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On the move: understanding passenger experience and journey integration in multimodal travel at Europe's airports

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ABSTRACT

The rise of multimodal travel underscores the need to design a cohesive journey that considers the passenger experience from start to finish. Achieving this requires integrating diverse travel modes and coordinating infrastructure and mobility services, especially at major transport hubs.

This research employs qualitative methods to study passengers' experiences in multimodal travel involving air transport in-depth. Using autoethnographic and interview methods, researchers and practitioners undertook a total of 26 multimodal journeys involving air transport at four European airport hubs to study the travel phases these journeys and factors influencing the experience.

The findings indicate that multimodal journeys involving air transport differ significantly from traditional air-to-air journeys. Multimodal passengers encounter friction as they must cross more system boundaries compared to single-mode travel, with each system governed by its own distinct rules and regulations. Consequently, multimodal journeys require different passenger flows, infrastructure, and services than air-to-air journeys.

This research identified eight journey integration factors that impact the passenger experience of multimodal journeys involving air transport: (1) journey explanation and preparation, (2) personalized and pro-active assistance, (3) wayfinding, (4) proximity of modalities and facilities, (5) multimodal transfer services, (6) balanced transfer time, (7) waiting environments, and (8) in-travel comfort.

Importantly, the passenger experience in multimodal journeys involving air transport is influenced by passengers' expectations and cannot be understood in isolated segments, as travel phases are interdependent. This highlights the importance of designing multimodal journeys involving air travel as cohesive units and emphasizes the crucial role of collaboration among actors across transport systems.

1. Introduction

In recent years, transport has increasingly shifted its focus toward multimodal systems, where different modes of travel are combined within a single journey (Babić et al., 2022; Rodrigue, 2024). This development has created a growing need for seamless integration between transport modes and mobility services, allowing passengers to plan, book, and pay for their journeys across various mobility operators and travel modes (Gebhardt et al., 2016; Veeneman et al., 2020).

This shift has been driven by advancements in digitalization and sustainability, which enable travel to become faster, safer, more efficient, cost-effective, and to produce fewer CO_2-emissions (Butler et al., 2020; Docherty et al., 2018; Nikitas et al., 2020). Specifically, digitalization can enable flexible and passenger-centric mobility services that put passenger experience centre stage, instead of the mode of travel (Canale et al., 2019; Ceder, 2021; Docherty et al., 2018). This emphasis on passenger experience highlights the need to design travel as a coherent journey from departure to arrival, considering the passenger's perspective rather than segmenting it by individual modes of transportation (Babić et al., 2022; Jittrapirom et al., 2017).

For airport hubs and airlines, it is advantageous to explore multimodal travel from departure node to arrival node (see Figs. 1 and 2), given the current increasing societal and governmental pressure to reduce the environmental impact of aviation (European Commission, 2021). This pressure is driving the replacement of short-haul flights with more sustainable alternatives like trains and buses.

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In the aviation sector, two main network structures are commonly used to organize transportation. First, the point-to-point network model (Fig. 1) connects each airport node directly to others, treating all nodes and links as similar in supply, demand, and capacity (B. Wang et al., 2024). In this system, passengers enter the air transportation network via the landside area (letter A) of the departure node airport. They proceed to the airside area which is bounded by passport and security checks (Marquez, 2019), travel to the arrival node airport (letter B), and exit the (air-)network (letter C).

Second, the hub-and-spoke model (Fig. 2) organizes air transportation around central hubs, which serve as key nodes in the network (Kwasiborska et al., 2021; Wang et al., 2024). In this system, passengers enter the (air-)network via the landside area at the departure node airport (letter A) and are then transferred to central hubs (letter B). From there, they are directed to the arrival node airport (letter C) before exiting the air-network via landside (letter D).

Airport hubs facilitating the hub-and-spoke model can leverage this system by integrating more sustainable modes of transportation, such as trains and buses, into the network (Chiambaretto & Decker, 2012). These alternative modes could also function as spokes and, when fully integrated, may serve as replacements for existing flight connections, thereby seamlessly connecting to long-haul flights and enhancing the connectivity and sustainability of both airports and airlines (Chiambaretto & Decker, 2012; Givoni & Banister, 2006; Román & Martín, 2014). This integration requires the presence of train and bus infrastructure at airport hubs, as research shows that the proximity of the train station to the airport is crucial for successful cooperation between air and rail operators, shorter transfer times, and improved transfer services (Li et al., 2018).

1.1. *Multimodal travel involving air transport*

The mobility industry can be seen as a high-order system composed of multiple subsystems, each based on different transport modalities such as airplanes, trains, buses, and bicycles (Schmitt & Gollnick, 2016; Toet et al., 2022).

While travelers to and from airports always combine different modes of transport (Schmitt & Gollnick, 2016), multimodal travel shifts the focus from individual trip segments to an integrated journey (Allard & Moura, 2016; Bagamanova et al., 2022; Huang & Mu, 2018; Schmitt & Gollnick, 2016; Babić et al., 2022; Rodrigue, 2024). Multimodal travel, with its increased integration, represents an advancement over intermodal travel, in which multiple modes of transportation are used but each operates independently with its own services, such as ticketing and information (Babić et al., 2022; Rodrigue, 2024). In contrast, multimodal transport offers a single integrated ticket across different modalities, to ensure seamless journeys (Babić et al., 2022; Li et al., 2018; Román & Martín, 2014) and provides connection insurance to mitigate disruptions or missed connections during the journey (Román & Martín, 2014). This paper examines the concept of the multimodal journey

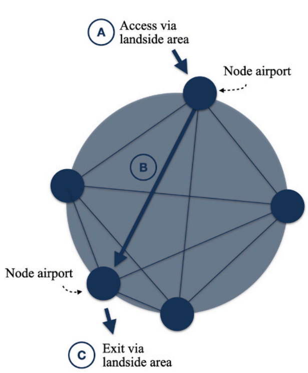

Fig. 1. Point-to-point network.

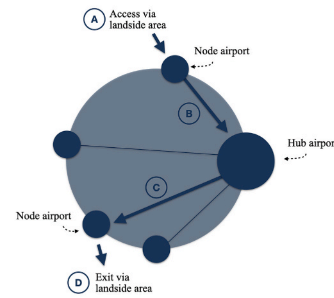

Fig. 2. Hub-and-Spoke network.

involving air transport (MJIAT), referring to multimodal travel from departure node to arrival node (see Figs. 1 and 2). Throughout the paper, we use the abbreviation MJIAT for conciseness. Air&rail, as well as air&bus, exemplifies a practical application of MJIAT.

