff, 1975, p. 3; Rowe and Wright, 2001, p. 126). The Delphi process we employed is based on the classical procedure from RAND Corporation, which is the most approved and accepted variant of the Delphi approaches (Dalkey, 1967, 1969; Chermack et al., 2001, p. 10). Fig. 1 illustrates the individual phases of our research and shows how the Delphi method was used for scenario development.

First, we developed a set of projections based on the macro- and micro-environments of the industry. Subsequently, we identified, evaluated, selected, and recruited logistics experts for participation in the Delphi survey. Third, the projections were evaluated by the experts, followed by an interim analysis to calculate the statistical group opinion and aggregate arguments. Fifth, experts were asked to revise first round answers based on the feedback of the interim results. Sixth, we used the Delphi data for scenario development.

We decided to conduct two Delphi rounds, thus including one feedback and possible revision of first round answers. This approach guaranteed that research fatigue was kept as low as possible, which, in turn, assured a higher response rate and validity of the data (Mitchell, 1991, p. 347). In addition, numerous researchers have revealed that the major opinion of the study changes over time and, therefore, the most reliable study value occurs after the first iteration (see e.g. Rowe et al., 1991, p. 237;

Woudenberg, 1991, p. 140). We recognised that this approach may not lead to consensus for all projections. Finally, the answers were analysed and used for scenario development. The latter included desk research, scenario writing, discontinuity analysis and an expert check for plausibility and consistency.

A planning horizon of nearly 20 years was chosen in order to fully distance ourselves from all planned and fixed decisions and to promote thinking "out-of-the-box". The scenarios focussed on the German logistics services market due to its central role in Europe: the largest market in Europe and the highest density of global players of the logistics services industry (Klaus and Kille, 2007). For the empirical part of the scenario study, we decided to concentrate on the largest organisations to guarantee a global perspective across all modes of transport. Overall, the participating experts come from 24 organisations, equalling 71% of the cumulative turnover of the top 50 logistics service providers in Germany.

Researchers agree that standardisation and pretesting may be considered the two most effective means to ensure reliability in Delphi research (Kastein et al., 1993, p. 322; Okoli and Pawlowski, 2004, p. 19). Standardisation was, in fact, implemented in all of our Delphi and scenario activities. Moreover, the definition of research scope and aim, the structuring of the scenario field, expert selection, development of projections, and interim analysis followed phase-based standard procedures. In addition, the entire survey process was strongly standardised since it was planned and executed in line with the Total/ Tailored Design Method (Dillman, 1978, 2006). In the following discussion, we provide a more detailed explanation of the research methodology.

3.1. Development of projections

The set of projections are listed to provide a better understanding of their nature and content before we explain how they were derived. The Delphi survey consisted of 38 projections on the future of the logistics services industry in 2025 (see Table 2). Since projections were added and modified during the interim analysis, the final list of projections includes 41 items.

Input for the development of our projections came from six sources (see Table 3). The exploitation of several sources for developing projections, as performed for our research basis, is recommended in literature (Gausemeier et al., 1996, p. 174).

(1) An internal workshop was organised with five academics from an SCM research centre in Germany. As a starting point, the workshop included a brainstorming session which resulted in 189 future events and development factors. These were grouped into 10 broad topics. (2) In addition, an external workshop was held at a German logistics conference in which 200 students, researchers and practitioners at the authors' university participated. Twenty
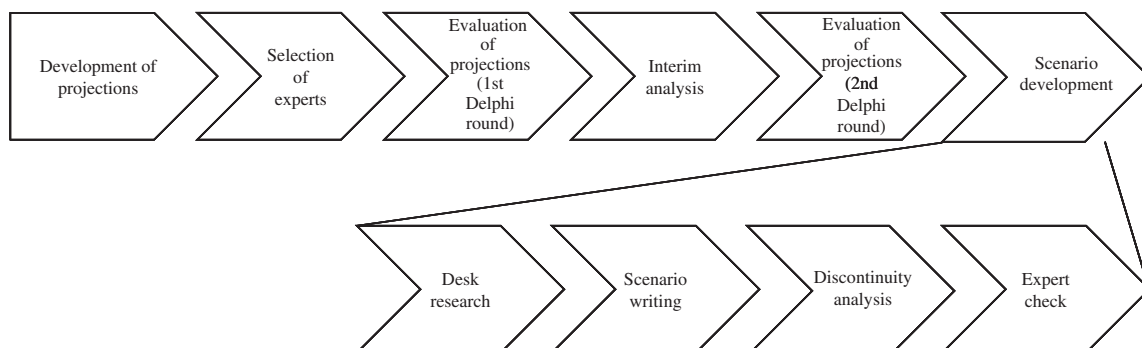

Fig. 1. Process of scenario development.

Table 2
Final list of projections in scenario study. Description: 41 projections that have been evaluated in the Delphi research according to their probability, impact, and desirability for 2025.

No.	Projections for 2025

Political–legal

1　The problem of energy supply (e.g. scarcity of fossil fuels, nuclear power) remains unsolved globally
2　The almost entire recycling of products and scrap within the value chain ("reverse logistics") has become a legal regulation
3　Source-based allocation of costs from the usage of natural resources (pollution, exhaustion of natural resources, etc.) has been accomplished to a large extent
4　International barriers of trade are significantly lower than compared to the year 2007
5　Intensified climate protection regulations have increased the attractiveness of rail and sea transportation
6　The absolute national investments in traffic infrastructure have significantly decreased in real terms
7　Increasing international harmonisation has led to global alignments of political and legal conditions

Economic

8　Global sourcing, production and distribution are common practice in almost all markets and value chains worldwide
9　The quality of a company's global networks and relationships has become the key determinant of competitiveness
10　Many developing and emerging countries have narrowed the gap to the industrial nations by economically catching up in the tertiary and quaternary industry sectors
11　The demand for local goods and services has significantly increased, primarily due to resource scarcity, environmental pollution, and the assimilation of living standards between developing/emerging countries and the industrial nations
12　Global standards and norms have been established that assure cost optimised planning, control and execution of international transports and their respective information flows
13　The cost factor "labour" has been displaced by the factor "access to resources" leading to relocations of production to resource sites

