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Door-to-door travel in 2035 – A Delphi study

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ABSTRACT

Intermodal, door-to-door (D2D) travel is gaining momentum for airlines, airports, and feeder traffic providers. At the same time, competition is increasing; having a better understanding of future travelers' requirements regarding D2D mobility is crucial for the mobility sector, for planning long-term, adapting products and services accordingly, and improving the overall passenger experience. Little information is available on this matter and gathering data in the future may be challenging. This paper considers future projections of European air passengers, and their requirements, for the entirety of the D2D travel chain, including long-haul air travel and airport access and egress modes. The research is based on a two-round Delphi survey (time horizon 2035) with 38 experts, incorporating panelists from the transport industry, academia, and consultants. The Delphi survey is supplemented with findings from a preliminary study, combining expert interviews ($N = 18$), a literature review, and an expert workshop. Based on the results from a hierarchical cluster analysis, the paper presents three possible future scenarios: (1) personalized D2D travel, (2) integrated D2D travel, and (3) the game changer.

1. Introduction

1.1. Relevance of door-to-door air travel

The airline industry is paying increasing attention to passengers' entire door-to-door (D2D) travel experience rather than considering the flight segment only (Airliners.de, 2018; Tritus, 2018). Intermodal travel products for air passengers, such as Rail&Fly by Lufthansa and Deutsche Bahn (Lufthansa, 2019) or the partnership between the application MyTaxi and Eurowings (Eurowings, 2018), have already entered the market. In today's liberalized market, passengers can choose between numerous booking opportunities, airlines, airports, and ancillary products. Digitalization throughout the travel chain creates new opportunities, not only for transport companies but also for digital platforms that serve passengers. Platforms offering convenient, seamless booking experiences, e.g. Google, Airbnb, Uber, and Kayak (Javornik et al., 2018), increase competition. New infrastructure projects and emerging mobility concepts, providing feeder traffic options, such as ride-railing, can alter passengers' mobility patterns (Young & Farber, 2019). Journey times to airports can influence passengers' choices, particularly regarding which airport to pick (Parrella, 2013). Supplementary trends, like the current environmental debate and flight shaming, might also alter customers' D2D air travel. At the same time, airlines increasingly offer products tailored to differentiated customer needs, for instance a premium-economy cabin class on long-haul routes[1] (Kuo & Jou, 2017).

To stay competitive and develop innovative, intermodal products, airlines and other travel companies should understand what travelers might want from integrated D2D mobility in the future, in addition to what successful D2D mobility offers could look like within this new paradigm. Enhanced knowledge may improve today's overall passenger satisfaction by reducing current travel *pain points*. Meeting or even exceeding passenger expectations creates customer satisfaction, which in turn leads to loyalty and positive word-of-mouth recommendations. These are important today, with user-generated online reviews that are accessible to everyone (Sezgen, Mason, & Mayer, 2019). Prospective customer desires can then be translated into passenger needs, cross-selling opportunities, and ultimately, new products or services (possibly realized through partnerships). However, despite its increasing importance, little research has been conducted to explore the future D2D travel market. Hence, the following research question emerges: *What could future D2D air travel look like?* This paper examines the relevant projections affecting future D2D air travel in Europe. It is here explored how the demand (passenger view) and supply side (transport market) of D2D air travel could develop and which scenarios could possibly occur.

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[1] Passengers are willing to pay additional US$545 to enjoy this upgrade from the economy class on long-haul round-trips (Kuo & Jou, 2017).

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1.2. Delphi based scenario study

There is high uncertainty around future developments. Only small amounts of information are available, and data collection is challenging, as consumers do not seem to be able to foresee what they desire for the future (Murugesan, 2011). As the scope of this paper is on a future-oriented research question, the Delphi technique, among other research methods such as trend impact analysis, cross-impact analysis, qualitative trend analysis, or scenario methods, is selected as the most appropriate research method to explore the research question, by surveying experts instead of potential future customers (Döring & Bortz, 2016). The Delphi technique, which was first used in the 1950s, applied by the company RAND, is a multi-stage, anonymous, and written survey technique using experts to evaluate possible projections of what the future might look like (Linstone & Turoff, 1975, 2011). The method has mostly been applied in health care, education, and business studies (Flostrand, Pitt, & Bridson, 2020). Advantages of using the Delphi technique are manifold. Receiving valuations from across Western Europe, the method supports the process of bringing geographically dispersed experts together via one survey, and of letting them communicate easily with each other (Linstone & Turoff, 1975). In that way, resources are conserved, and barriers against experts participating are kept low. The Delphi technique can also be combined with other methods. In this study, scenarios are developed that help to present the Delphi results in a vivid manner while supporting companies within their organizational learning and understanding of possible future developments (incl. shocks and uncertainties) (van der Heijden, 1996).

As the transport sector starts to broaden its scope, beyond focusing only on one mode, taking the entire travel chain into consideration, the D2D focus is aimed here[2]. Airport access and egress modes are defined as feeder ground transports to and from the airport, such as bus services, airport shuttles, railway, taxi, or the personal vehicle. The scope of this study is the year 2035, within the European transport market for long-haul flights, taking into consideration the entire travel chain. The year 2035 is chosen as it seems to be a point in the future that will differ from today but is still imaginable for experts to assess in the survey. As projects in mobility and air travel have long-term planning horizons, this framework also offers providers the opportunity to implement proposed managerial implications and to prepare products and services to cope with upcoming trends. The long-haul air traffic market, defined here as flying over a longer distance and more than 4000 km point-to-point[3] (Crocker, 2007; Eurocontrol, 2005), has grown by 50% in the last ten years (Airbus, 2018). In 2018, almost 10% of the total planned seat capacity was dedicated to long-haul[4] routes (OAG, 2018). Globalization and the growing demand for travel between regions might increase this further (ACI, 2018; Airbus, 2018). Emerging ultra-long-haul flights result in longer, non-stop flights increasing on-board journey time for passengers. Advanced aircraft technology, such as the A321LR planned for market entry in 2023 (Airbus, 2019), will allow arrival and departure from smaller airports for long-haul routes. This could lead to changing passengers' travel behavior as traffic flow, along with access and egress modes, might be altered accordingly. Long-haul flights also generated more than 30% of the total fuel burn and related CO_2 emissions from global air transport in 2016 (BADA, 2019), making travel of these distances of high interest in the light of the current environmental debate.

1.3. Structure of the paper

Providing the theoretical background in Section 2, key papers with a similar research scope are discussed. Section 3 presents an overview of the research process and the designs of the future projections; findings are used to develop the Delphi questionnaire. Section 4 describes the two-round Delphi approach, including the expert selection and survey execution. Section 5 delineates study results and three future scenarios. Managerial implications are further discussed here. Section 6 concludes with limitations and future research.

2. Prior work

2.1. Review of door-to-door travel research

The understanding of D2D travel is mostly examined within the sphere of urban mobility. Stopka (2014) studies D2D travel with regard to public transport usage. Conducting focus group research, she identifies travelers' requirements for an application improving seamless D2D, urban mobility, as services on the current market cover only parts of the travel chain and do not support a seamless experience. Improving D2D trips is a complex endeavor, mostly due to incompatible systems and reluctance in sharing data (both provider and user). Similar challenges are also discussed in more recent works by Dolinayova et al. (2018) and Schulz et al. (2018), indicating little progress within the last years. For instance, a first theoretical solution proposal for a privacy preserving architecture, supporting seamless D2D air travel, is developed by Höser and Kluge (2020). In their work, privacy and secure data sharing are identified as open issues. Developing future passenger profiles, Kluge et al. (2018) also analyze passenger requirements on D2D air travel chains and the respective mobility solutions. Results show that changes in demographics (like age) could still affect future passenger requirements. Travel time is an additional factor analyzed in the light of D2D travel, concerning the use of novel mobility concepts like on-demand air taxis (Sun et al., 2018) or regarding access and egress travel times (Rothfeld et al., 2019). Reducing the overall travel time seems to be a key driver in improving the passenger journey.

Overall, D2D travel needs to be improved in several ways. An understanding of possible future projections can help to create seamless, intermodal travel. For this exploration, future-oriented research is necessary.