The services facilitating multimodal travel involving air transport differ per airport hub and operator (Li et al., 2018). For example, airlines like Air France and Swiss, at the time of writing provide full baggage handling for their MJIATs. Additionally, Frankfurt Airport features a dedicated air&rail terminal, and partnerships between air and rail companies offer priority treatment at airport security. These initiatives suggest that instances of multimodal integration involving air transport are emerging, though they are not very common, and in not all MJIATs the legs are integrated to the fullest extent. This builds on previous research (Toet et al., 2022) that frames airports as not yet fully developed Multimodal Transport Hubs (MTHs) due to incomplete integration, especially on the service layer, but sometimes also lacking in infrastructural alignment.

There is a considerable body of studies on air transport and multimodal travel that examines the factors that influence the choice for a specific way of traveling, such as time, fares, and schedules (Avogadro et al., 2023; Babić et al., 2024; International Union of Railways, 2022; Pels et al., 2003; RLI, 2020). However, less studied is how to ensure and raise the quality of the multimodal journey, even though this plays a crucial role in determining whether passengers will reuse or even consider multimodal options in the future (Lai & Chen, 2011; Schmitt & Gollnick, 2016; Van Lierop & El-Geneidy, 2016; Wang et al., 2017). Specifically, passenger satisfaction with the overall journey is closely linked to the transfer experience during multimodal travel (Babić et al., 2022; Chauhan et al., 2021; Durand & Romijn, 2023). Therefore, this study focuses on the passenger experience of MJIATs, from the departure node to the arrival node. To achieve this, it is essential to understand what properties of MJIATs affect the passenger experience.

1.2. *Passenger experience*

We consider passenger experience to be related to the concept of user experience. The ISO organization defines user experience as the *"user's perceptions and responses that result from the use and/or anticipated use of a system, product or service"* (ISO, 2019, p.4). In the context of travel, the passenger is considered a user of the travel service. The perceptions and responses that user experience encompasses include emotions, beliefs, preferences, comfort, behaviors, and accomplishments (ISO, 2019), which arise from external stimuli (Desmet, 2003). These perceptions and responses are highly contextual, meaning that the experience depends on where, when and with what purpose interactions take place (ISO, 2019; Roto et al., 2011).

The quality of a passenger experience is often defined by a combination of aspects. One key element is the efficiency of the process (Hernandez Bueno, 2021). Kirk et al. (2012, p. 8) underscore the importance of *"understanding the activities, the sequence of activities and the reason why they were carried out"* to improve the passenger experience at airports. At the same time, previous studies show that mandatory airport procedures, such as security checks, can cause stress (Kim et al., 2020). In addition to process efficiency, other features, such as comfort, services, and shopping opportunities, also play a role in shaping passengers' perceptions (Hernandez Bueno, 2021).

1.3. Multimodal passenger experience

Multiple authors stress that integrating multimodal journeys at hubs requires consideration of both infrastructure and services (Bell, 2019; Chauhan et al., 2021; Monzón et al., 2016; Toet et al., 2022). We reviewed existing literature to identify factors from both categories that affect the passenger experience. The review was conducted using Scopus and Google Scholar, applying keyword searches such as 'multimodal,' 'transfer,' 'level of integration,' 'passenger experience' and their synonyms. The review was structured in three steps: first, we examined passenger journey experiences with transfers at airport hubs; second, we synthesized factors around mobility hubs; and finally, we focused on multimodal passenger experience factors at airport hubs, particularly concerning air&rail and air&bus transfers.

1.3.1. Multimodal infrastructure for passenger experience

From the literature, we identified four clusters of passenger experience factors related to the infrastructure of the (multimodal transport) hub: (1) *wayfinding and signage,* (2) *hub facilities,* (3) *waiting environment,* and (4) *hub design.*

First, wayfinding and signage help passengers navigate efficiently through the transfer environment (Nielsen et al., 2021; Wang et al., 2020). Clear information and signage within the terminal are critical for enhancing the passenger experience at airport hubs, making services easier to find and use (Allen et al., 2020).

Second, the presence of hub facilities, such as shops and restaurants, enhances the overall attractiveness of a hub (Hickman et al., 2015). Additionally, passengers prioritize safety and security, both within the hub and its surrounding areas, as some of the most significant factors influencing their experience (Eboli & Mazzulla, 2015; Hernandez & Monzon, 2016). Furthermore, facilities designed specifically for passengers with impairments contribute to the hub's overall appeal (Eboli & Mazzulla, 2015).

Third, well-maintained waiting areas, which include adequate seating and shelters, can contribute to a positive passenger experience (Eboli & Mazzulla, 2015).

Finally, airport hub design encompasses both ambiance and layout, which includes characteristics such as a clean and spacious terminal, pleasant lighting, and optimal acoustic quality. These factors are fundamental in shaping the passenger experience (Geng et al., 2017; Wattanacharoensil et al., 2016). When these design elements fail to meet expectations, they can negatively impact passenger satisfaction (Geng et al., 2017). According to Hernandez and Monzon (2016), the walking experience is influenced by environmental factors and distance, with positive experiences frequently associated with shorter walking distances. Given that walking distances are constrained by fixed infrastructure, enhancing passenger comfort during extended walks can be achieved by improving the walking environment with amenities such as air conditioning and rain shelters (Hernandez & Monzon, 2016; Wang et al., 2020). Moreover, for effective multimodal cooperation, the proximity of train and bus stations to airports is crucial, as co-locating these hubs offers passengers greater convenience and reduces transfer times (Li et al., 2018).

1.3.2. Multimodal services of passenger experience

Our review of existing literature resulted in five clusters of passenger experience factors associated with the services of the (multimodal transport) hub: *(1) journey process information, (2) personal communication, (3) special transfer services, (4) ticketing services, and (5) transfer coordination.*

First, keeping passengers informed about flight status and the movement of their baggage provides a sense of autonomy (Hernandez Bueno, 2021; Allen et al., 2020). Access to real-time information is critical for keeping passengers informed throughout their journey, thereby enhancing their sense of control (Cascajo et al., 2019; Watkins et al., 2011). Holistic information for trip planning enables passengers to make informed decisions and manage their journey effectively (Antwi et al., 2020; Babić et al., 2022).

Second, communication between passengers and airport personnel significantly influences airport satisfaction (Antwi et al., 2020; Lubbe et al., 2011).

Third, special transfer services include options such as baggage handling and shuttle services. Babić et al. (2022) and Wang et al. (2020) argue that baggage services should be integrated within the airport feeder system, allowing passengers to check in hold baggage at the departure station. However, Román and Martín (2014) found that baggage handling is more appreciated by leisure passengers, as business passengers typically do not travel with hold baggage. They also noted that costs associated with expanding baggage handling systems at stations pose a significant challenge, as passengers are often hesitant to pay additional fees for these services.