Socio-cultural

14　Customer demands for convenience, simplicity, promptness, and flexibility have turned logistics into a decisive success factor for customer retention
15　The supply and disposal among densely populated areas on the one hand and depopulated, rural regions on the other hand have led to location-dependent price structures for logistical services
16　Security costs and protection costs against industrial espionage, crime, and terrorism have disproportionately increased in the logistics industry
17　The social responsibility has lost its national basis. Logistics service providers increasingly make location and personnel decisions based upon global ethical standards and independently from national, cultural, and ethnical interests
18　Labour shortages for young, highly-qualified, mobile personnel have led to restraints in company growth
19　The increasing knowledge expansion and the focus on knowledge generation, processing, and dissemination have led to a substantial ongoing relocation of production activities outside of Germany (international division of labour)

Technological

20　Paperless transport has become common practice in national and international transport business
21　Due to the integration of physical and electronic document flows, almost all documents reach their receiver the same day
22　Innovations in transport logistics (e.g. new types of vehicles, alternative propulsion, innovative materials) have substantially contributed to the reduction of resource consumption
23　New technologies in logistics obtain faster acceptance as compared to 2007
24　Required information and communication technology demands large capital investments, which can hardly be raised by small and medium-sized logistics service providers alone
25　Biometric identification has become standard identification technology in logistics and enables fast and secure access controls
26　Intelligent, automated planning and control systems (agent systems, autonomous cooperation) are widely used in logistics
27　Innovations in transport logistics (e.g. new types of vehicles, alternative propulsion, innovative materials) have substantially contributed to a recovery of the current traffic infrastructure
28　The area-wide utilisation of e-business has led to direct sales contacts between end customers and producers, which resulted in the displacement of wholesale and retail
29　The decentralised production of many goods on-site in small-scale factories (fabbing, 3D printer, digitised products) has led to substantial structural changes in the logistics industry

Industrial structure

30　The demand for high-value, customised logistics services has increased disproportionately
31　Small and medium-sized specialised logistics service providers have merged into global networks in order to stay competitive
32　Customers increasingly demand consultancy services from logistics service providers in order to cope with the increasing complexity and dynamism in their markets
33　The market for digitised document logistics has largely displaced the market for physical document logistics
34　Alternative distribution networks have been established in the
　　CEP-market (courier, express, parcel). Petrol stations, kiosks, and local public transport are increasingly used for pickup and delivery of parcels
35　The consolidation phase among large logistics service providers has reached saturation so that the global mass market is divided among five to nine providers
36　The volumes of classical logistics services (transport, handling, storage) have significantly increased
37　Large logistics service providers (more than 250 employees, more than €50 million turnover) take longer planning horizons for their vision and strategy development into consideration and therefore increasingly use corresponding futures methodologies (e.g. scenario technique, early warning systems)
38　Customers increasingly take ecological aspects into consideration for their establishment of international logistics networks and the selection of logistics service providers
39　The logistics industry is more strongly affected by large-scale outsourcing deals than in 2007
40　Customers expect document logistics to be an integral element of the service portfolio of a logistics service provider
41　Service providers from adjacent industries (e.g. facility management, IT-services, security services) increasingly enter the market for logistics services so that the classical borders between industry, retail and wholesale, and logistics services are blurred

experts were selected from the workshop applicants based upon their logistics knowledge and motivation to contribute to the development of the logistics industry. These participants discussed potential developments in the logistics industry until 2025 in brainstorming and mapping sessions in groups of four persons. Seventy relevant factors were identified. (3) Moreover, in

Table 3
Content generation for development of projections.

No.	Content generation phase	No. of identified factors
1	Internal expert workshop	189
2	External expert workshop	70
3	Survey among top futurists	89
4	Interviews with scenario experts	134
5	Desk research of existing scenario studies	134
6	Database with future factors	59

an E-mail survey among 22 international top futurists, we asked for five keywords that come to mind when thinking about the future of logistics. Purposive sampling was performed, based on databases of members of the World Future Society and Association of Professional Futurists, to find the sample of 54 futurists. The selection criteria were: technical specialisation in logistics-related fields of global issues; methodological specialisation in scenario planning; quantity and quality of publications; academic title; education; profession; and position in science or practice. These futurists identified 89 influencing factors in order to prepare the projections on the future of logistics. (4) In a similar fashion, 20 experts from specialist trend and futures consultancies were interviewed. Based on market research, organisations were identified, which offer scenario consultancy services in Germany. The sample of 24 organisations was used as a census. The experts within the organisations were selected based on the following criteria: long scenario planning experience and specialisation within the logistics field, if available in the organisation. In total, 134 factors were identified and analysed. (5) Secondary data was reviewed through desk research, of which 134 influencing factors could be determined. (6) Finally, the database of a futures consultancy provided 59 factors.

Pretesting to ensure reliability as well as content and face validity were performed at two stages in the Delphi process. First, after their initial formulation, the 38 projections were assessed by five experts, which checked for completeness and plausibility of the content as well as methodological soundness. Second, after completion of the questionnaire design, another pretest was conducted among six experts from industry and academia.

Similar to hypothesis development in survey-based research, the formulation of projections directly impacts the quality of the entire study (Mićić, 2007, pp. 203–205). To ensure methodological rigour we employed the following measures: first, the projections were checked for ambiguity and precise wording was used to guarantee specificity in formulation without including too many elements (Salancik et al., 1971, p. 67). Second, we ensured the avoidance of conditional statements by making the primary question dependent on the fulfilment of a series of conditions or by urging experts to evaluate the two parts of the projection in the same manner, even if they had a different opinion on each statement. If a projection was formulated with conditions, it was split into two projections. Third, a monitoring team, consisting of two researchers, separately checked and validated the contents of the analyses (Turoff, 1975, p. 93). Fourth, the questionnaire was structured into clusters of topics to make it easy to follow, according to the terms in the PEST-analysis, in addition to the structure of the logistics services industry (Häder, 2002, p. 121).

3.2. Selection of experts

We decided to include 20–30 participants, a recommended panel size for Delphi surveys among a homogeneous group of experts that includes both quantitative and qualitative data collection (see e.g. Parentè and Anderson-Parentè, 1987,

pp. 149–150; Skulmoski et al., 2007, p. 10). The improper selection of experts is considered the most severe validity threat in Delphi research (Creswell, 2003, p. 171; Hill and Fowles, 1975, pp. 179, 187). In our study, we therefore followed a three-stage procedure including the identification of potential experts, the evaluation of identified experts, and expert recruitment. Our initial pool of potential experts comprised 72 members of the board and heads of strategy departments of the 50 largest logistics service providers in Germany. Each one of the selected companies generated a turnover of more than €200 million in 2005 and most of these companies also belonged to Europe's top 100 logistics service providers.