2.2. Delphi studies on the future of mobility

Several Delphi studies examine the future of mobility (see Table 1 for an overview). They mostly focus on aviation and urban mobility, which are both sub-elements of D2D travel. A classical approach to a Delphi-based scenario study is applied by Linz (2012) focusing on the question of what aviation of the future might look like in 2025, with respect to passenger, business, and cargo aviation. Linz does test projections describing developments concerning Social, Technological, Economic, and Political aspects (STEP-framework), with aviation industry experts and researchers. Based on the study's outcomes and a cluster analysis, Linz develops three future scenarios for the aviation industry overall: (1) the probable scenario with the highest probability to occur, (2) eventualities, and (3) potential surprises, characterized by the lowest estimated probability. As Linz's industry focus is broad, it seems difficult to summarize each scenario. However, Delphi findings confirm within one projection that *"[c]ustomers will increasingly demand*

[2] The focus is on D2D mobility only. Vacation packages provided by travel companies are not within this scope.

[3] The paper focuses on passengers using scheduled, commercial air transport services, based on the classification of civil aviation activities by ICAO (2009). According to this definition, commercial air transport services incorporate 1) scheduled and 2) nonscheduled air transport services. Nonscheduled air transport services include (1) charter; (2) on demand (air taxi, commercial business aviation, others); and (3) other nonscheduled air transport services. Business aviation, aviation training, pleasure flights and other activities are excluded here. The paper also does not distinguish between direct flights or connecting flights.

[4] Analysis of OAG data based on worldwide planned seat capacity; long-haul defined as flight distance greater than 4000 km

Table 1
Delphi studies within mobility and transportation research.

Author (s) (Year)	Study Scope	Time Horizon	# of Projections	# of Panelists	# of Rounds	Response Rate	Research Details
Julsrud & Uteng (2015)	Urban, daily mobility in Norway	2050	16	280	RTD	56%	Delphi combined with factor analysis
Wittmer & Linden (2017)	Overall mobility & passenger traveling in Switzerland	2040	19	50	2 (RTD)	64%	Delphi survey combined with consumer survey, workshops, expert-interviews, means-end analysis and customer segmentation
Schuckmann, Gnatzy, Darkow & von der Gracht (2012)	Transport infrastructure	2030	15	104	RTD	31%	Delphi study
Spickermann, Grienitz & von der Gracht (2014)	Urban mobility in Germany	2030	16	201	RTD	28%	Three parallel Delphi studies with different expert groups, combined with workshops and scenario development
von der Gracht & Darkow (2010)	Worldwide, logistics service industry	2025	41	30	2	42%	Extensive Delphi-based scenario study
Linz (2012)	Aviation industry (incl. cargo)	2025	40	57	RTD	71%	Delphi-based scenario development
Linz, Ziegler & Lang (2011)	European business aviation industry	2025	25	57	Ø3.1 (RTD)	71%	Real-time Delphi survey combined with STEP-framework, Porter five forces and expert interviews
Mason & Alamdari (2007)	Air transport in the EU	2015	27 (1st round) 14 (2nd round)	26	2	43%	Two-round Delphi; projections developed based on desk research and by air transport researchers

RTD: Real-Time Delphi (web-based)

integrated services, door-to-door, out of one hand (one-stop-shopping)" (Linz, 2012, p. 3), underpinning the D2D scope as a relevant future paradigm.

Applying the Real-Time[5] Delphi (RTD) approach, Wittmer and Linden (2017) validate future projections for two mobility scenarios for the Swiss transport market in 2040. Delphi results show that future customer needs of Swiss passengers will be diverse and complex. Individual lives and future working environments are two confirmed aspects that could change and influence passengers' mobility behavior in Switzerland. Wittmer and Linden do not distinguish between daily commuters or air travelers. Several key findings are also tested further in this study for D2D air travel.

A local focus to the research is applied by Julsrud and Uteng (2015) as well as by Spickermann et al. (2014). Future projections for day-to-day mobility within urban areas in Norway for the year 2050 are developed by Julsrud and Uteng. Evaluated by national experts from academia and the mobility industry in a RT Delphi survey, the authors develop three possible visions of future urban mobility in Norway: (1) technopolis, (2) controlled mobility, and (3) shared mobility. Within a multi-stakeholder scenario development study, Spickermann et al. design a desirable future vision and probable perspectives for future urban mobility in Germany. Three parallel online Delphi surveys are carried out to capture a broad view from multiple expert groups. The study reveals that multimodal mobility in urban areas might increase, and, at the same time, customer expectations and urban transport systems are also likely to change before 2030.

Mason and Alamdari (2007) conduct a two-round Delphi study determining future developments of network carriers, low cost carriers, and passengers projections within the EU air transport market. Outcomes reveal possible route network developments, market consolidation trends, and changes in passenger demand. Mason and Alamdari use a shorter time horizon and focus on the year 2015, which has only been eight years away at the time of the study.

The Delphi technique is also applied in studies with a broader scope of transport and mobility research, such as by Linz et al. (2011) examining the European business aviation industry. One could also apply the scenario approach (Michelmann et al., 2019; Will et al., 2016), which can also be combined with the Delphi technique. An overview of transport related Delphi studies with a focus on scenario development is provided by Melander (2018).

Looking at the prevailing literature, the Delphi technique is suitable for examining future-oriented, mobility-related research questions. Gaining different perspectives and avoiding biases, researchers seem to prefer diverse sets of experts, often combining panelists from both the industry and academia. The most common approaches are RTD or two-round Delphi studies with an overall response rate of 51% across all studies. As also discussed by Nowack et al. (2011), the number of panelists seems higher in the RTD. The RT approach could help to reach a higher number of participants; however, the quality of a Delphi study also depends on the qualifications of the experts. Using the offline Delphi approach, we can potentially reach more pertinent domain experts.

2.3. Contribution to the literature

Intermodal D2D travel is gaining momentum for transport companies and researchers, mostly studying D2D urban mobility. This paper examines the relevant future projections affecting D2D air travel in Europe. To the knowledge of the authors, this scope has not been used in any Delphi survey yet. The long-haul market is identified as an important air transport product. Compared to prior Delphi studies, this research also focuses on air passengers taking long-haul flights. The Delphi technique helps combine experts' judgments from several

[5] Web-based

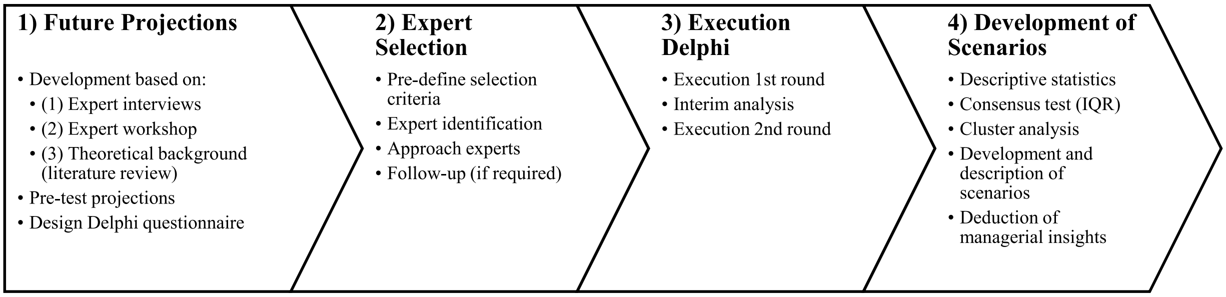

Fig. 1. Design of this Delphi study, depicted as four-step research approach adapted from von der Gracht and Darkow (2010).

transport providers, thus creating a D2D scope. Further, the research objective is not just to gain consensus among the experts but also to analyze which projections trigger diverse opinions. The theoretical contribution of this research to the literature on future mobility and for the industry is threefold. The findings contribute to (1) the current Delphi literature (and future-oriented research community) by applying a novel scope of D2D air travel; (2) exemplifying that the Delphi technique is a sufficient tool for capturing this broad scope, by surveying multi-stakeholder panelists; (3) the transport industry, by providing insights into possible future projections and elaborating on managerial implications.

3. Delphi survey

3.1. Future projections

This Delphi study followed a four-step research approach (Fig. 1). This section elaborates on the development of future projections (step one). To ensure data triangulation and to identify main focal points to discuss in the Delphi survey, the use of multiple sources for the development process is recommended (Belton et al., 2019; Nowack et al., 2011). Hence, three sources were used here: (1) semi-structured expert interviews, (2) one exploratory expert workshop, and (3) a literature review providing theoretical background.

