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Scenarios for the aviation industry: A Delphi-based analysis for 2025

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A B S T R A C T

A Delphi panel of aviation experts is used to anticipate probable and wildcard scenarios on the future of aviation in 2025. According to the experts' estimations, the passenger, business aviation, and air cargo segments will be faced with 27 probable high-impact developments. These include long-haul growth primarily linked to emerging countries, a number of substitution threats, liberalization and deregulation, increasing industry vulnerability, finiteness of fossil fuels, and emissions trading. The emergence of low-cost cargo carriers and air cargo substitution by sea transportation were identified as potential surprises. Several wildcard scenarios were identified such as natural catastrophes, era of virtual communication, and home-producing "fabbing" society.

1. Introduction

The future of the aviation industry is dynamic and poses many opportunities and threats. The passenger, business and air cargo industry segments are experiencing strong long-term growth rates, but are also confronted with short-term volatility and shocks as a result of an increasingly complex and dynamic environment. Further liberalization and deregulation, intensifying competition, changing customer demands and resource scarcity are just a few of the factors contributing to a more turbulent and uncertain future for aviation. Scenario planning is a way of addressing uncertainty to do long-term planning and support decisions.

Here scenarios are developed to examine potential long-term developments in the aviation industry with a view to supporting aviation managers in developing robust long-range future strategies and to challenge strategies that are already in place. To consider what is the most probable scenario for the future of aviation 40 projections are developed portraying potential developments in the social, technological, economic and political environment.

2. Prior work

While there are numerous studies dealing mainly with quantitative scenarios on the development of aviation fuels and emissions, and other individual aviation topics, there have only been a few scenario studies on the potential development of the aviation industry as a whole, based on the development of multiple external factors, have been identified (Mason, and Alamdari, 2007). Table 1 provides an overview of these studies. The different research contributions are classified by scenario type, focus, planning horizon, methodology and content.

Most of the studies we found were published after 2000; a finding in accordance with Varum and Melo (2009) who revealed that 70% of all scenario articles were published after year 2000, confirming a substantial increase in academic research in this field in recent years. The planning horizon of the studies varied from one year to 44 years. According to the recommendations and findings of Nowack et al. (2011), all studies but one used a qualitative explorative methodology in view of their long-term planning horizon. None of the studies attempted to identify both a probable aviation future scenario and surprising and disruptive wildcard scenarios as recommended by Cornish (2003) and Grossmann (2007). In addition, the studies mainly focused on the passenger business. Special developments in the air cargo and business aviation segments of the aviation industry have not been taken into account before.

3. Methodology

Many authors specifically recommend the development of Delphi-based scenarios for the explorative and long-term oriented derivation of future scenarios. This method is suitable for the derivation of probable and surprising wildcard scenarios (Nowack et al., 2011). In this context Delphi delivers valid and reliable data and the Delphi process itself can be easily integrated into the scenario composition process (Kameokaa et al., 2004). The Delphi method is a judgmental forecasting procedure in the form of an anonymous, written, multi-stage survey process (Rowe and Wright, 2001). The Delphi method aims at systematically fostering expert consensus about future developments, which are formulated as

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Table 1
Prior analysis.

Author(s) (year)	Type of scenarios	Focus	Planning horizon	Methodology	Research details
Franke and John (2011)	Explorative	External factors	2010/2011	Genius judgment	Development of three end game scenarios for the time after the 2008 recession
HHL (2010)	explorative	external factors	2015	Scenario matrix	Development of four scenarios for the European aviation industry
ICE (2010)	Explorative	External factors	2040	Scenario matrix	Development of four scenarios for the European aviation industry
Mason and Alamdari (2007)	Explorative	External & internal factors	2015	Delphi	Assessment of eight predefined passage scenarios
CONSAVE (2006)	Explorative	External factors	2050	Modeling, simulation	Development of four global aviation background scenarios
Advisory Council for Aeronautics Research in Europe (2004)	Explorative	External factors	2020	Genius judgment, workshops	Development of three global aviation scenarios
Jarach (2004)	Explorative	External Factors	2004	Genius judgment	Scenario of the European Airline Industry