For each of the expert candidates, we determined a score to reflect their individual expertise. The scores were based on a set of criteria including the management level, academic background, job specialisation, education, functions inside and outside of the organisation, publications, and age (Delbecq et al., 1986, pp. 87–88; Lipinski and Loveridge, 1982, p. 214; Mehr and Neumann, 1970, p. 245). In each company, the expert with the highest score was invited to participate in the study. If the expert was not willing to participate, the expert with the next highest scores was invited, and so forth. In total, 30 experts (41.7%) from 24 of the top 50 logistics service providers agreed to take part in the Delphi survey.

Of the 30 participants, 11 (36.7%) were members of the management board, whereas 12 of the experts (40.0%) were head of the strategy or corporate development department of their company. In 7 cases (23.3%), the initial target person delegated the questionnaire to other persons within the organisation who were considered to be more suitable. These experts predominantly came from marketing and innovation departments. All experts had at least 5 years of experience within the logistics services industry; on average the experts had 17.5 years of industry experience (see Fig. 2).

All experts took part in both Delphi rounds, leading to a drop-out rate of 0%. The fact that all of the experts participated in the second round indicates a high level of satisfaction in terms of survey content and questionnaire design. It is reasonable to assume that a high level of satisfaction increases commitment and involvement, which inevitably results in high survey data quality.

3.3. Evaluation of projections and interim analysis

During the Delphi rounds, the experts assessed each projection in terms of its expectational probability, impact on the industry and desirability for the year 2025. The expectational probabilities were measured in percentages, industry impact on a 5-point Likert scale, and desirability on a nominal scale with values "desirable" or "not desirable". The experts were asked to provide a written justification for each probability estimate. Since it was unlikely that the experts would modify their assessment of impact and desirability, they were only asked to re-evaluate their initial assessment of the expectational probability in the second Delphi round.

After the first round, we performed an interim analysis based on descriptive statistics (mean, standard deviation and interquartile range—IQR[2]). We specifically checked for consensus, outliers and potential misunderstandings. The respective consensus criterion deducted from literature was an IQR of 2 or less (see e.g. Hahn and Rayens, 1999, p. 138; Raskin, 1994; De Vet et al., 2005; Scheibe et al., 1975, p. 277). Since the experts were asked to provide reasons for their probability estimates, the

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[2] The interquartile range (IQR) is the measure of dispersion for the median and consists of the middle 50% of the observations (Sekaran, 2003, p. 399). Thus, an IQR of less than 1 means that more than 50% of all opinions fall within 1 point on the scale (De Vet et al., 2005, p. 198).
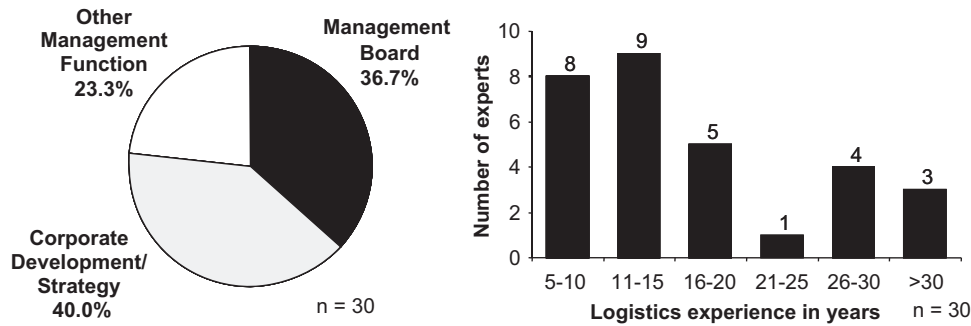
Fig. 2. Characterisation of the panel members (position within the company and industry experience).

amount of qualitative data was large. In total, 1039 usable arguments, mostly written in whole sentences, were collected in the first round. These arguments were aggregated with a summarising content analysis.

Based on the interim analysis, the second questionnaire was developed; it included only those projections in which consensus was not achieved in the first round. In addition to each projection, the feedback included the group response and aggregated arguments. In the subsequent second round, each expert had the chance to revise first round answers.

In the final analysis, only 41 of 4380 items were missing, resulting in an exceptionally low missing value rate of 0.9%. This low missing value rate indicates a high degree of involvement and commitment of the participating experts. Therefore, it is reasonable to assume that the validity of the data is high. Also, the low missing value rate, in combination with the fact that many comments were provided at the end of the questionnaire, is an indicator for a low level of fatigue.

3.4. Scenario development

Based on the evaluation of projections by the experts, we identified relevant scenarios of the future of the logistics services industry in 2025. These included probable, extreme and unforeseen scenarios. The qualitative description of the most probable scenario is based on the experts' comments during the Delphi rounds as well as desk research. This probable scenario will be presented in Section 4.

It has been criticised that many scenario studies exclude discontinuities or, in other words, "wildcards" (Cornish, 2003, p. 20; Grossmann, 2007, p. 892). Such events or developments can be characterised as having a low probability of occurrence, but a high impact on the decision field, e.g. the industry or the company. Their selective inclusion helps to identify further alternatives, to increase the ability to adapt to surprises, and to test the robustness of strategies and decisions (Mičić, 2007, pp. 232–233). Based on a further analysis of the experts' comments, eight wildcards were extracted, out of which three will be presented later. As recommended by van der Heijden (2004, p. 264), a final expert check of the scenarios was conducted to ensure compliance with quality criteria. In addition, further desk research was conducted to support the plausibility and consistency of the scenarios.

4. Research results

4.1. Results of Delphi survey

Table 4 summarises the relevant Delphi statistics. Particularly, the development of consensus in Delphi rounds 1 and 2 is

illustrated. An analysis of the expectational probabilities revealed a decrease in the standard deviations (SD) of all projections that had been evaluated in both rounds. In line with the fundamental rational of the Delphi method, the feedback of the statistical group response and the experts' comments led to a convergence among the expert panel's opinions, implying that the participants more strongly agreed on their estimations. The strongest convergence was measured for projection 20 (paperless transport). Its standard deviation decreased by 27.9%. Projection 26 (agent systems), in turn, recorded the weakest change at 4.5%. Consensus was measured after two Delphi rounds for 25 of the 41 projections (61.0%). In total, for 9 of the 25 projections (36.0%) consensus was already achieved in the first round.