3.1.1. Expert interviews and expert workshop

Expert interviews were used for this study in an exploratory way (Bogner, Littig, & Menz, 2014). They helped to gain an understanding of how European D2D mobility could look in 2035, by incorporating the industry at an early stage of the research process and identifiying essential D2D travel trends to use as focal points for the projections. Of the 55 experts who were contacted, 18[6] agreed to be interviewed. Interviews were carried out via phone or face-to-face from March until October 2018. In line with the D2D scope, interviewees covered all segments of the travel chain. Representatives from public transport providers and car manufacturers covered airport access and egress modes (feeder traffic). Two airports and two airlines covered the airport transfer and the flight segment. Additionally, representatives of business to business (B2B) suppliers from the aviation and automotive industry, a mobility researcher, and five mobility experts on digitalization and marketing methods were included for a third perspective. All interviews were semi-structured, using the interview questionnaire as a guidance for the conversations (Döring & Bortz, 2016). The regional focus was on the European travel market. After obtaining consent from experts, interviews were recorded and transcribed based on Kuckartz (2014), who provides transcription rules focusing on content. The coding of the qualitative interview data was based on the summarizing and inductive category formation approach proposed by Mayring (2014). Based on findings of the expert interviews and the accompanying literature review, a first list of 51 projections was drafted. A further exploratory workshop, with two mobility researchers, was carried out in October 2018, revising all projections, suggesting additional projections, broadening the perspective, and breaking down the list to develop the questionnaire draft.

3.1.2. Delphi questionnaire

As recommended by the literature (Belton et al., 2019; Frewer et al., 2011), to refine the questionnaire and to ensure plausibility, comprehensibility, and consistency, the draft questionnaire was pre-tested with two adequate experts, who were not part of the expert panel. Based on their feedback, minor modifications were carried out. Avoiding research fatigue and keeping the dropout rate low, the final list was shortened to 17 projections (Table 2). The final list is not exclusive nor exhaustive but covers essential future D2D mobility trends as identified. Projections are structured further to evaluate external factors impacting future D2D mobility. Adapted from Linz (2012), the Social, Technological, Economic, Environmental, and Political development (STEEP) framework was used for an additional grouping. Most projections are assigned to the social and technological category, indicating these two as possible drivers for future D2D mobility.

Throughout the Delphi study, an annual GDP growth of 1.8% and a stable population (no strong growth or decrease) were expected. An annual Revenue Passenger Kilometers (RPK) growth at 3.1% were assumed as a proxy for air travel demand for the European market until 2035 (adapted from Airbus 2018 and United Nations 2017). No financial crises, natural catastrophes, medical crises, nor terrorist attacks were assumed either. This scenario was added to the questionnaire so that experts could presume them to be framework conditions when completing it. Following, it is presented how interview data, findings from the literature review, and workshop insights were used to design the final projections.

3.1.3. Theoretical background: trends on the demand and supply side

As argued by the interviewed experts, one major trend is the personalized journey, which provides a high customer benefit. Driven by the passenger, the transport market is considered to be transformed from offered mobility to demanded mobility. Customers want on-demand, flexible solutions, adaptable towards personal preferences. This trend is essential within the D2D context, as travel chains are individualized to a high degree depending on passenger type, itineraries, and available budget. The connected, personalized passenger journey is also discussed in the recent technical press (Schaal, 2019; Sheivachman, 2019). The increasing demand for personalized D2D journeys is hence further tested in the Delphi study (projection 1).

Several studies look into demographic trends in the context of travel. Millennials (young adults) are characterized by Garikapati et al. (2016) as a generation owning less cars, traveling less, and spending more time at home. Their mobility behavior might change with age (early 30s) given a new life stage. At that point, Millennials are likely to adapt a similar mobility behavior as the prior generation. Due

[6] The overall response rate is 33%. 17 expert interviews have been conducted within the CAMERA-project (H2020 "Aviation Research and Innovation Policy," GA769606).

Table 2

Final projections of future European D2D air travel into the year 2035 and sources of development.

No.	Projections (year 2035)	Category (STEEP)	Demand / Supply Side	Source
1	In 2035, passengers will increasingly demand personalized D2D journeys (on-demand, flexible & adapted towards personal preferences).	Social	Demand	■ Expert interviews ■ Schaal (2019), Sheivachman (2019)
2	In 2035, age will not define passengers' needs that much anymore.	Social	Demand	■ Expert interviews ■ Garikapati et al. (2016), Siren and Haustein (2013, 2015), Wittmer and Linden (2017)
3	In 2035, gendered travel preferences within D2D journeys will increasingly differ from each other.	Social	Demand	■ Expert interviews ■ Scheiner and Holz-Rau (2017), Siren and Haustein (2013, 2015)
4	In 2035, novel working environments will influence requirements of business travelers on the D2D travel chain.	Social	Demand	■ Expert interviews ■ Sinicki (2019), Wittmer and Linden (2017)
5	In 2035, passengers will increasingly demand to use travel time along their D2D journey as value-adding time (such as for working, networking, education, etc.).	Social	Demand	■ Expert interviews ■ Bouwens et al. (2017), Tang et al. (2018)
6	In 2035, passengers will increasingly demand not just transportation services but comfort and convenience along their D2D journey (such as options for sleeping and napping, comfortable seating, etc.).	Social	Demand	■ Expert workshop ■ Bouwens et al. (2017), Vink & Hiemstra-van Mastrigt (2011)
7	In 2035, passengers will be increasingly price sensitive throughout the entire travel chain.	Economic	Demand	■ Expert interviews ■ Conrady et al. (2013)
8	In 2035, passengers will increasingly be willing to pay more for eco-friendly D2D journeys.	Environmental	Demand	■ Expert interviews ■ Alcock et al. (2017), Büchs (2017), Lu & Wang (2018)
9	In 2035, passengers will increasingly provide private data to personalize their D2D journeys.	Technological	Demand	■ Expert interviews ■ Dolinayova et al., (2018); Javornik et al., (2018); Schulz et al., (2018)
10	In 2035, internet-enabled mobility services will be the personal travel planner of passengers and completely control each aspect of their D2D journeys.	Technological	Demand	■ Expert interviews ■ Linton & Kwortnik (2019)
11	In the context of increased automatization and digitalization in 2035, passengers will increasingly demand human interaction throughout their D2D travel chain.	Technological	Demand	■ Expert interviews
12	In 2035, advanced information and communications technology (ICT) will partly replace long-haul air travel for private trips (such as holidays, visiting friends and relatives, etc.).	Technological	Supply	■ Expert workshop ■ Voronkova (2018)
13	In 2035, autonomous mobility will facilitate D2D mobility.	Technological	Supply	■ Expert interviews ■ Expert workshop ■ Young & Farber (2019)
14	In 2035, providers along a D2D travel chain, such as public transport, airports, airlines, and travel platforms, will increasingly collaborate to offer integrated mobility products and services.	Economic	Supply	■ Expert interviews ■ Javornik et al. (2018)
15	In 2035, integrated offers around D2D mobility will become the competitive advantage for airlines.	Economic	Supply	■ Expert interviews ■ Javornik et al. (2018)
16	In 2035, airlines, public transport, and airports will mainly focus on providing transport services. Tech companies will take over additional services offered to passengers (such as on-board shopping, entertainment, etc.).	Economic	Supply	■ Expert interviews ■ Chang (2017)
17	In 2035, political frameworks will support integrated, seamless D2D mobility.	Political	Supply	■ Expert workshop

to factors such as increased longevity and lifestyle changes, Siren and Haustein (2013, 2015) show that the generation of Baby Boomers, entering retirement age, will be in turn very active in travel and leisure activities. Elderly passengers (50+) do not comprise a homogeneous segment but different sub-segments that behave increasingly atypically to their traditional patterns, described as down-aging by Wittmer and Linden (2017). Several interviewed experts predicted the retention of traditional segments with fragmented changes in the mobility behavior and lifestyle. Age might not be a differentiating characteristic for passengers' mobility needs; this trend is tested for D2D long-haul travel (projection 2).