short and concise future projections. The Delphi process employed here is based on the classical procedure from the RAND Corporation, (Dalkey, 1969) and follows the multi-stage process proposed by Bood and Postma (1997): First, 40d projections were developed; as a next step, aviation experts were identified, evaluated, selected, and recruited for participation in the Delphi survey; third, the projections were evaluated online by the experts, followed by an automated interim analysis of the statistical group opinion and aggregated arguments; fifth, the experts were asked to revise their first round estimations based on the feedback of the interim results in real-time. Up to five Delphi and revision rounds were possible. Research fatigue was kept as low as possible, which, in turn, assured a higher response rate and greater validity of the data (Mitchell, 1991). After the closure of the online Delphi survey, scenarios were developed based on the Delphi data provided, desk research and scenario writing. In addition, a discontinuity analysis and an expert check for plausibility and consistency were carried out. The derivation of scenarios was mainly based on a hierarchical cluster analysis.

Standardization and pretesting are considered to be the most effective means to ensure reliability in Delphi research (Okoli and Pawlowski, 2004). Therefore standardization was implemented in all Delphi and scenario processes: The definition of the research aim and scope; the structuring of the scenario field; the selection of experts; the development of projections; and the interim analysis all followed phase-based standard procedures. In addition, the entire online survey process was standardized since it was planned and executed in line with the total/tailored design method. To assure a high quality of work in terms of creativity, credibility and objectivity several measures were undertaken. The anonymity of the experts was guaranteed in order to eliminate a potential bandwagon effect. Additionally, the experts' comments were communicated to all experts in each Delphi round as recommended by Nowack et al. (2011). Objectivity was assured by carefully selecting industry experts with an overall average industry expertise of 22.7 years and following the neutral STEP framework for the projection development as suggested by Nowack et al. (2011). Credibility of the scenario process was guaranteed in line with Nowack at al. by integrating the Delphi process into the scenario process, by incorporating discontinuities and surprising wildcard scenarios. A standardized and documented process was applied to assure that the study is replicable. As recommended by van der Heijden (2005), an additional final expert check of the probable and wildcard scenarios was conducted to ensure plausibility and consistency of the scenarios and compliance with quality criteria. Additionally, further desk research was conducted to support the plausibility and consistency of the scenarios.

3.1. Development of projections

The Delphi survey consisted of 40 projections on the future of the aviation industry in 2025. These projections were developed according to the neutral STEP framework in order to include social, technological, economic and political developments and to avoid biases in the questionnaire design as suggested by Nowack et al. (2011). The exploitation of several sources for developing future projections is recommended in Gausemeier et al. (1996). The projections used in this study were therefore based on three sources (Table 2).

First, an internal workshop was organized with two academics from an aviation research center in Germany. The workshop started with a brainstorming session which produced 66 future events and development factors. These were grouped into seven broad topics (Table 3).

Second, three external experts were selected based on their aviation knowledge, years of industry experience and willingness to contribute to the development of the future projections. These participants discussed potential developments in the aviation industry up to 2025 in brainstorming and mapping sessions. Seventy relevant projections were identified.

Third, secondary data mainly consisting of industry studies was reviewed in desk research. This highlighted 80 influencing factors. Similar to hypothesis development in survey-based research, the formulation of projections directly impacts the quality of the entire study (Mićić, 2007). In order to ensure their reliability, as well as content and face validity, the projections were pretested at two stages in the Delphi process. After their initial formulation, the projections were assessed by two internal experts who checked for completeness and plausibility of the content as well as methodological soundness. To ensure methodological rigor, 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). In addition, conditional statements were avoided by making the primary question dependent on the fulfillment 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

Table 2
Sources of potential future projections.

	Projection generation phase	No. of identified factors
1	Internal expert workshop	66
2	External expert workshop	70
3	Desk research of existing industry studies	80