Especially the analysis of the survey data along the two dimensions "expectational probability" and "impact" provides valuable insights. In Fig. 3, we illustrate the results for all of the 41 projections in the form of a scatterplot. Each number represents the corresponding projection listed in Table 1. A diamond represents a projection where consensus among the experts was achieved. A black dot represents those projections, where consensus among the experts was not achieved.

The distribution of projections in Fig. 3 provides interesting insights. It can be observed that most of the projections have an average impact of 3 or higher, as well as an average expectational probability of 50% or more. In general, this demonstrates the relevance of the projections developed in the first phase within the research project. The results indicate that the *a priori* formulation and selection of projections have accurately taken place.

Another interesting result can be observed with respect to the consensus/dissent distribution. The results clearly demonstrate that projections, where consensus was not achieved, have an average expectational probability of 40–60%, whereas consensus projections predominantly exhibit a probability of 60–80%. This finding is rather common in Delphi studies (see e.g. Ogden et al., 2005, pp. 34–35). By its nature, dissent is more likely to be associated with projections for which the future development is still difficult to assess. Clearly, for projections with high expectational probabilities (above 60%), the experts have a higher level of agreement. Further interpretation of the results will be provided in Section 4.2.

4.2. Scenario of the probable future

One of the major contributions of this research is the development of a scenario for the most probable future in the logistics services industry in 2025 which considers changes in the macro- and micro-environments. Fig. 3 illustrates an interpretive clustering result for the probable scenario of 2025. In total, 12 projections can be grouped that are characterised by high mean expectational probability and consensus among the expert panel, see Table 5.

Table 4
Delphi statistics: illustration of convergence among experts regarding expectational expected probability estimates.

Thesis no. and short title	Round 1 (n=30)			Round 2 (n=30)			Mean change	SD change	Impact	Desirability
	IQR	Mean	SD	IQR	Mean	SD				
Political–legal										
1. Energy supply	(2)	6.9	1.7						3.9	20.7
2. Reverse logistics	3	6.3	2.2	(2)	6.6	1.9	3.7	−12.2	3.9	76.7
3. Source-based allocation	4	5.3	2.4	3	5.6	2.0	5.7	−17.2	3.4	96.7
4. Barriers of trade	3	5.5	2.1	(2)	5.6	1.9	0.6	−12.4	3.7	80.0
5. Attractiveness of rail and sea	3	5.4	2.0	3	5.6	1.9	3.1	−6.1	3.6	76.7
6. Traffic infrastructure	4	5.0	2.1	4	5.0	1.9	0.0	−8.3	3.8	30.0
7. International harmonisation	5	4.1	2.4	3	3.9	2.0	−4.1	−13.5	2.7	80.0
Economical										
8. Global sourcing	(2)	7.7	1.2						4.4	90.0
9. Global networks	3	6.8	1.9	(1)	7.0	1.4	3.9	−23.7	3.8	72.4
10. Developing countries	(2)	6.7	1.6						3.3	80.0
11. Local goods	3	4.9	2.0	(2)	5.0	1.5	1.4	−24.7	3.5	63.3
12. Standards	4	5.0	2.5	3	4.6	2.0	−7.9	−20.4	3.5	65.5
13. Labour vs. resources[a, c]				3	4.6	1.8			4.0	100.0[c]
Socio-cultural										
14. Customer demands	(2)	7.8	1.4						4.1	89.7
15. Location-dependent prices	4	6.2	2.4	(2)	6.5	1.9	5.4	−17.5	3.3	51.7
16. Security costs	3	6.2	1.9	3	6.5	1.5	5.9	−19.2	3.8	25.0
17. Social responsibility	4	6.1	2.2	3	6.2	2.1	1.6	−6.4	3.2	50.0
18. Labour shortage	5	5.7	2.4	3	6.1	2.0	5.8	−17.9	3.6	16.7
19. Production relocation	4	5.0	2.1	3	5.4	1.8	8.7	−14.6	3.7	40.0
Technological										
20. Paperless transport	3	7.1	2.1	(2)	7.5	1.5	6.1	−27.9	3.5	86.7
21. Document flows	3	7.1	2.1	(2)	7.3	1.7	2.3	−19.3	3.3	86.7
22. Transport innovation—resources	5	5.7	2.3	3	6.4	1.8	12.2	−22.3	3.5	80.0
23. Technology acceptance	3	5.5	2.0	(2)	5.9	1.6	7.2	−19.3	3.4	89.7
24. ITC investments	5	5.8	2.3	3	5.7	2.0	−0.6	−14.0	3.6	31.0
25. Biometric identification	3	5.4	1.8	(2)	5.6	1.7	3.7	−6.7	2.2	72.4
26. Agent systems	3	5.4	1.7	(2)	5.5	1.7	2.5	−4.5	3.4	75.0
27. Transport innovation—traffic infrastructure	5	5.7	2.3	3	5.5	2.1	−4.7	−5.0	3.5	80.0
28. E-Business	3	4.90	2.0	3	4.87	1.8	−0.7	−7.0	3.4	34.5
29. Fabbing	(2)	4.2	1.8						3.0	50.0
Industrial structure										
30. Customised logistics	(1)	7.2	1.7						4.3	82.8
31. SME mergers	(2)	7.2	1.4						3.7	90.0
32. Consultancy	(1)	6.9	2.2						3.8	93.3
33. Digitised document logistics	3	6.5	2.1	(2)	6.8	1.6	3.6	−23.1	3.0	80.0
34. CEP-market	3	6.6	1.9	(2)	6.7	1.7	2.5	−11.2	3.2	83.3
35. Consolidation	(2)	6.6	2.0						3.9	37.9
36. Classical logistics services[b]	3	6.4	2.1	(2)	6.6	1.9	2.2	−9.2	3.9	71.4
37. Futures orientation	2	6.4	1.8	(2)	6.5	1.5	2.1	−17.8	3.6	79.3
38. Ecological aspects	3	6.1	2.0	(2)	6.2	1.7	1.1	−14.9	3.4	100.0
39. Outsourcing[c]				4	5.9	2.1			4.0	100.0[c]
40. Document logistics as integral element	4	5.5	2.1	(2)	5.8	1.8	6.1	−16.3	3.1	55.2
41. Adjacent industries	5	5.60	2.2	4	5.57	2.1	−0.6	−7.2	3.0	43.3

Note: Brackets mark theses, where final consensus was reached, i.e. an interquartile range of minimum 2.