Besides age, recent research shows gendered differences within mobility behavior. Scheiner and Holz-Rau (2017) show that women's daily travel patterns are more complex compared to those of men. Women tend to conduct more trip chaining due to the increased number of tasks, with females still carrying out more family duties and having additional anchor points. Female travel behavior also differs in the older age cohort of the population (Siren & Haustein, 2013, 2015). Findings from expert interviews predict a further growth in female business travelers. Women have differentiated travel needs along the travel chain (focusing more on healthy offers and safety), but air travel with its surrounding infrastructure (physically and service-wise) is still male-oriented, leading to possible future pain points for the increasing number of female business passengers. It is hence explored if gendered preference might develop in the future (projection 3).

As a side finding, future passenger segments were identified during the expert interviews. One of these was the business traveler segment, which already exists today. Wittmer and Linden (2017) identified, in a former Delphi study, that new working environments might possibly influence the mobility behavior of the Swiss market in 2040. The new era of the gig economy (defined as an employment system with many temporary, short-term contracts, often applicable to tech professionals (Sinicki, 2019)) is considered by the experts to be a high growth market. Self-employed experts and freelancers are mobile, and hence, travel increasingly for temporary, short-term project work and engagements. Some of these gig workers might not have places of permanent residence, creating new customer needs along the journey, such as mobile offices, luggage storage, showers, or medical care. It is tested if such novel working environments could influence requirements of business travelers (projection 4).

Time is already identified as a main driver in the current D2D travel literature, mostly with respect to time saving. Interviewed experts however elaborated on the requirement of passengers to spend actual travel time in a value-adding way, such as for working or entertainment, instead of losing time while traveling. As seen in examples for high-speed rail and long-haul flights, this can vary as preferences for on-board activities are diverse (Bouwens et al., 2017; Tang et al., 2018). For long-haul D2D travel, creating value-adding time is essential for the actual long flight but challenging for all transport modes along the journey. Hence, this possible challenge is also tested in the Delphi study (projection 5).

Moreover, the personal comfort levels during different activities and flight phases of long-haul flights varies (Bouwens et al., 2017; Vink & Hiemstra-van Mastrigt, 2011). Legroom, seats, hygiene, and crew behavior are influential comfort factors in an aircraft cabin (Vink & Hiemstra-van Mastrigt, 2011). Next to the actual transport service of providers, researchers from the expert workshop discussed the hypothesis, whether this would become a demand covering the entire travel chain in 2035. Hence, comfort as a demand driver is tested in the Delphi study (projection 6).

Besides, the price sensitivity of airline passengers is currently high (Conrady et al., 2013), and the majority of interviewed experts argued that this could be an upcoming challenge for the transport industry. Mobility is already a commodity and providers need to offer an entire travel experience to differentiate their products on the market. Next to ticket fares, parking charges at airports can also be extremely high, as parking time increases when traveling long-haul. With regard to access and egress modes, emerging mobility platforms and sharing modes offer feeder traffic at low costs, competing with public transport fares. This increasing price sensitivity is verified in this Delphi study (projection 7).

Another aspect is the mitigation of self-generated emissions by passengers, particularly applicable to the scope of this study as long-haul air traffic has generated more than 30% of the total fuel burn, and subsequent CO_2 emissions, of global air transport (BADA, 2019). Passengers' mitigation strategies could be paying for voluntary carbon offsetting schemes (Lu & Wang, 2018), or reducing the personal propensity to fly (Büchs, 2017). Studies show that passengers continue to fly despite concerns about their known personal impact on climate change (Alcock et al., 2017); this is known as the value-action gap (Büchs, 2017). As the environmental aspect was also seen as a major challenge for the overall transport system by interviewed experts, and is currently highly debated by society at large in many parts of the world, the increasing willingness of passengers to pay more for environmentally friendly travel is tested in the Delphi study (projection 8).

To provide tailored mobility solutions and to create a personalized journey experience, transport providers have already started to use the passenger data available to them, gathered from the booking process and loyalty programs, traffic data, and in-house survey results. Secondary data, from other mobility companies, competitors, or market research companies, is also accessed. To offer a true personalized journey, providers need all D2D information from the passenger side (Javornik et al., 2018), but the willingness to share data between providers is still low (Dolinayova et al., 2018; Schulz et al., 2018). Interviewed experts also considered data security regulations, increased competition, lack of in-house data analytic skills, and customer data security concerns as possible drawbacks. It is hence to be tested, if future passengers would be willing to provide data for personalization (projection 9).

Interviewed experts foresaw personal mobile devices or travel platforms to become interim media for travel planning and managing, schedules knowledge, and other D2D information, to provide seamless mobility solutions. Such 'travel buddies' will also adopt to individual preferences and possible disruptions during the journey, translating between the demand and supply sides. It could also be considered as a solution for regulating societal interests, such as avoiding overcrowded stations and intersections or for choosing environmentally friendly routes. There is still a supplier–user gap, partly as it is challenging to keep information on mobile devices up to date (Linton & Kwortnik, 2019). It is tested if internet-enabled mobile services could become personal D2D travel planners (projection 10).

In times, with automatization and digitalization as driving trends in the travel industry, processes and touch points along the travel chain will increasingly be replaced by machines. However, interviewed experts argued that human contact would still play a vital role for passengers in the future, especially for customers who experience a high amount of stress at the airport, such as children traveling alone or sporadic flyers. Human touch could become a main differentiator for transport providers and is hence investigated for future D2D air travel (projection 11).

Conversely, during the expert workshop, concerns arose that advanced information and communications technologies (ICT), such as augmented and virtual reality (AR, VR), could partly replace long-haul air travel for holidays or visiting friends and relatives. VR-glasses replacing tourism has several advantages, such as virtual tours to museums and difficult to reach cultural heritage sites or offering remote tourism to the disabled and the elderly (Voronkova, 2018). Yet it seems uncertain how ICT and virtual tourism might replace air travel for private purposes and hence it is tested (projection 12).

Emerging mobility concepts, such as ride-railing, can alter passengers' travel desires and mobility patterns (Young & Farber, 2019).

Advanced technology, such as autonomous vehicles, might further facilitate D2D mobility and offer innovative modes for access and egress. Experts stated that either existing modes could be used differently (like cars) or new forms of mobility could emerge (such as urban air mobility). Such modes of the future, primarily with focus on autonomous vehicles (AVs) providing airport access and egress, are seen as value-adding facilitators for travel time use within the travel chain. Further customer benefits are the availability of AVs at any time and the low costs. The effect of those on D2D is tested in the Delphi study (projection 13).

The digital transformation allows airlines and ground transport to work better together within a connected ecosystem (Javornik et al., 2018). In fact, partnerships between providers were seen as necessary for providing a true D2D experience (see projection 9) but also as challenging by the interviewed experts. Some D2D mobility products, based on partnerships, already exist. It is tested if providers increasingly collaborate to increase D2D services (projection 14).

Interviewed experts also argued that such integrated offers around D2D mobility could become a competitive advantage for airlines. As discussed in the literature, airlines should start to change their management mind-set towards creating true value for their passengers (Javornik et al., 2018). Mobility is already a commodity and providers need to offer an entire travel experience to differentiate their services. This hypothesis is also assessed by the Delphi panel (projection 15).

This trend could also develop differently. In 2035, airlines, public transport, and airports could mainly focus on providing the pure transport services of D2D. Tech companies could take over additional services offered to passengers, such as on-demand, on-board entertainment by the movie streaming provider Netflix, who has already partnered up with airlines (Chang, 2017), as they already have passengers' data and know the customers' preferences. This counter-trend proposed by the interviewed experts is tested in the Delphi (projection 16).

Autonomous driving (see projection 7) is seen by experts to be market-ready in ten to fifteen years. The technology already exists, but official regulations in terms of usage and safety are not currently in place. Mobility platforms and emerging sharing modes covering access and egress might require further regulations. As discussed in the expert workshop, political frameworks could be an enabler of enhanced D2D mobility. The Delphi tests if political frameworks could support D2D mobility (projection 17).