Finally, transfer coordination, including fast movement and minimal waiting times, is crucial for the multimodal passenger experience (Abenoza et al., 2019; Babić et al., 2022; Hernandez Bueno, 2021; Wang et al., 2020). While short transfer times are essential for connectivity, excessively long waits are inconvenient, and too short waits may cause stress due to the risk of missed connections (Jiang et al., 2022; Román & Martín, 2014; Song et al., 2018).

1.4. Aim and research question

From the previous research we conclude that designing MJIATs as integrated experiences is crucial. Although previous studies provide insights into the factors that influence the (multimodal) passenger experience, these studies mostly focus on passenger satisfaction, which is only one aspect or a result of the overall travel experience. Moreover, only a few studies address multimodal travel with airports as integrated parts of the trip, and most studies rely on existing literature and quantitative research methods such as passenger surveys.

This highlights the need to study MJIAT experiences to better understand the travel phases of these journeys, the factors that influence the passenger experience, and how airports currently facilitate MJIATs. Hernandez Bueno's (2021) emphasis on the need to study passenger experiences in context to inform passenger-centered design solutions, further underscores the need for a qualitative research approach in this matter. This could complement and expand the existing (mostly quantitative) discourse.

This paper presents an in-depth qualitative study in response to growing calls within the transportation research community to complement predominantly quantitative methods with qualitative studies, thereby offering a more comprehensive understanding of travel behavior (Farinloye et al., 2019; Julagasigorn et al., 2021). As argued by Eisenhardt and Graebner (2007, pp. 25–26), qualitative research plays a key role in theory building by providing rich empirical data that generates accurate, interesting, and testable theories, serving as an essential complement to traditional deductive research.

This study identifies the phases that form the backbone of MJIATs, and which other factors influence the multimodal passenger experience, thereby enabling researchers to further study these journeys, as well as practitioners to develop effective multimodal travel solutions. This research aims to address the following questions: *1) How are MJIATs structured in terms of travel phases?* and *2) Which properties of MJIATs affect the passenger experience, and in what ways?*

By examining these questions, this study seeks to provide insights into how MJIAT can become a more attractive alternative for traditional air-to-air travel by optimizing for passenger needs and expectations.

2. Method

Given the variability of multimodal travel involving air transport and associated services, this study adopts an exploratory case study (Patton, 2014). The case study method is widely recognized for its effectiveness in investigating phenomena within real-life contexts (Yin, 2003). We opted for qualitative methods as these allow for the uncovering of the "why and how" of the elements affecting the passenger experience (Miles et al., 2014). As long-distance multimodal travel through airports is an emerging phenomenon, qualitative research is a very suitable approach, as it can help to inductively uncover unknown factors. Patton (2015) argues that surveys and performance indicators are insufficient for discovering new insights, as they are usually based on predetermined hypotheses and established metrics.

For data collection, we utilized two qualitative methods of data collection to capture detailed experiential data: autoethnography and reflective interviews (Fig. 3). Autoethnography was chosen for its extended researcher engagement with the phenomenon (an MJIAT in this case). Autoethnography makes it possible to study situational and experiential variables that might remain hidden in large-scale surveys (Adams et al., 2017; Wall, 2006). The study involved two researchers and nine transportation practitioners who acted as passengers to gather behavioral, sensory, and emotional data (Eccles & Arsal, 2017). The intention of involving practitioners was to combine personal travel experiences with professional expertise, the latter leading to the informants being more sensitized (Sanders & Stappers, 2014) to the studied phenomenon and enabling more nuanced reflections on the operational aspects of MJIATs. In service design, our autoethnographic approach corresponds to what is often referred to as mystery shopping, where researchers act as customers and document their own service experiences, although in our case the focus was not evaluative but rather exploratory (This is Service Design Doing, n.d.). After the data collection by practitioners, reflective interviews were conducted to enhance data quality, address discrepancies in documentation, and ensure that salient observations were captured.

The unit of analysis (Yin, 2003) was the MJIAT, examined across various cases at different airport hubs. Each case represented a specific MJIAT, with transfers occurring at major airport hubs. The emphasis was placed on the journey as a whole rather than on the specific hubs, thus treating the airport hubs as contextual elements influencing the MJIAT.

2.1. Case selection

We adopted a comparable case sampling strategy, intending to select cases with relevant characteristics (Miles, Huberman, & Saldaña, 2014), while also diversifying the execution of the MJIATs offered. Airports providing MJIATs were selected through a two-step process to meet the study criteria.

In the first step, criteria for journeys to be included in the study were:

- *MJIAT*: in addition to an air journey, the journey should feature one leg of train or bus transport, a single integrated ticket, and connection assurance.
- *Transfer at airport hub*: the transfer location in the journey should be an airport serving as a hub in the hub-and-spoke model, as these were seen as having the largest potential to integrate various long-haul travel modalities in the future.
- *Substitution potential*: the train or bus leg should connect destinations within the airline's network, with potential for substitution of short-haul flights in the long term.
- *Modality proximity*: airport hubs facilitating the multimodal transfer should feature integrated train or bus stations, as literature indicates that close proximity of the connected modalities is an important enabler for multimodal hubs (Li et al., 2018).
- *Passenger volume*: the airport hub facilitating the multimodal transfer should handle more than 20 million passengers in 2019 (Airport Council International, 2022), to ensure comparable operational complexities, including security processes.
- *Location*: journeys should take part within Europe to ensure alignment with EU regulations and to minimize travel challenges posed by COVID-19 restrictions during November and December 2022.

Based on these criteria, we identified six MJIATs with multimodal transfers facilitated by these airport hubs: Amsterdam Airport Schiphol (AMS), Charles de Gaulle Airport Paris (CDG), Frankfurt Airport (FRA), Helsinki Airport (HEL), Zurich Airport (ZUR), and Vienna Airport (VIE).

In the second step, the multimodal service offerings of these MJIATs were assessed: 1) comprehensive baggage handling for multimodal passengers, 2) dedicated multimodal touchpoints (referred to as MM touchpoints), and 3) specialized transfer services (Table 1).

For the first round of data collection (autoethnography by two researchers) this led to the selection of cases at AMS, CDG, FRA, and HEL. AMS, CDG, and FRA were selected as they included two of the three multimodal services, while the journey at HEL included a bus

Table 1
Comparison of additional services at different airport hubs.