[a] n=24.
[b] n=29.
[c] Thesis proposed by expert in round 1, solely assessed in round 2.

In three cases, the consensus was very strong, i.e. the interquartile range was 1. The projections 10 (developing countries) and 34 (CEP-market) have, with 67%, the lowest mean expectational probability of the 12 projections and, therefore, represent the left border of the cluster. Interestingly, the group includes at least one projection from each of the five groups (political–legal, economical, etc.), resulting in a diverse mix of scenario elements. Five of the projections are related to the industrial structure, capturing Porter's Five Forces.

Almost all projections were found desirable by the majority of experts. In 10 cases, 80% or more of the panel members assessed an occurrence as desirable. Projection 9 (global networks) achieved a desirability of 72.4%, which is still very high. Projection 1 (energy supply), however, is found desirable by only 20.7% of the experts.[3] The picture of the probable future is, to a large extent, also a picture of a desirable future.

We now proceed with the results of our scenario. The 12 projections were analysed based on the experts' comments collected during the Delphi rounds. For each of the 12 projections, the experts gave major arguments for low and high probability. Furthermore, the numbers of entries which experts provided for

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[3] If one takes into account that the projection has been inversely or negatively formulated, it may not be considered a "true" outlier.
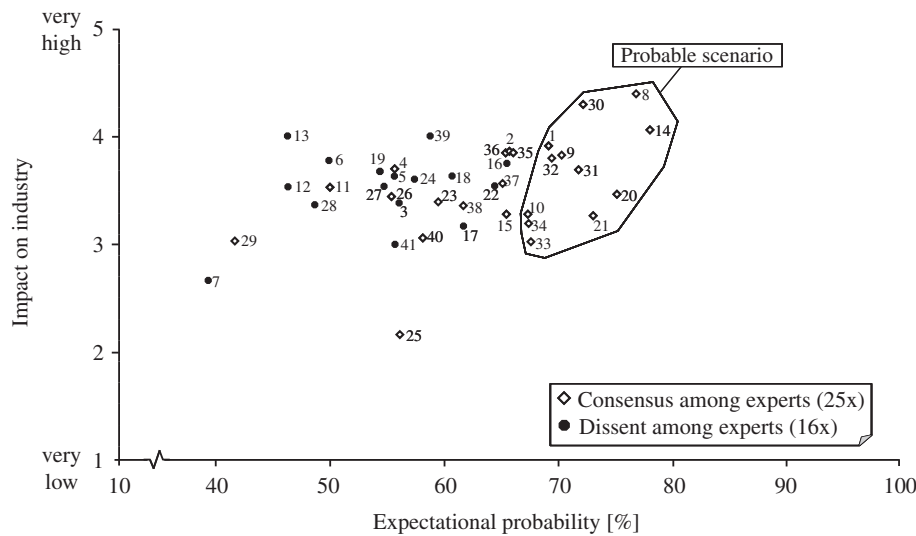
Fig. 3. Comparison of projections and elements of a probable scenario 2025.

Table 5
Probable scenario: 12 Projections with highest probability.

No.	Projection for 2025
1	The problem of energy supply (e.g. scarcity of fossil fuels, nuclear power) remains unsolved globally
8	Global sourcing, production and distribution are common practice in almost all markets and value chains worldwide
9	The quality of a company's global networks and relationships has become the key determinant of competitiveness
10	Many developing and emerging countries have narrowed the gap to the industrial nations by economically catching up in the tertiary and quaternary industry sectors
14	Customer demands for convenience, simplicity, promptness, and flexibility have turned logistics into a decisive success factor for customer retention
20	Paperless transport has become common practice in national and international transport business
21	Due to the integration of physical and electronic document flows, almost all documents reach their receiver the same day
30	The demand for high-value, customised logistics services has increased disproportionately
31	Small and medium-sized specialised logistics service providers have merged into global networks in order to stay competitive
32	Customers increasingly demand consultancy services from logistics service providers in order to cope with the increasing complexity and dynamism in their markets
33	The market for digitised document logistics has largely displaced the market for physical document logistics
34	Alternative distribution networks have been established in the CEP-market (courier, express, parcel). Petrol stations, kiosks, and local public transport are increasingly used for pickup and delivery of parcels

each argument is listed. Table 6 describes the scenarios including a conclusion per projection.

4.3. Discontinuities and the surprising future

The previous scenario development gives insights into the most probable future for the logistics services industry in 2025. As recommended by many researchers, the analysis of eventualities with low probabilities but a high impact on the industry, known as "wildcards", should be an essential aspect of scenario development (Cornish, 2003, p. 20; Grossmann, 2007, p. 892). We, therefore, decided to conduct a discontinuity analysis within the scope of this study. The Delphi data formed the overall fundament of which the general framework was developed.

A wildcard scenario looks at the consequences of one single surprising event or development. Such incidents could be the result of technological breakthroughs, social tension, or political overthrows, and have to be considered infinite in time. In his book, "Out of the Blue: How to Anticipate Big Future Surprises", the futurist John L. Petersen (2000) discusses 80 wildcards of the future, ranging from climatological and space-based threats to biomedical or geopolitical surprises. Our wildcard scenarios picture possible situations in the future for which logistics service providers might prepare contingency plans to better prepare themselves. Analysis of wildcard scenarios supports companies by

making them more aware of events and developments which are not very likely to occur, but could have fundamental impact on the logistics services industry.