3.2. Expert selection

The identification of experts was based on two sources, desk research (LinkedIn and conference participation lists) and the personal networks of the authors. As shown in Section 2, it seems beneficial to include multi-level perspectives in the expert panel to avoid biases. To ensure such heterogeneity, approached experts had to have an academic background, represent a transport company, work as futurists, or work in mobility consultancy. To capture a true D2D focus as was done in the expert interviews, the selected experts represented a diverse set of means of transport, such as public transport, air (airports and airlines), automotive, and their suppliers. Another pre-selection criterion was the European scope, panelists should mainly have been based and/or worked in Europe. Experts should also have profound mobility expertise, assured via their curriculum vitae.

A total of 45 experts participated in the first survey round of the 113 experts contacted via e-mail, phone, or in person. Due to too many missing answers, two questionnaires were eliminated, leading to a total of 43 participants in round one (response rate 38%). Of those, 504 comments out of 731 possible comments were provided (comment rate 69%). Such high comment rate could be an indicator of a high level of involvement from the experts. In the second round, 5 experts dropped out (dropout rate 12%), leading to 38 final participants and to an overall response rate of 34%. The experts had, on average, 14 years of experience within the mobility sector, ranging from 3 years to over 40 years. 31 participants rated their own expertise for answering the questions as 'high' or 'very high', six assessed their expertise as 'basic' and one as 'low'[7]. 39% of the panelists were female. The divisions of panelists by industry segment and job level are depicted in Table 3.

Table 3
Delphi participants by industry segment[8] and job level.

Industry/mode (most applicable)	*N* (in %)	Position	*N* (in %)
Research facility or university	16 (42%)	Researcher (PhD / Dr.)	8 (21%)
Public transport	5 (13%)	Employee	7 (18%)
Supplier	4 (11%)	Middle Management	5 (13%)
Airport	3 (8%)	Researcher (Prof.)	4 (11%)
Consulting	3 (8%)	Top Management	3 (8%)
Automotive	3 (8%)	Researcher (Doctoral Student)	3 (8%)
Other	2 (5%)	Consultant	3 (8%)
Airline	1 (3%)	Futurist	3 (8%)
Futurist	1 (3%)	Other	2 (5%)

3.3. Execution of the Delphi study

Various Delphi techniques have evolved next to the traditional approach, as published by Linstone and Turoff (Linstone & Turoff, 1975; Rowe & Wright, 2011). For the purpose of this study, a two-round Delphi technique was applied. As the overall research goal was not to gain consensus among all experts, the Delphi was pre-limited to two rounds. Three rounds or more were not considered able to increase the quality of the findings but could have increased the risks of research fatigue and panelist dropout. Hence, rounds were capped to avoid a high panel motility.

The final Delphi questionnaire for the first round was created as a read-only word form and distributed to experts via e-mail, along with a covering letter containing information concerning the scope of the study, an overview of the research approach, and information to preserve anonymity and confidentiality. The first part provided a future scenario, as described above, as well as instructions for the answering process. In the main part, experts were asked to evaluate the expected probability (P), impact (I), and desirability (D) for each projection on a seven-point Likert scale, providing sufficient variance for the experts' answers. Depending on the estimation, the value 1 was defined as 'not probable', 'very weak', or 'very undesirable'. Respectively, the value 7 was defined as 'very probable', 'very strong', and 'very desirable'. As seen in other transport-related Delphi studies such as Schuckmann et al. (2012), providing a written justification in support of the personal assessment was optional. In the second part of the questionnaire, basic socio-demographic information was requested, such as gender, position, type of company, years of experience in the mobility industry, and a self-assessment of the experts' expertise measured on a five-point Likert scale, going from 'very low' (1) to 'very high' (5).

To guarantee anonymity and an unobstructed process, the entire Delphi process was coordinated by a moderator who was not part of the panel. The first round was conducted between October 2018 and November 2018 and the second round between December 2018 and January 2019. In order to gain as many participants as possible, at least one e-mail reminder was sent to the contacts for each round.

[7] Due to the careful usage of prior expert selection criteria, the low self-assessment response of one participant could be explained through a higher degree of critical self-assessment of one's own competence and expertise.

[8] Due to rounding >100%.

3.4. Interim analysis

Based on guidelines by Häder (2009), participants received controlled feedback in the second round. The spread of the aggregated results in format of histograms, the means, the minima and maxima of all answers, a summary of all comments regarding each projection as well as the position of one's own response compared to overall results, were provided. In line with the approach of the Delphi technique, experts had the possibility of revising their estimations, based on the additional information provided. Participants were also invited to leave a comment in case they wanted to adapt answers. Although the dropout rate between the two rounds was unexpectedly high, experts provided estimations for all projections in the second round, leading to a dataset without any missing values. This can be seen as an indicator of a high panelist engagement level.

4. Development of scenarios

4.1. Descriptive statistics

Before analysis, the data from both rounds was checked for errors (Häder, 2009). Descriptive statistics, such as the calculations of the means, medians, and standard deviations (SD), were generated. The interquartile range (IQR) was used as the measurement of consensus. The change in the standard deviation between rounds was used as a measurement of convergence. An extract of the results is depicted in Table 5, including the short title of respective projections.

As all estimations were measured on the seven-point Likert scale, a standardization of the data was not necessary. After round two, a decrease in the standard deviation (measured in the % SD change) of the probability was observed for eleven projections, indicating a convergence of estimations among the experts. Comments of participants on the rationales behind why they altered their estimations in the second round supported this. The strongest convergences between the rounds were measured for projection 9 (private data) with a decrease in SD of 13.16%, projection 11 (automatization and digitalization) with a decrease in SD of 10.49%, and for projection 4 (novel working environments) with a decrease in SD of 7.23%.

Most projections were considered to have an average impact greater than or equal to 5, which is equivalent to 'somewhat strong' or stronger, indicating that relevant projections were addressed in the Delphi. The strongest impact was estimated for projection 9 (private data) with a mean of 6.13 and for projection 14 (collaborate mobility providers) with a mean of 6.13. Projection 14 (collaborate mobility providers) was also considered as the most desirable development for D2D journeys in 2035 ($D = 6.18$). Although projection 8 (eco-friendly journeys) was estimated as only 'somewhat probable' ($P = 4.76$), it was the second most desirable development according to the experts ($D = 6.03$).

Plotting the mean of probability versus the mean of impact revealed an almost linear development within the data (Fig. 2). Each number in the scatter plot indicates the corresponding projection. Projections with a lower mean of probability went along with a rather weak impact and vice versa. For instance, projection 3 (gender) was estimated to have the lowest probability to occur in 2035 and would also have the lowest impact. As also seen in Table 4, projections that reached consensus showed higher impact and probability estimations, indicated in Fig. 2 by the dashed line.

The measurement of consensus is a key component in analyzing Delphi results, and the IQR is a widely accepted and largely used classification for this purpose (von der Gracht, 2012). A small IQR indicates a large consensus among the panelists. As seen within other Delphi studies using a seven-point Likert scale (Vet et al., 2005), the threshold for reached consensus of $IQR \leq 1$ was used. Projections with higher IQR values were not considered in scenario development. In round one, consensus was obtained for projection 1 (personalized D2D journeys), projection 4 (novel working environments), projection 5 (value-adding time), projection 10 (internet-enabled mobility services), and projection 14 (collaborate mobility providers). Although the panel was rather diverse, consensus was obtained for two additional projections (6 and 16), after the second round. All projections reaching the threshold were related to changing passenger needs, novel business models, and technology; many were driven by digitalization, such as internet-enabled D2D mobility services, or new service offers by tech companies. Additional descriptive statistics were conducted with these seven projections, including checking for correlations and developing boxplots to depict outliers.

4.2. Diverging opinions among experts

More than 50% of projections did not meet the IQR threshold, which could have been an indicator of remaining high levels of uncertainty among the experts. The highest IQR values, thereby showing the strongest divergence of opinions among the experts, were measured for the estimated probability of projection 3 (gender), projection 12 (ICT), and projection 2 (age).

Despite evidence from previous research (Scheiner & Holz-Rau, 2017; Siren & Haustein, 2013, 2015), experts did not collectively agree on future travel preferences differentiated by gender, within D2D journeys in 2035. One reason could be that trip chaining, as explored by Scheiner and Holz-Rau (2017) as a reason for gendered mobility behavior, is less relevant in long-haul, D2D travel. Experts stated that gender will generally be less important in the future and travel preferences will be shaped by other factors such as age, education, income, available free time, and lifestyle. However, the opposing point of view considered women would form a major customer segment in the future, providing opportunities for service differentiation among providers and opening up new revenue streams.