Multimodal service offerings	AMS	CDG	FRA	HEL	ZUR	VIE
Full baggage handling	–	V	–	–	V	–
Dedicated multimodal touchpoints, such as an air&rail terminal	V *(at departure station)*	V *(at departure station)*	V *(at airport station)*	–	–	–
Special transfer services, such as dedicated fast lanes for multimodal travelers	V	–	V	V	–	–

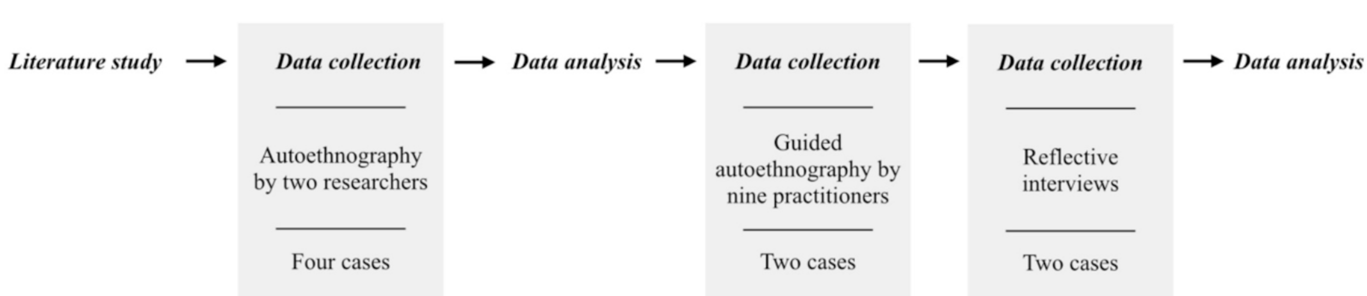

Fig. 3. Overview of the method followed.

connection instead of a train, introducing a valuable variation. The MJIATs were selected for the sequence from train/bus-to-plane (instead of plane-to-train/bus) because in these journeys the airport transfer is more critical, as passengers then must navigate mandatory airport procedures such as check-in, baggage handling, and security checks.

The data collection in the second round (guided autoethnography by nine practitioners) then focused on the MJIATs through CDG and AMS. Again, the journey through CDG was selected for the integrated baggage handling it offered, which is identified in the literature as a crucial factor for successful MJIATs and one of the most significant barriers to effective implementation. On the other hand, the journey through AMS was selected to investigate in the reverse direction compared to the first round of data collection (plane-to-train), to enhance understanding of its level of integration and the factors influencing it.

The selected journeys took place within Europe, meaning there was no immigration and border control. The journeys made are presented along with their order and timing Table 2 Case 2 and Case 5 are identical journeys, although offered by different airline operators that collaborate through code-sharing.

2.2. Data collection

To investigate the phases and experiences of MJIATs, data was collected in two rounds (also shown in Table 2).

Round 1involved four different train/bus-to-plane journeys, each independently examined by two researchers using autoethnography. This phase generated eight journey datasets (four journeys, collected by two researchers). In the remainder of this article, these researchers are referred to as ‘researcher-passengers’.

Round 2aimed to confirm and complement the findings from round 1, and to include different perspectives from the practitioners. To this end, nine practitioners from the air and rail sectors participated in guided autoethnography. Drawing on their prior knowledge of MJIAT, the practitioners provided nuanced and sensitized insights (Sanders & Stappers, 2014). Unlike round 1, which exclusively focused on train/bus-to-plane journeys, round 2included journeys in both directions. This phase resulted in 18 journey datasets (two journeys, collected by nine practitioners). In this article, these practitioners are referred to as ‘practitioner-passengers’.

Table 2
Overview of the travel schedule of cases 1 – 6.

	Departure node	Hub airport	Arrival node
Data collection round 1: Autoethnography by two researchers			
Case 1. Train – airport (AMS) – Plane	ZYR Train Station (Brussel, Belgium)	AMS Airport (Amsterdam, the Netherlands) *Planned transfer tim. e: 1.5h*	BER Airport (Berlin, Germany)
	6/11/2022	*6/11/2022*	*6/11/2022*
Case 2. Train – airport (CDG) – Plane	ZYR Train Station (Brussel, Belgium)	CDG Airport (Paris, France) *Planned transfer time: 3h*	MUC Airport (Munich, Germany)
	25/11/2022	*25/11/2022*	*25/11/2022*
Case 3. Train – airport (FRA) – Plane	ZMU Train Station (Munich, Germany)	FRA Airport (Frankfurt, Germany) *Planned transfer time: 2.5h*	RIX Airport (Riga, Latvia)
	28/11/2022	*28/11/2022*	*28/11/2022*
Case 4. Bus – airport (HEL) – Plane	TKU Bus Station (Turku, Finland)	HEL Airport (Helsinki, Finland) *Planned transfer time: 2.5h*	AMS Airport (Amsterdam, the Netherlands)
	01/12/2022	*01/12/2022*	*01/12/2022*
Data collection round 2: Guided autoethnography by nine practitioners			
Case 5. Train – airport (CDG) – plane	ZYR Train Station (Brussel, Belgium)	CDG Airport (Paris, France) *Planned transfer time: 2.5h*	AMS Airport (Amsterdam, the Netherlands)
	22/03/2024	*22/03/2024*	*22/03/2024*
Case 6. Plane – airport (AMS) – train	FRA Airport (Frankfurt, Germany)	AMS Airport (Amsterdam, the Netherlands) *Planned transfer time: 2h*	ZYR Brussel South-Midi Train Station (Belgium)
	21/03/2024	*21/03/2024*	*21/03/2024*

2.2.1. Data collection round 1: Autoethnography

In round 1of the data collection, two researcher-passengers assumed the role of passengers during four distinct train/bus-to-plane journeys. These included the first author of this article and a research assistant, both experienced in multimodality research. While they were familiar with airports, neither had previously transferred at the selected hubs or undertaken a MJIAT. Desk research conducted during case selection informed their expectations regarding aspects such as baggage handling, touchpoints, and priority lanes, posing potential biases. An analytical framework, outlined in Section 2.3, details the expectations of data collectors and is designed to minimize potential subjective influences on the results.

Using autoethnography combined with the think-aloud method (Adams et al., 2017; Boren & Ramey, 2000), the researcher-passengers documented their behavioral, sensory, and emotional experiences throughout the journey (Eccles & Arsal, 2017).

Prior literature has indicated that events leading up to the transfer can impact experiences in subsequent phases of a journey (Hernandez Bueno, 2021). Therefore, data collection already began at the departure node (train/bus station) and continued until the airport gate, capturing key phases and influential properties of the MJIAT via audio recordings, photographs, and notes.

The journeys were conducted in November and December 2022, with planned transfer times of 1.5h at AMS, 3h at CDG, 2.5h at FRA, and 2.5h at HEL (see Table 2). One researcher-passenger carried hold baggage, while the other traveled with hand baggage only, in order to diversify the passenger experiences. To ensure independent observations and to reduce mutual influence, they undertook the journeys separately, with rest days between trips to facilitate immediate transcription of audio recordings.