Based on an analysis of our Delphi experts' comments, we selected eight wildcards for the logistics service industry 2025 for analysis. For example, the comments in the projection about the impact of terrorist attacks (projection 17) were used to elaborate on the wildcard "terrorist attacks on logistics networks". The projection was selected because there was no consensus within the expert panel but probability and impact were rather high. The wildcard "fabbing" (projection 29) was chosen because experts did agree in their evaluation, but allocated a low probability and a medium impact on the industry. The third wildcard "spread of a pandemic through logistics networks" was an outcome of the experts' arguments within several projections. The remaining five wildcards were identified in a similar way: return of protectionism; dictatorship of data protection (e.g. prohibition of exchange, storage, and internal use of any type of individual-related data); worldwide system failure (information and communication system breakdowns); the rise of revolutionary transportation technologies; fully automated, self-monitoring logistics. Desk research revealed additional information on the selected wildcards.

The full presentation of all of the eight wildcards is beyond the scope of this paper. However, we would like to briefly present the key content of three of the eight wildcards (see Table 7). The

Table 6
Scenarios incl. projections, main arguments, conclusion, number of expert entries.

No.	Projection for 2025 and PRO/CONTRA arguments	Number of entries by experts
1	**The problem of energy supply (e.g. scarcity of fossil fuels, nuclear power) remains unsolved globally**	
Low probability	The technological innovations until 2025 are not considered efficient enough to compensate the increase	5 entries
	Alternative sources of energy will be used more often in the future	4 entries
	The extraction of difficult-to-access fossil fuels will become easier and less expensive	2 entries
High probability	Due to energy sector lobbying, conflicts of interest in international negotiations are likely to hinder the development of a turnaround in the use of energy	10 entries
	The combination of progressing resource depletion and increasing demand for energy by developing and emerging countries will increase	5 entries
	New technologies and energy savings in industrialised nations will not be sufficient to compensate the increase in demand	5 entries
Conclusion	Increasing costs for fuel will give rise to high transport costs since the development of resource-saving energy will not be finished yet. Due to the increasing energy costs, operating expenses of logistics property, such as warehouses, will also rise. This will be noticeable in the field of temperature-controlled logistics in particular, due to the higher energy consumption. An emerging solution will be the installation of solar cells on the roofs of warehouses and distribution centres. Nevertheless, due to the energy problem, logistics services are likely to be more cost-intensive in 2025	
8	**Global sourcing, production and distribution are common practice in almost all markets and value chains worldwide**	
Low probability	Regional structures offer advantages in some markets	3 entries
High probability	In order to remain competitive, companies cannot ignore the growing advantages, which result from globalisation	11 entries
	The megatrend started years ago, will intensify over the next 20 years, and is irreversible	7 entries
Conclusion	For 2025, it is also considered highly probable that global sourcing, production, and distribution will have become common practice in almost all markets and value chains worldwide. The unsolved problem of energy supply is not expected to stop the globalisation movement	
9	**The quality of a company's global networks and relationships has become the key determinant of competitiveness**	
Low probability	Technologies and optimised information flows make networking easier and thereby is one of the less important competitive factors	4 entries
	Regional networks are established	3 entries
High probability	The creation of performance will become less important, rather relationships make the difference	8 entries
	Most industries will be organised according to divisions of labour	4 entries
	Know-how inter-linked with production advantages is the success model of the future. Networking is the main prerequisite in order to generate knowledge and use it profitably	3 entries
Conclusion	It is very likely that the quality of a company's global networks and relationships will be the key determinant of competitiveness in 2025. For this reason, small and medium-sized, specialised logistics service providers will have merged into global networks	
10	**Many developing and emerging countries have narrowed the gap to the industrial nations by economically catching up in the tertiary and quaternary industry sectors**	
Low probability	The catch-up process will be slower	9 entries
	Brain Drain will hinder the development of the quarternary sector	3 entries
High probability	High degree of economic growth	4 entries
	Higher levels of education and salaries	4 entries
	Process already underway, especially in the tertiary sector	3 entries
Conclusion	The ongoing globalisation will undoubtedly produce winners and losers in the coming 20 years. Winners will, to a large extent, come from the group of developing and emerging countries. A multitude of these countries is expected to narrow the gap to industrial nations by economically catching up in the tertiary and quarternary industry sectors. Strong economic growth, increases in the levels of education and wages, as well as IT offshoring activities are current indicators. The major drivers will be resource abundancy, e-business, and long-term Western knowledge transfer. This development, however, also means that the environment of globally-active logistics service providers is becoming more competitive	
14	**Customer demands for convenience, simplicity, promptness, and flexibility have turned logistics into a decisive success factor for customer retention**	
Low probability	Price remains a primary factor in decision criteria	3 entries
	Buying power and payment reserves could develop insufficiently	2 entries
High probability	Logistics offers opportunity for differentiation if products are similar	10 entries
	A significant trend is already apparent in all four areas	6 entries
	Convenience, simplicity, promptness, and flexibility will become more and more important	4 entries
Conclusion	For 2025, customers are expected to be more sophisticated, segmented, and demanding in terms of convenience, simplicity, promptness, and flexibility. It will be even more imperative for logistics service providers to engage in new service developments in order to adapt to the changing customer needs. Logistics will become a decisive success factor for customer retention	
20	**Paperless transport has become common practice in national and international transport business**	
Low probability	Legal and safety regulations will increase	3 entries
	Emotional hurdles have to be overcome	2 entries
High probability	Technical capability already exists	11 entries
	Standardisation of IT and interfaces will simplify integration	5 entries
Conclusion	Companies will strive for huge cost-saving potentials and process-related optimisations. It is expected that increasing internet security, higher data transmission capacities, as well as deregulation of legal requirements will further drive the substitution. Paperless transport is likely to become standard in national and international transport business	
21	**Due to the integration of physical and electronic document flows, almost all documents reach their receiver the same day**	
Low probability	Heterogenity in the transport industry and numerous interfaces make the implementation of an integrated system difficult	3 entries
	Legal and saftety requirements are necessary in sub-areas	1 entry
High probability	The technical capability exists	6 entries
	Paperlessness is already widespread in CEP services	5 entries
	High cost-saving potentials exist	3 entries

Table 6 (*continued*)