Experts did not always foresee ICT replacing long-haul air travel for private purposes, regardless of advantages elaborated earlier (Voronkova, 2018). Whereas some imagined trips being replaced by VR and AR, partly due to increased prices for personal travel, others considered human interactions and personal experience on-site as irreplaceable. Advanced ICT was also considered to become a complement rather than a substitute, increasing the number of contacts and therefore the desire to meet in person and to explore new distant travel destinations. However, regarding business trips only, several experts estimated a decrease here due to advanced ICT, indicating that the trip purpose will still be an important component in future mobility.

Finally, experts had diverse opinions on if age would still define passengers' needs in future D2D travel. Literature suggests that age might not necessarily influence mobility behavior, due to factors such as new life stages or the down-aging effect (Garikapati et al., 2016; Siren & Haustein, 2013, 2015; Wittmer & Linden, 2017). These findings were not confirmed in the Delphi study. Some panelists argued that age might not be as important anymore and cultural background, trip purpose, or affinities towards specific services will drive passengers' needs. Others saw future passengers merge to one potential customer group reducing complexity. Conversely, experts also elaborated that elderly passengers have specific needs and those will continuously influence their travel, such as health status or travel budget. Particularly in an aging society, the needs of older people should be considered. For instance, autonomous driving vehicles will offer personalized D2D service to different age groups, such as to the elderly or children traveling alone, providing the possibility to participate in road traffic without the ability to drive a vehicle.

4.3. Cluster analysis and scenarios

To detect structure in the data, various cluster algorithms[9] were tested, considering average probability, impact, and desirability from projections that reached the consensus threshold. Where necessary, several clustering validity indices were applied determining the optimal number of clusters in line with the majority rule by Charrad et al. (2014). After comparing resulting classifications, the

[9] fuzzy clustering, hierarchical clustering, k-means clustering, partitioning around medoids (PAM clustering)

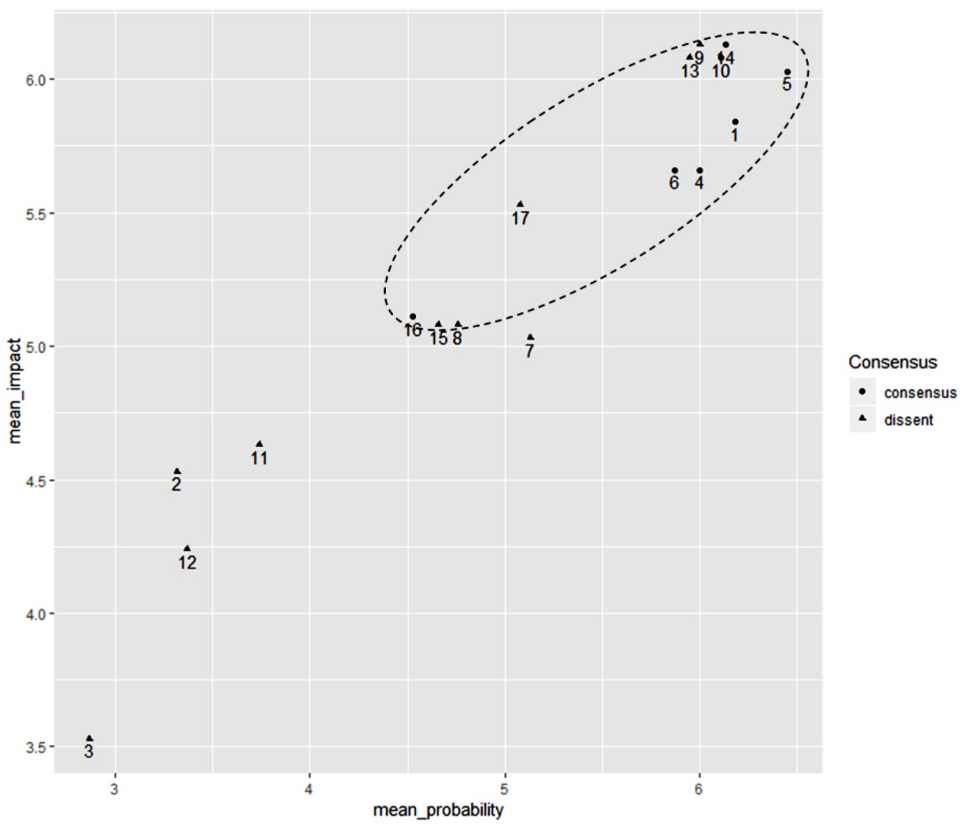

Fig. 2. Scatter plot (all 17 projections).

Table 4
Quantitative results (extract).

Projection (short title)	P round 1 (N = 43) IQR	Median	Mean	SD	P round 2 (N = 38) IQR	Median	Mean	SD	SD change (in %)	I (mean)	D (mean)
1. Personalized D2D journeys	**1**	6	6.19	1.03	**1**	6	6.18	1.06	2.91	5.84	5.58
2. Age	3	3	3.3	1.61	3	3	3.32	1.54	-4.35	4.53	4.32
3. Gender	4	3	2.98	1.71	2.75	3	2.87	1.61	-5.85	3.53	3.53
4. Novel working environments	**1**	6	6.02	0.83	**0.75**	6	6	0.77	-7.23	5.66	5.37
5. Value-adding time	**1**	7	6.44	0.85	**1**	7	6.45	0.83	-2.35	6.03	5.76
6. Comfort and convenience	2	6	5.79	1.26	**1**	6	5.87	1.28	1.59	5.66	5.61
7. Price	2	5	5	1.18	2	5	5.13	1.19	0.85	5.03	4.26
8. Eco-friendly journeys	2	5	4.72	1.37	1.5	5	4.76	1.34	-2.19	5.08	6.03
9. Private data	2	6	5.98	1.14	2	6	6	0.99	-13.16	6.13	4.82
10. Internet-enabled mobility services	**1**	6	6.14	1.1	**1**	6	6.11	1.16	5.45	6.08	5.29
11. Automatization and digitalization	2.75	4	3.69	1.62	2	4	3.74	1.45	-10.49	4.63	4.21
12. ICT	3	3	3.33	1.68	3	3	3.37	1.65	-1.79	4.24	3.71
13. Autonomous mobility	2	6	5.95	1.09	2	6	5.95	1.14	4.59	6.08	5.79
14. Collaborate mobility providers	**1**	7	6.14	1.18	**1**	7	6.13	1.23	4.24	6.13	6.18
15. Competitive advantage	2	5	4.93	1.5	2	5	4.66	1.44	-4.00	5.08	4.87
16. Tech companies	1.75	5	4.6	1.53	**1**	5	4.53	1.45	-5.23	5.11	4.18
17. Political frameworks	2	5	5.1	1.22	1.75	5	5.08	1.17	-4.10	5.53	5.74

Desir.: desirability
IQR: interquartile range (Q3 – Q1)
SD: standard deviation (in %)

hierarchical clustering algorithm, using the Euclidean distance, and ward method[10] (Kaufman & Rousseeuw, 2005; Ward, 1963) proved to generate the most feasible results for this rather small dataset. Three future scenarios for D2D mobility in 2035 were developed: (1) personalized D2D travel, (2) integrated D2D travel, and (3) the game changer. These scenarios are not mutually exclusive but offer different perspectives on the future. Below, they are described in more detail, supported by the comments provided by the experts in their interviews and in the Delphi survey.

(1) Personalized D2D travel: Scenario one describes digital-controlled future D2D travel, focusing on high personalization and customer needs. The scenario was evaluated as, on average, probable to occur with a strong impact on D2D mobility offers, and as somewhat desirable

[10] There are two algorithms for conducting ward clustering which can produce different outcomes. Please note that only Ward2 implements clustering after Ward (1963) in R (Murtagh & Legendre, 2014).

Table 5
Cluster statistics.

Scenario name	Included projection	P (mean)	I (mean)	D (mean)
(1) Personalized D2D travel	1,4,6,10	6.04	5.81	5.46
(2) Integrated D2D travel	5,14	6.29	6.08	5.97
(3) Game changer	16	4.53	5.11	4.18

for travel providers and D2D mobility.