The trips were booked through the respective airlines (KLM, Air France, Lufthansa, and Finnair). A train delay occurred in Case 1 but did not disrupt the connection, while in the other cases no delays occured.

2.2.2. Data collection round 2: Guided autoethnography

Round 2of the data collection involved nine Dutch practitioners from government, rail and aviation operators, and infrastructure managers. Each participating company contributed at least one practitioner, with most providing two. These individuals were selected because they were actively engaged in strategic initiatives to develop air&rail journeys in Europe, giving them valuable expertise on MJIATs. Although none had prior first-hand experience with MJIATs, their professional knowledge allowed for more in-depth and nuanced insights (Sanders & Stappers, 2014). Participation was voluntary, with all practitioner-passengers providing informed consent (see Table 3 for an overview of their organizations).

The practitioner-passengers employed guided autoethnography through service safaris, supported by one of the researcher-passengers from the first round of data collection (AT, the first author) and the second author (JK), who both traveled with them during their journeys (Stickdorn et al., 2018). Using diaries designed by the first author (Visser et al., 2005), practitioner-passengers documented their observations through photographs and notes, guided by reflective prompts to describe key phases and properties influencing their experiences.

Following the experiences from round 1, informants were asked to go through the booking process before the actual travel. Although the booking process itself was not analyzed, as it fell outside the scope of this study, it was important that all practitioner-passengers completed the

Table 3
Overview of practitioner-passengers and the data collection groups. Practitioner-passengers are coded with the first letter of their organization.

Practitioner-passengers	Organization	Hold baggage	Group 1	Group 2	Group 3	Group 4
A1	Airline operator	–		V		
A2	Airline operator	–	V			
AI1	Airport infrastructure manager	–			V	
AI2	Airport infrastructure manager	*Yes*				V
R1	Rail operator	–		V		
R2	Rail operator	*Yes*			V	
RI1	Rail infrastructure manager	–				V
RI2	Rail infrastructure manager	*Yes*	V			
G1	Government	*Yes*		V		

steps up to the point of payment. The first author (AT) then finalized the bookings to ensure consistent travel arrangements (e.g., same flights) across groups. This approach ensured that all practitioner-passengers had the same level of information as actual passengers would receive when booking a journey.

Furthermore, data collection covered the journey from the departure node (train/bus station or airport) until the arrival node (airport gate or train platform). Journeys took place in March 2024 (Table 2) and included train-to-plane (Case 5) and plane-to-train (Case 6) sequences, with planned transfer times of 2h at AMS and 2.5h at CDG.

The practitioner-passengers traveled in groups, as classified by the first author (AT). Each group consisted of members from different organizations, with one practitioner-passenger in each group carrying hold baggage to compare experiences (Table 3). This arrangement encouraged cross-sector perspectives while reducing mutual influence. The practitioner-passengers were asked to document their observations immediately after each journey to ensure clarity and prevent confusion with later experiences.

Unexpected flight delays during round 2provided additional insights into how disruptions impact passenger experiences. Despite these delays, the connections were successfully made.

To capture all insights and address possible discrepancies in documentation, reflective interviews were conducted a few days after the journeys. Each interview, lasting approximately 30min, was guided by structured yet conversational questions (Patton, 2014), such as: *"How would you describe your experience of the journey and why?"*; *"What aspects should be improved as quickly as possible?"; "What aspects of the journey did you find particularly positive?"; and "Looking back, what made the biggest impression on you?"*.

The interviews, conducted via videoconferencing in the practitioner-passengers' native language (Dutch), allowed practitioner-passengers to reflect while their experiences were still fresh in their minds. To avoid bias, the first author did not review the journey data prior to the interviews.

2.3. Data analysis

Thematic analysis was used by applying the six-phase approach described by Braun and Clarke (2006), consisting of the following steps: 1) familiarizing with the data, 2) generating initial codes, 3) searching for themes, 4) reviewing themes, 5) defining and naming themes, and 6) reporting findings.

Data familiarization involved transcribing audio recordings and notes from round 1and creating verbatim transcripts of the diaries and refining the interview transcripts from round 2.

This was followed by the generation of initial codes, conducted iteratively using an analytical framework. The framework was developed as a lens for data analysis, aiding in the interpretation of the material and providing a reference for understanding specific situations (Malterud, 2001).

The framework consists of two key models. First, it incorporates the foundational elements of customer journey maps, which illustrate the journey from the user's perspective by highlighting its phases, the touchpoints that facilitate the journey, and the associated emotions (indicated by letter A in Fig. 4) (Van Hagen & Bron, 2014). Second, the analytical framework incorporates the Product Emotions Model proposed by Desmet (2003), which posits that user emotions emerge from an appraisal process that evaluates a product based on a user's concerns, such as goals, attitudes, and standards (letter B). During data analysis, Desmet's model helped to analyze and indicate the presence of specific expectations, desires, or knowledge in the users, which may influence their experience.

Both models demonstrate that emotions are shaped by several elements, including the phases and touchpoints in customer journey maps, as well as product usage and user concerns in the Product Emotions Model. This study aims to identify the phases and properties of MJIATs that affect passenger experiences; therefore, the "product" in this context refers to the MJIAT itself. This journey includes phases and touchpoints from the customer journey map (Letter C). This led to the development of the study's analytical framework (Letter D in Fig. 4), in which the journey phases, touchpoints, but also (unforeseen) circumstances, of the MJIAT are appraised based on user concerns, resulting in the emergence of user emotions.

The analytical framework facilitated the generation of codes, which were applied first to the data from Round 1 of the collection and later to Round 2. Its application is detailed below and illustrated in Table 4.

- Step 1: Identify meaning units (Graneheim & Lundman, 2004) with a focus on appraisals.
- Step 2: Condense meaning units and assign codes describing the appraisal.
- Step 3: Assign an 'Emotion' code based on the categories from Desmet's model (2003).
- Step 4: Link the identified emotion code to the corresponding *'Concern'* category (goal, attitude, or standard) and assign a code describing the concern.
- Step 5: Identify the relevant codes for the condensed meaning unit that correspond to the subcategories *'phase'*, *'touchpoint'*, and *'circumstance'*, all of which fall under the broader category *'journey stimuli'*.

This process resulted in the identification of a total of 231 codes which were classified into categories and subcategories in accordance with the analytical framework. This showed that most of the codes were part of the appraisal category (158 codes). During the coding process, it was observed that not all subcategories of the analytical framework, specifically *'attitude concern'*, *'aesthetic emotions'*, and *'interest emotions'*, appeared to be present in the dataset. Additionally, no circumstances were identified that drastically affected the journey compared to the other journeys. The emotions identified within the dataset were further classified into positive and negative categories.