No.	Projection for 2025 and PRO/CONTRA arguments	Number of entries by experts
Conclusion	It is expected that, through efficient document logistics solutions, a seamless integration of physical and electronic document flows will have become standard. Against this background, it is likely that almost all documents will reach the receiver the same day. Such business models are already technically feasible today and ongoing standardisation in information and communication technology drives us towards such a future. Thus, logistics services will be provided faster in 2025	
30	**The demand for high-value, customised logistics services has increased disproportionately**	
Low probability	Higher costs will result from customised services	2 entries
High probability	There will be an increase in customer demands	14 entries
	Stronger networking will be required	4 entries
	The complexity will increase	1 entry
Conclusion	Logistics services are also likely to be more customised in 2025. Expected changes in customer demands towards more convenience, simplicity, promptness, and flexibility have already been noted before. In line with these changes, the demand for high-value, customised logistics services is considered to increase disproportionately in the future. This is primarily attributed to the increasing complexity and diversity of networked business processes. The relocation of production and outsourcing initiatives are considered the key drivers of the development. In particular, reductions in the value added increase the demands for effective and efficient logistics networks. In this context, logistics performance is increasingly seen as competitive factor	
31	**Small and medium-sized , specialised logistics service providers have merged into global networks in order to stay competitive**	
Low probability	Integration problems will occur	3 entries
	Special interests by individual providers	2 entries
High probability	It will be possible to illustrate global supply chains	9 entries
	The financial performance and cost-optimisation potentials will improve	5 entries
Conclusion	Small- and medium-sized, specialised logistics service providers will have merged into global networks. It will allow them to offer services beyond their regional niche portfolios and provides them with financial power. In addition, customers will increasingly ask for global presence and network capabilities. Cost optimisation is seen as an additional driver of the merger process. Thus, the logistics services industry will be more global and more networked in 2025	
32	**Customers increasingly demand consultancy services from logistics service providers in order to cope with the increasing complexity and dynamism in their markets**	
Low probability	Customer companies know their markets better than logistics service providers	4 entries
High probability	Increasing complexity increases the demand for consulting	6 entries
	Logistics service providers have branch-specific and geographical characteristics know-how at their fingertips	2 entries
	Logistics service providers have cross-industry knowledge	2 entries
Conclusion	Uncertainty in business will have steadily increased, leading to more severe risks than before. Due to the global cross-industry activities, logistics service providers are building up a comprehensive knowledge base that they can use for consultancy services. In 2025, it is likely that many of their customers will demand not only classical logistics services but also consultancy in order to cope with the increasing complexity and dynamism in their markets. This situation may primarily be attributed to three developments. First, the globalisation and the international division of labour will have reached new, higher levels. Second, the "care factor" will be more distinctive as a consequence of extensive outsourcing initiatives. Third, the likely occurrence of this projection is seen as a concomitant phenomenon of the increasing information overload. Thus, logistics service providers are expected to act in more complex and more dynamic environments	
33	**The market for digitised document logistics has largely displaced the market for physical document logistics**	
Low probability	There are application fields in which physical documents are superior	2 entries
	Sub-areas will continue to be protected by legal obstacles	1 entry
High probability	Cost and processing advantages will exist	4 entries
	Safety standards and data processing capacities will increase	2 entries
Conclusion	The logistics business will be more digitised in the future. Document logistics will play an even greater role in 2025 than today. Presumably, the market for digitised services will have displaced the market for physical document logistics to a large extent. Nevertheless, in some business segments, such as direct marketing and private communication, physical document logistics will still be preferred over digitised procedures. The major challenge of digitisation will be to keep up with the newest technological standards in order to satisfy customer demands and to guarantee the trouble-free integration in global networks	
34	**Alternative distribution networks have been established in the CEP-market (courier, express, parcel). Petrol stations, kiosks, and local public transport are increasingly used for pickup and delivery of parcels**	
Low probability	Established networks in Germany are very strong	4 entries
	Punctuality, reliability and endurance of alternative networks are not safeguarded	1 entry
High probability	There will be many opportunities for cost savings	7 entries
	The quality of service will improve	2 entries
Conclusion	Alternative distribution concepts for the last mile will additionally create more convenience for the customer by new, time-independent pickup and delivery processes	

following table provides a summary of their important elements and allows for easy comparison and analysis.

Fabbing (wildcard 1) could, for example, revolutionize production fundamentally. Currently, the Massachusetts Institute of Technology (MIT) and the Fraunhofer Alliance "Rapid Prototyping" are working intensely on this topic. Although from today's viewpoint it is unlikely that it would be prevalent by 2025, fabbing cannot be ruled out. Some historical events show that (not) considering wildcards can influence decision making for companies significantly: the advantages of PCs were underestimated for a long time. Ken Olsen, founder of the Digital Equipment Corporation, said in 1977 that there was no reason why someone would want to have a computer at home. As we

know today, by the year 1998, 21 years later, the U.S. Census Bureau counted 42.1% of U.S. households with a computer and 26.2% with Internet access.

Logistics service providers might also consider the possibility of terrorist attacks in planning (wildcard 2). Since "9/11" (September 11, 2001), the fear of such attacks on logistical networks has grown, particularly to the most important ship routes and seaports. The attack on the French ocean vessel "Limburg" along the coast of Yemen in October 2002 proved that these fears are realistic: a boat filled with explosives rammed a hole in the starboard of the ship and 90,000 of the 400,000 barrels of oil on board poured out into the sea. The economic costs of disruptions in sea transport can be dramatic. Logistics service providers might develop alternative

Table 7
Wildcard scenarios to describe eventualities and discontinuities.