The overall trend of personalization and individualization was declared by the interviewed experts in the preliminary study. Journeys shall be, for instance, on-demand, flexible, and adapted towards personal preferences (projection 1). This trend was confirmed by the Delphi results. In fact, personalization and individualization are already observable today in other sectors and has started to influence mobility. In 2035, passengers will increasingly demand personalized D2D mobility. Digitalization, new technical solutions, and novel concepts of mobility (e.g., urban air mobility) will enable this development and make it easier to cater to different needs. However, some experts have concerns that personalized D2D journeys might be too complex in terms of technology used, planning, and implementation, and too expensive to achieve by 2035. Today, long-haul air travel takes up a small market share within the overall transport sector, and personalized D2D could be even less important compared to short-haul traffic, only being relevant for business travelers and wealthy private travelers. As elaborated in Section 1, there are indicators of an increasing growth in long-haul routes (ACI, 2018; Airbus, 2018), which might invalidate this argument.

In any case, digitalization will support personalized travel. Internet-enabled mobility services will be the personal travel planners of passengers and completely control each aspect of their D2D journeys (projection 10). Developing a well-connected platform, allowing passengers to place all their inconvenient travel arrangements in the hands of technology in a single place, might create a new, improved travel experience. Real-time travel information and online navigation are two essential convenient aspects that will provide future passengers with significant benefits during entire journeys and will allow route optimization based on user preferences. Internet-enabled mobility services will also support seamless and intermodal mobility. Literature shows that passengers wish to receive more information on hospitality as well, such as restaurant recommendations or hotel information (Linton & Kwortnik, 2019). This could also be considered to have been confirmed by the Delphi results here, as the travel planner would control each aspect of the D2D journey, including hospitality. Another aspect will be the quality of data and, in turn, the quality of services and reliability. Yet, there might be obstacles concerning the achievement of complete control of the journey, e.g., cooperation limits between operators and other factors discussed earlier in this paper.

Looking at different passenger profiles, novel working environments will influence the requirements of business travelers (projection 4). The impact of new working on corporate travel, driven, for instance, by the high growth market of the gig economy (Sinicki, 2019), is huge and confirmed by interviewed experts and by the Delphi results. Flexible home office models with appropriate ICT might reduce the need to travel. On the other side, global collaboration could also promote mobility. Corporate passengers will expect a complete integration of their business life as travel time has long formed an unproductive part of working hours. This will also impact customers' preferences and the demand on public transport providers (e.g., to provide an office on rails), on airports (e.g., to provide co-working space), and in the cabin (e.g., to provide connectivity, space optimizing).

Passengers will also demand comfort and convenience along their D2D journey, such as options for sleeping and napping, or comfortable seating (projection 6). Looking specifically at long-haul air travel segments, some experts assume a reverting trend to more convenience again. As the personal comfort level during different activities and flight phases varies (Bouwens et al., 2017; Vink & Hiemstra-van Mastrigt, 2011), this will enable the opportunity for further differentiation, also to avoid the trend of commoditization of transport services, such as the long-haul air segment. One also needs to distinguish between the types of traveler. The available travel budget will, next to the travel purpose, influence customer demands. There will be price sensitive passengers, already existing today (Conrady et al., 2013), but also those with a need to maximize the benefits.

(2) Integrated D2D travel: Scenario two focuses less on differentiated products from single mobility providers, rather on collaboration to offer integrated services and create valuable travel time. It was also assessed as a probable occurrence, with a strong impact on the market and as desirable for travel providers. Compared to scenarios one and three, the integrated D2D travel scenario was evaluated with the highest probability to occur and the strongest impact.

Passengers will increasingly demand to use travel time along their D2D journey as value-adding time, such as for working, networking, education, and other activities (projection 5). Travel is not just the mere transport from A to B, as already mentioned in scenario one, but how this time is being used. For that purpose, digitalization will be more advanced and seamless internet access throughout a journey will be a crucial requirement, as also discussed in the literature by Javornik et al. (2018). Particularly applicable to long-haul air travel, this could also mean that the reduction in travel time might not be the highest priority anymore as longer travel times with a convenient working environment could be preferable to shorter travel times. At the same time, providers along a D2D travel value chain, such as public transport, airports, airlines, and travel platforms, will increasingly collaborate to offer integrated mobility products and services (projection 14). D2D travel affects various stakeholders and the growing passengers' demand for integrated services will drive the cooperation of multiple players further. For an integrated product, collaboration will be necessary, and the efficiency of the whole transport system can only increase in line with collaboration significant players. Some of those partnerships already exist (Eurowings, 2018; Lufthansa, 2019). Data privacy laws, open APIs, open data, and global connectivity might enable this development. New political frameworks and guidelines (e.g. Flightpath 2050 by the European Commission (2011)) need to support in order to overcome or manage diverging interests of the multiple stakeholders to be involved. Conversely, some experts have concerns that integrating these providers in the value chain is challenging, and that costs of integration would be higher than the benefits. Some envision third party integrators acting as the customer interface providing mobility services, combining different modes – with the risk of reducing mobility companies to pure logistics providers. Scenario three will elaborate on this further.

(3) Game changer: Scenario three contains an alternative future for 2035 towards a full monetization of the cabin by tech companies, disrupting the supply side along the travel chain and changing revenue streams for transport providers. This setting was evaluated as somewhat probable with a somewhat strong impact. Compared to scenario one and two, the game changer was the least desirable[11] one for the panelists.

Airlines, public transport, and airports will mainly focus on

[11] A possible desirability bias is discussed in the limitations.

providing basic transport services and tech companies, like Amazon or Google, will take over additional services offered to passengers, such as on-board shopping or entertainment (projection 16). Tech companies already provide a seamless and convenient booking experience today (Javornik et al., 2018). The customer interface creating a positive experience is the central value proposition here. Another business advantage for tech companies is the access to passengers' data and derived knowledge of customer preferences. Tech companies will be better positioned here and already have a head start today. In this scenario, the in-flight entertainment system will be relocated to personal devices, carried by each passenger, being equipped with applications from tech companies containing personalized content ready to use on-board and along the entire travel chain.

These three scenarios show possible developments in the future D2D air transport market. Whereas scenario one is focused on personalization and differentiated products and services offered by single mobility providers along the travel chain, scenario two focuses more on collaboration and partnership between providers to deliver integrated offers. Scenario three downgrades mobility companies to be purely transport providers with ancillary products only accessible through collaboration with tech companies. Looking at commonalities between the scenarios, one can conclude that digitalization and personalization will be significant drivers for future D2D travel. The 'annoying' travel time shall be used as pleasantly as possible: either for working, relaxing, or entertainment, which will be challenging to offer at all touch points across the travel chain. Flexible use of travel time according to personal preferences might be the key in all three scenarios, also showing that the projections are interlinked with each other. In addition, one still needs to distinguish between the types of traveler (business vs. leisure), the available travel budget (low-cost vs. premium) and travel distance (short-haul vs. long-haul).

4.4. Managerial insights

Forecasting tools are essential for long-term planning. Additionally, scenarios are helpful for organizations to gain deeper understandings of potential future business environments (Sarpong & Amankwah-Amoah, 2015) and hence make long-term plans. Findings from all three scenarios reveal possible future developments and can support the work and decision-making process of strategy departments, customer experience units, and product development processes departments of mobility firms, along the entire travel chain in this new paradigm. However, not all mobility providers might be equally affected by each scenario.

1) Personalized D2D travel: As the personalization and heterogeneity of passengers' needs will become increasingly important in this scenario, gaining knowledge about future D2D projections seems crucial and of high practical relevance, for the entire mobility industry, in order to adapt and innovate D2D products and services towards main passenger groups and their respective needs. The strong demand for personalization will be beneficial for suppliers, as they finally know their customers' destinations, routings, and service expectations. Due to many differentiated customer requirements, such as in the business context or regarding comfort and convenience, providers along the travel chain have many opportunities to position individualized products and services, also through partnerships. They might turn such amenities into key differentiators, especially for the premium D2D mobility market while also offering a menu of options, ranging from cheap (standardized) to expensive (individualized) products and services. Access and egress transport providers like public transport, railways, long-distance bus services, and taxis can offer basic, low-cost transport targeting price sensitive customers but also premium, highly customized mobility options with on-board amenities to enhance the travel experience or to enable work during travel. Likewise, airlines could consider such tailorable offers. Seat classes could be replaced by a basic transport seating system for every passenger, additionally equipped with bookable ancillary services and in-flight retail if required. In this way, customers' needs could be fulfilled to the maximum, while avoiding costs for unused services. As the entire value chain could be affected by this scenario, original equipment manufacturers (OEMs) would already start to support this trend with building flexible cabin systems and aircraft seats meeting minimum standards of each passenger.