This coding process provided insight into the phases of MJIATs and was followed by the third, fourth, fifth, and sixth steps of Braun and Clarke's (2006) thematic analysis to uncover the properties that influence the multimodal passenger experience. In this process, patterns within the codes and (sub)categories derived from Data Collection

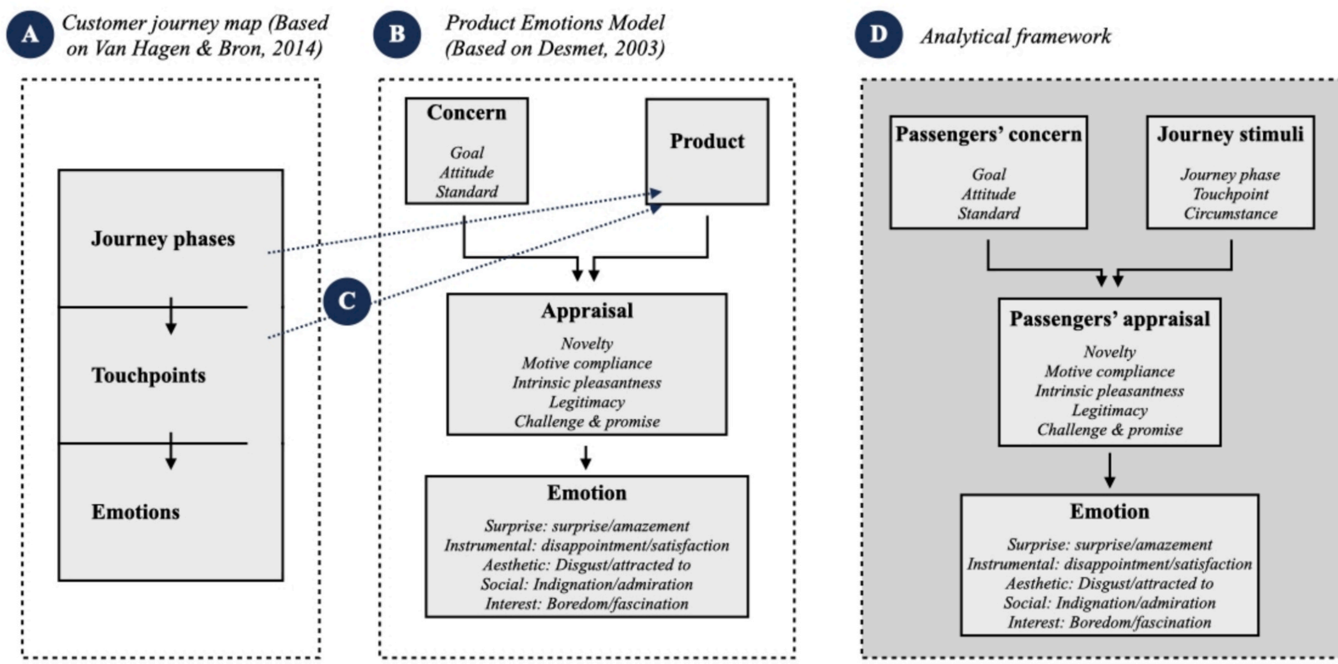

Fig. 4. Buildup of analytical framework, based on customer journey map and Product Emotions Model.

Table 4
Example of Step-by-step guide for applying the analytical framework in data analysis.

Step 1. Meaning unit	Step 2. Passenger's appraisal	Step 3. Emotion	Step 4. Concern (goal, attitude or standard)	Step 5. Journey stimuli (phase, touchpoint, circumstances)
"We only have an hour to go, and I still have to check in my bag. The train didn't say anything at all about checking in; they just said, 'Sorry, we're delayed…'" (researcher-passenger, Case 1).	Short transfer time causing stress	Disappointed	Goal: Seamless trip	Phase 5): Arrival at airport station
"The MM touchpoint is really close to the platform, barely a two-minute walk, and I think that's really a big plus" (airline operator, Case 5).	MM touchpoint next to platform	Satisfied	Goal: Seamless trip	Phase 3) go to platform

Round 1were identified, reviewed, and refined (Braun & Clarke, 2006). The resulting patterns were established at the level of journey integration factors, representing critical aspects of service and infrastructure design that facilitate passenger-oriented MJIATs. Subsequently, the codes and (sub)categories from Data Collection Round 2were compared with the existing factors to identify similarities and uncover new elements, and if necessary new findings were integrated into the existing factors. Insights that differed more substantially from the established factors prompted the development of new factors. Finally, the data from Round 1were revisited to ensure consistency with the expanded set of factors. This analysis was conducted by the first author and reviewed by all co-authors.

Illustrative quotations from informants were compiled and paraphrased for clarity and translated to English. The final paper was reviewed and approved by all authors.

3. Results

The results of the case studies are presented in three sections. Section 3.1 describes the phases of MJIATs and their effects on the passenger experience. Section 3.2 outlines the journey integration factors related to the passenger experience of MIJATs. Section 3.3 demonstrates how well the factors were grounded in the data sets to estimate their validity.

3.1. Phases of MJIATs

This chapter outlines the phases of MJIATs and how their components impact the passenger experience. Fig. 5 illustrates the structure of train/bus-to-plane journeys (Cases 1, 2, 3, 4, and 5), while Fig. 6 depicts the plane-to-train journey (Case 6).

Figs. 5 and 6 illustrate that MJIAT can consist of up to 10 phases; however, the number of phases may vary across different cases. We identified two main journey structures: the segmented MJIAT, where the two legs are primarily treated as separate journeys, and the partially-integrated MJIAT, where the phases are (partially) designed to function as one continuous journey. Understanding the structure of a MJIAT is crucial for improving the passenger experience, as this experience depends on the sequence of phases and their purpose (Hernandez Bueno, 2021; Kirk et al., 2021).