Wildcard 1: Personal fabricators	• Direct fabrication of objects from computer models by using additive-fabrication-technologies, such as 3D printing and laser sintering • The personal fabricator would be an affordable device for the production (fabrication) of goods in one's own home • 3D printers are already available for $4995 (e.g. Desktop Factory, Inc.) • Decentralisation for less complex consumer goods; consumer becomes "pro-sumer", i.e. producer and consumer in one, and is strongly integrated in development and production process • Strong increase in bulk transport of fabbing raw materials • In some industries, manufacturers and retailers would become obsolete (cf. music industry)
Wildcard 2: Terrorist attacks on logistics networks	• Disturbance of networks have detrimental effects on the economy of a country • Sea trade is concentrated on a few straits where attacks would have dramatic effects • Strong dependency on maritime logistics infrastructure, e.g. 80% of the oil for Japan, South Korea, and China is transported through the Strait of Malakka • Terrorist attacks on oil tankers could block-off regions, e.g. a closure of the hub port Singapore alone can easily exceed US$200 billion per year from disruptions to inventory and production cycles (Ho, 2005, p. 8) • A one-week halt in the flow of cargo containers into America's two largest ports would cost national economy $65 million to $150 million a day (Congressional Budget Office, 2006, p. 2) • Global procurement, production, and distribution may concentrate on secure regions and avoid endangered locations and routes • High insurance premiums may eliminate certain trade routes • Shortfalls in supply could hinder the development of affected countries • Ultimately, efforts to liberalise international trade which have gone on for years could be thwarted
Wildcard 3: Spread of a pandemic through logistics networks	• Quick spread of a virus via international transport of people and animals possible • World Health Organisation estimates that in case of a spread of the avian influenza virus (type A/H5N1) 1.5 billion people would have to be treated and 40 million could die • Marsh and the Albright Group estimate that with a global epidemic 4.4 trillion dollars in losses could be expected; potential for workplace absences due to illnesses is at a rate of at least 35% • The World Bank recently calculated that the mere occurrence of the bird flu in several East Asian countries, which did not claim many lives, caused costs between 0.1% and 0.2% of the GDP • Nations and regional associations of countries would seal themselves off from potential regions of danger • Trade and tourism would be discontinued as with the outbreak of Severe Acute Respiratory Syndrome (SARS) in Asia in 2002/2003 • Comprehensive state control and quarantine provisions would become effective • Production and supply chains would be interrupted, particularly just-in-time production

transport routes and train their employees in order to respond to possible crises situations quickly.

Experts have been warning for years against wildcard scenario 3, i.e. the outbreak of a pandemic. Some companies have indeed specialised in such scenarios and developed emergency plans in order to sustain operation to some extent. A notable German online magazine cited several statements from large corporations (Becker, 2006). For example, some large financial institutes, such as HSBC, plan home office work on a large scale in case of emergency or rely on external providers. Deutsche Post World Net, in turn, reports of detailed emergency plans in agreement with health and regulatory agencies. Since SARS, several large industrial firms, e.g. BMW, have crisis plans in order to avoid production stops. However, various studies, such as Deloitte & Touche's annual Pandemic Preparedness Survey, prove that most companies are not prepared for pandemics and have not worked out corresponding emergency plans.

5. Conclusion and implications

In our research, we aimed at closing a research gap with respect to scenario development in the logistics services industry. More specifically, two research questions guided our research: (1) How will the macro-environment (political/legal, economic, socio-cultural, and technological structure) of the logistics services industry change by 2025? and (2) How will the micro-

environment (industrial structure) of the logistics services industry change by 2025?

By using empirical research, we examined possible events and developments, identified major factors, and aggregated expert knowledge for the long-term future. Our research makes four important contributions to the existing body of literature. First, we conducted a Delphi survey within the German logistics services industry in order to determine the probability, impact, and desirability of 41 projections on the future of this industry. In general, the Delphi survey led to a convergence among the expert panel's opinion, implying that the participants strongly agreed in their estimations. For 25 out of 41 projections, consensus was reached; for 9 projections consensus was already achieved in the first Delphi round. Most projections yielded an average impact on the logistics services industry of 3 or higher (5-point Likert scale) as well as an average expectational probability of 50% or more; consensus projections even 60–80%.

Second, we conducted a scenario development process to picture the most probable future of the logistics services industry 2025. Five dominant themes can be identified that are likely to influence the macro-environment and industry structure in the future: the general notion towards strong social responsibility and ecological awareness; the intensifying pace of globalisation and its imperative for global networks; the shortage of young, qualified, and mobile personnel; the changing customer demands towards more convenience, simplicity, promptness, and flexibility; and the digitisation of business. The highly probable picture of

the future is thus one of a more cost-intensive, complex, dynamic, competitive, digitised, global, networked, customised and faster logistics services business.

Third, we included analyses of discontinuities and surprising occurrences in our scenarios research to give further insights on possible changes in the macro-environment and industry structure for the logistics services industry. In fact, scenario planning might be of more relevance for logistics service providers in the future due to the turbulent business environment, which is highly susceptible to discontinuities. Our discontinuity analysis came up with new, inspiring, and surprising issues although it was limited in its scope. The wildcard scenarios on fabbing, terrorism attacks, and pandemics illustrated that such analyses help to sensitise companies for events and developments which are very improbable, but might have fundamental impact on the business if they do happen.

Fourth, we focused on the application of the Delphi method as a basis for scenario planning. Although recommended by several authors, rigour is seldom discussed in detail. This study has drawn attention to issues of validity and reliability and proposes rigorous methodology to develop scenarios based on a Delphi survey. The research was conducted in the form of a two-round expert-based scenario study among the top 50 logistics service providers, of which 24 participated.

Managerial contributions of our research primarily concern the generation of planning data and the exemplification of systematic and methodologically sound scenario development. The scenario data offers a starting point to customise specific long-term strategies for the company. For organisations already investing in environmental scanning, the Delphi data can provide a validation or expansion of their own scans. A scenario transfer, i.e. the usage of the scenarios for decision support, may be either active or passive. While the former concerns the update or development of new strategies, the latter refers to testing existing strategies regarding their robustness. The wildcards are particularly suitable for developing contingency plans for the future. Logistics planners may use our data as a basis for an extended wildcard analysis and the establishment or support of an early warning system.

There are limitations to this research which also reveal possible avenues for further research. The research, and especially scenario development, is mainly based on qualitative research, even though we provide statistical data to support our qualitative findings. Further quantitative data (e.g. with respect to cost implications and industry growth rates) may be included in the analyses to provide a more tangible basis for strategic planning. Furthermore, the Delphi study exclusively focused on the top 50 logistics service providers in Germany. Future research might also examine the implications for small- and medium-sized companies and can also be extended to include other regions of interest.

The Delphi panel was additionally limited to 30 experts, since it was the recommended size for a homogeneous group of experts and a questionnaire with qualitative information. However, future research might place more emphasis on a larger sample rather than on qualitative data, to identify scenarios that represent the perspective of the entire logistics industry, i.e. also manufacturing and retail.

The Delphi survey was limited to two rounds. As a consequence, several projections did not reach consensus. Nevertheless, there was convergence among all of them. Future research might continue with their evaluation and eventually find further consensus projections.

The Delphi survey aimed at collecting data for scenario development. It, therefore, excluded continuative analyses, such as of subgroups. Future research might engage in the comparison of views of different stakeholders. It would, for example, be of interest to see where the expectations of logistics service providers and their customers differ and why.

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