Internet-enabled mobility services improve the customer experience. As described by Linton and Kwortnik (2019), there is currently a supplier–user gap, partly as it is challenging to keep information on mobile devices up to date. Incompatible systems, unwillingness to share data, and privacy protection are also identified as existing bottlenecks for creating a D2D travel assistant. To stay competitive, technical solutions are necessary to cope with these challenges. Due to the D2D scope, each transport provider would need to work equally towards this goal as the quality of data and in turn the quality of services and reliability will be the essential success factor.

(2) Integrated D2D travel: Compared to scenario one, providers in scenario two should not just exchange data but work in partnerships. Collaboration would enable offerings of integrated, D2D mobility products and services, increasing the travel experience for passengers and creating seamless and intermodal D2D mobility. Some D2D partnerships already exist, as discussed. Additional collaborations, such as between airlines, airports and public transport providers or airlines and the hospitality sector could increase seamless D2D travel further. Examples could be the support of passengers in managing disruptions due to delays within one travel segment with automated check-ins or rebooking services.

As the actual travel time shall be spent in a value-adding way, there is also a lot of room for improvement, new business opportunities, and the construction of unique selling propositions (USPs): offerings of ancillary services, dedicated spaces at the airport (office, playground, spa, etc.), and other touch points people come across along their journeys. In the D2D context, creating value-adding travel time could also mean reduced waiting times at airport security, for boarding and for connections, as currently passengers cannot always use that time efficiently. Applicable to airlines and the long-haul flights, the reduction in travel time might not be the highest priority anymore, which could enable lower aircraft airspeeds, resulting in operational cost savings and emission reductions.

(3) Game changer: Although this scenario is assessed to have the lowest probability, it could be considered a black swan scenario, transforming the market dynamics in the transport industry. It raises the question who will obtain the customer interface and earn on future passengers. The supply side should appreciate the business advantages of tech companies for organizational learning and business development purposes. Several experts assess this development as a growing trend, and it might be an alternative scenario particularly if airlines do not manage to change their roles to real D2D mobility providers, including next to transport services additional entertainment and hospitality offers. In fact, some already try to oppose this trend and invest heavily to stay in the game. In this context, there might also be a cooperation with ICT companies to provide the best offers to passengers, subject to their individual needs. Eventually, such cooperation could also increase ancillary revenues.

5. Limitations and conclusion

5.1. Limitations and future research

There are several practical ways to improve this Delphi study, including the improvement of the overall response rate. Since many corporate e-mail addresses have been approached for this study, e-mails with the word document attachment could have possibly gone into spam resulting into a lower response rate. However, literature also discusses that word document surveys may also create advantages, such as the personal approach via e-mail and the user-friendliness of the format compared to more complex online tools (Belton et al., 2019). The dropout rate of 12% in the second round was probably due to the holiday season with Christmas and New Year's Eve at the time of the survey. Due to self-interests of experts leading into possible desirability biases, the expert panel composition of this Delphi study needs to be assessed critically (Ecken et al., 2011; Melander, 2018). Looking at the segmentation of participants, one can see that 42% of experts come from academia, thus exceeding other segments. That might be due to the cooperativeness of scholars for taking part in such a study or based on the fact that personal networks were partly used for approaching experts. Such expert distribution could lead to biases; however, one could also argue that scholars possess a comprehensive overview of the topic of D2D mobility. As there are only two airline representatives as interview partners in the preliminary study and one in the Delphi, one could discuss the underrepresentation of airlines in the expert sample. Additional experts from airlines were contacted but, unfortunately, could not be won over for participation. Other experts from the area of management consulting do also know the aviation industry very well and their estimations are included in this research. At the same time, consultants as experts could also be seen rather critical, as they might try to shape results towards their business advantages. Another desirability bias could be explained by the rather low desirability for scenario three (D = 4.18). According to the game changer, transport providers would be downgraded to pure logistic providers, handing the interface to passengers and parts of their business to tech companies. However, tech companies are not included in the sample and D2D transport providers might hence assess this scenario as rather undesirable.

Generally, the Delphi technique is not an approach on its own but part of a wider research process (Rowe & Wright, 2011). Results may not be generalizable or enable theory building but rather provide insights into possible future developments (and to future-related questions otherwise difficult to address), depicted here in the three scenarios. Further research needs to be conducted to explore results in more depth and to balance out limitations of the future-oriented research method for enhancing utilities.

The year 2035 has been identified as an appropriate focus year for this Delphi study. One could also perceive this time frame to be too far removed from today, especially with technology and working environments advancing at an unforeseeable speed and new policies and laws to come. Further research could incorporate the replication of this Delphi survey with another focus year, such as 2025. Other markets (next to the European scope) could also be explored.

Passengers representing the demand side are essential stakeholders in the transport sector and were not included. That is due to the fact that this Delphi study aimed to focus on the assessment from the supply side (mobility provider). A complementary further study incorporating the demand side could be an approach for further research and comparison of results. A parallel Delphi study, such as done by Spickermann et al. (2014), would also be possible as a next research step. One could argue that the definition of D2D mobility can be expanded with additional stakeholders. Looking specifically at scenario three, the present panel could be complemented with experts from the hospitality industry, the tech industry, or from travel platform providers.

Further research is also possible by examining if companies today are already acting upon these identified future projections. Possible methods for conducting such trend testing analysis could be surveys, interviews but also data science techniques to provide quantitative results. Single projections could also be explored in more detail. For instance, projection 8 (eco-friendly journeys) is estimated as only ‘somewhat probable’ but as the second most desirable development according to the experts. As environmental aspects were seen as one major challenge for the overall transport system by several of the interviewed experts, and as of recent, are gaining increasing attention from broader society and political institutes, it might be important to explore the rationale behind this contrary result.

5.2. Summary

This paper presents findings from a Delphi survey, with 38 experts, on the assessment of 17 projections, concerning the question of what future D2D air travel in Europe could look like in 2035. The study tried to capture possible future projections on the D2D air travel market, considering trends from both the supply and demand sides. The Delphi was modified with results from a preliminary study, combining semi-structured expert interviews (N = 18), a literature review, and an exploratory workshop. Hierarchical clustering was applied to develop three future D2D mobility scenarios for the year 2035. Managerial insights, the limitations of this approach and future research were discussed. The research goal was two-fold: first, to identify projections that gained consensus and second, projections with dissent among experts. Several projections developed from the preliminary study, which also have foundations in previous research, were confirmed in the Delphi. The paper had also proven that the Delphi technique can be used as a feasible tool to capture potential D2D mobility projections and to develop future mobility scenarios.

Overall, future projections cannot be seen as isolated but interlinked. Findings also reveal that the passenger type, origin, the available travel budget, and travel distance still need to be taken into consideration when thinking about future D2D air travel. Digitalization and personalization will be the key drivers of D2D mobility in the long-haul market. Looking at the travel market, some projections can already be observed today, such as the overall trend for the personalization of products and services. Moreover, travel will not be just the mere transport from A to B anymore. Passengers will demand to spend their travel time in a value-adding way, such as working, relaxing or being entertained. Here, other additional activities are possible and might open up new business opportunities, such as for tech companies. Conversely, there is still disagreement between the experts regarding gendered travel preferences, ICT as a replacement of private long-haul journeys, and on the weight of age as an influencing factor on future travel needs.

To sum up, companies along the D2D air travel value chain face a variety of challenges and are urgently advised to adopt measures aimed at the personalization and digitalization of journeys overall and to establish partnerships with other providers and tech companies.

CRediT authorship contribution statement

Ulrike Kluge: Conceptualization, Methodology, Software, Formal analysis, Writing - original draft, Writing - review & editing. **Jürgen Ringbeck:** Conceptualization, Supervision, Writing - review & editing. **Stefan Spinler:** Conceptualization, Supervision, Writing - review & editing.

Declaration of competing interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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Supplementary materials

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