3.1.1. Segmented MJIAT (C1, C3, C4, C6)

The segmented journey structure was observed in both train/bus-to-plane and plane-to-train journeys (respectively cases 1, 3, and 4, and

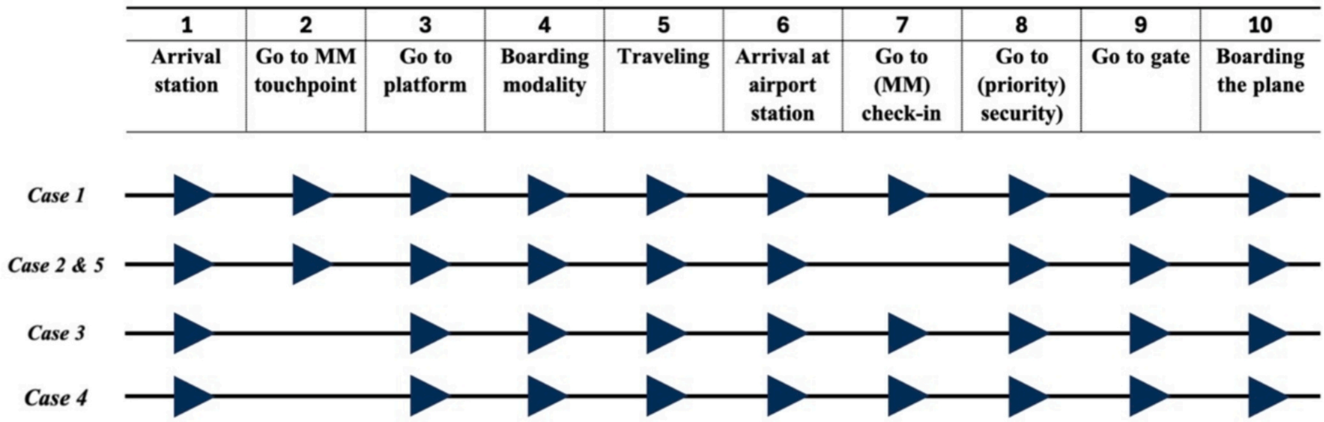

Fig. 5. Overview of the phases involved in the train/bus-to-plane journey for cases 1–5.

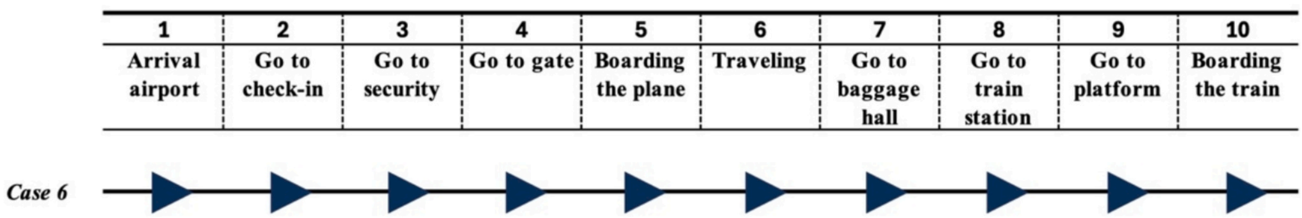

Fig. 6. Overview of the phases involved in the plane-to-train journey for case 6.

case 6). During these journeys, the airport procedures, including baggage handling and security screening, were conducted during the transfer at the airport, resulting in the trip feeling like two separate journeys (Fig. 7).

In case 1 and 3, efforts had been made to make the journeys flow more smoothly into each other. In Case 1, passengers used an MM touchpoint at the train station for check-in (Phase 2), where airline staff provided information about the upcoming phases of the journey. In Case 3, a special MM touchpoint at the airport hub allowed baggage check-in (Phase 7), offering a faster and more convenient process during the multimodal transfer at the airport.

3.1.2. *Partially-integrated MJIAT (C2 & C5)*

In this journey structure, phases are designed to function as one continuous journey (Fig. 8). This structure was observed in Cases 2 and 5, where baggage check-in for the whole journey happened at the train station, at the same MM touchpoint as in Case 1 (phase 2). This shift of baggage check-in from the airport to the node station, was seen as a convenience: *"I really see baggage check-in [at the station] as a big plus."* (airline operator, Case 5).

Drawbacks of the partially-integrated structure included increased demands on train and bus stations regarding equipment, staffing, training, physical space, wayfinding, and an overall rise in travel time. While fewer steps were required at the airport, passengers still faced long waiting periods at the airport. Additionally, the need to check in baggage earlier at the train station further prolonged the journey, as described by a practitioner-passenger: *"And then we ended up waiting for*

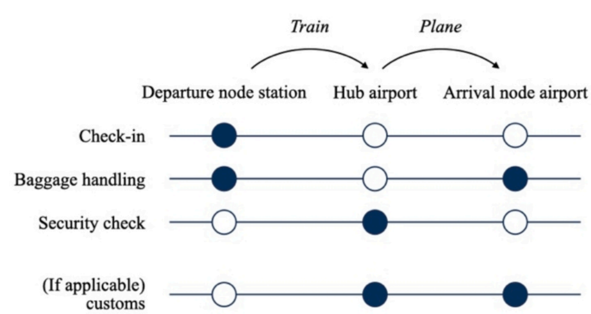

Fig. 8. Division of airport procedures in partially-integrated multimodal train-to-plane journey.

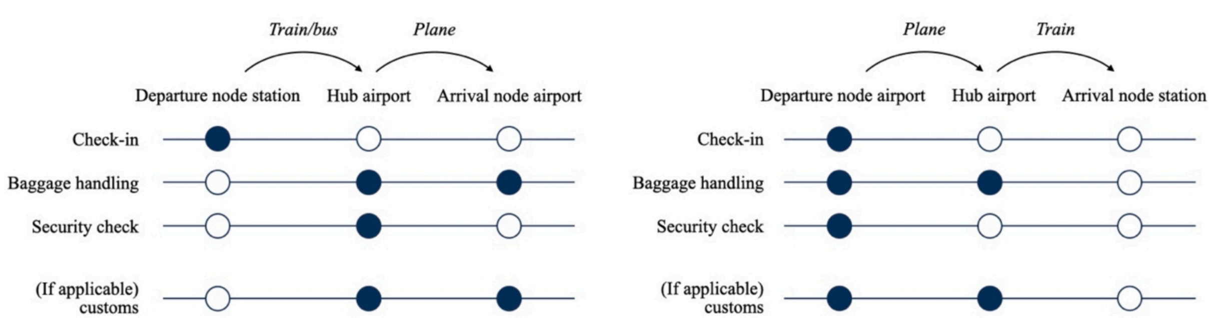

Fig. 7. Division of airport procedures in segmented MJIATs, with the train/bus to plane sequence on the left and plane-to-train on the right.

a long time. I thought to myself, I saved time at the beginning of the journey; they could have planned the transfer with a shorter connection time as well. I wouldn't have had to arrive at that station in Brussels earlier if I had this time anyway." (rail operator, Case 5).

3.2. Journey integration factors

This section describes eight journey integration factors that influence the multimodal passenger experience. These factors were identified through thematic analysis within the analytical framework. Findings from Data Collection Round 1were compared with the data from Case 5, with the guided ethnography by practitioner-passengers. Especially, Case 6 provided new insights, potentially due to the reversed travel sequence (plane-to-train). Table 5 and Table 6 present an overview of identified journey integration factors across the travel phases, highlighting in which phases of the journey factors play a role.

The following subsections detail each factor, addressing passenger concerns (goals and standards), the associated touchpoints, and their impact on the overall passenger experience.

3.2.1. Journey explanation and preparation

The findings indicate that journey explanation and preparation are critical for a stress-free journey and seamless multimodal transfer at the airport. Key touchpoints supporting this factor include terminal information, itineraries on boarding passes, app- or website-based information, real-time updates on screens across various transport modes (e.g., plane, train, bus), instructional videos, and assistance from staff members. The data emphasize the importance of these touchpoints, particularly at the start of the journey, as multimodal travel involves unfamiliar structures and rules compared to single-mode or non-integrated travel. One researcher-passenger reflected on the positive impact of receiving detailed instructions from airline staff during the transition phase, noting it contributed to a smoother experience: *"She provided detailed information about the train departure, the designated carriage number, seat allocation, and the terminal I needed to go to in Paris, so I received a lot of useful information."* (researcher-passenger, Case 2).

Additionally, informants indicated that preparation for each subsequent phase of the journey, such as knowing where to stand during train boarding, estimating walking distances, and locating key facilities, was essential for maintaining a "stress-free" experience.

Cases 4, 5, and 6underscore the benefit of instructional videos that include information on passenger rights, schedules, and what is or isn't included in the journey. In Case 4, the video was shown on the bus, and the researcher-passengers identified it as a positive aspect of the journey: "I was on the bus, and then a video played showing everything you needed to do when you arrived at the airport. That was really helpful." (researcher-passenger, Case 4). In Cases 5and 6, a video was available online but not proactively shown on screens, resulting in passengers missing it due to a lack of awareness.

Transparency about delays emerged as another critical aspect of a positive passenger experience, as indicated by data from Case 6. However, other cases showed a lack of tailored information for MJIATs. Informants observed that MJIAT remains relatively unfamiliar to staff, resulting in inconsistent communication and information provision during critical moments of the journey.

3.2.2. Personalized and pro-active assistance

Personalized and pro-active assistance plays a crucial role in ensuring a stress-free journey, particularly by facilitating smooth transfers and providing clear journey information. Key touchpoints found for this assistance include digital applications and trained staff at stations, at MM touchpoints, and in vehicles.

Personal assistance showed to positively impact the passenger experience by providing reassurance and a sense of acknowledgment: *"It's comforting when he confirms your name; then you know you're on the right bus"* (researcher-passenger, Case 4). In Cases 1, 2, and 6, MM touchpoints enabled personalized assistance, with specially trained staff guiding passengers through their journeys. However, in Cases 1and 6, communication fell short during delays, leaving passengers uninformed about the (possible) impact of the delay on their MJIAT.

In Case 5, practitioner-passengers were disappointed that the pro-active support provided to air-only passengers was not extended to multimodal passengers. Their plane-to-train journey lacked information about the connecting train leg, and practitioner-passengers noted that recognizing them as transfer passengers would have improved their experience: *"I think it's mainly about getting recognition from the staff that you're a passenger who also needs to catch a train. I don't necessarily need a guarantee that I'll make it, but more that the staff member acknowledges, 'Hey, I know that; I'm aware that's one of the connections'."* (rail operator, Case 6).

3.2.3. Multimodal wayfinding

Our findings highlight that multimodal wayfinding reduces uncertainty throughout the passenger journey. Key touchpoints found for multimodal wayfinding include physical wayfinding screens at airports and stations, as well as digital tools such as apps, emails, websites, and operator logos.

The data revealed that current wayfinding systems often operate in silos, with distinct styles for each mode of transport and limited references to other modalities. Wayfinding that explicitly incorporates multimodal transfer signage in stations or airports improved the

Table 5
Overview of the factors affecting passenger experience in different travel phases of train/bus-to-plane journeys.

Factor (affecting the multimodal passenger experience)	Stimuli - travel phases of train/bus-to-plane journeys									
	1) Arrival station	2) Go to MM touchp.	3) Go to platform	4) Boarding modality	5) Traveling	6) Arrival at airport station	7) Go to (MM) check-in	8) Go to (priority) security	9) Go to gate	10) Boarding the plane
1) Journey explanation & preparation	V	V	V	V	V	V	V	V	V	V
2) Personalized & pro-active assistance		V	V	V	V			V		V
3) Multimodal wayfinding	V	V	V	V		V	V	V	V	V
4) Proximity of modalities & facilities	V	V	V			V	V		V	
5) Multimodal transfer services		V					V	V		
6) Balanced transfer time		V			V	V	V	V	V	V
7) Waiting environment	V	V	V			V			V	V
8) In-travel comfort					V					

Table 6
Overview of the factors affecting passenger experience in different travel phases of the plane-to-train journey.

Factor (affecting the multimodal passenger experience)	Stimuli - travel phases of plane-to-train journeys									
	1) arrival airport	2) go to check-in	3) Go to security	4) Go to gate	5) Boarding the plane	6) Traveling	7) Go to baggage hall	8) Go to train station	9) Go to platform	10) Boarding the train
1) Journey explanation & preparation		V	V				V		V	V
2) Personalized & pro-active assistance		V	V	V		V	V	V		
3) Multimodal wayfinding	V	V		V				V	V	V
4) Proximity of modalities & facilities	V	V		V			V	V	V	
5) Multimodal transfer services			V				V			
6) Balanced transfer time			V		V	V	V		V	
7) Waiting environment				V	V				V	
8) In-travel comfort						V				

passenger experience, as illustrated by this researcher-passenger: *"Ah, there's flight number LH3465, yay! Oh, that's great. And right behind it, it says Lufthansa Express Rail, nice! Okay, I need to go to platform 20"* (researcher-passenger, Case 3). Both physical and digital wayfinding at transit hubs (including airports, bus, and train stations) proved critical to the passenger experience, regardless of the journey phase.

However, wayfinding to MM touchpoints in Cases 1, 2, and 6was found to underperform, leading to confusion and frustration. As one practitioner-passenger remarked, *"I thought the air-rail terminal is super hard to find when you're not familiar with its location. I ended up Googling it myself"* (airport infrastructure manager, Case 5).

Indirect communication, such as through apps, emails, websites, or screens, also played an essential role in providing cues and maintaining clarity. Notably, the *'multimodal wayfinding'* factor emerged most frequently during journeys, suggesting immediate relevance. However, it was less prominently discussed in the reflective interviews, indicating that its importance may be more evident in the moment than in hindsight when reviewing the overall experience.

Proximity of modalities and facilities

Our findings indicate that the proximity of transfer modes and facilities plays a critical role in shaping a seamless multimodal transfer at the airport and a convenient journey overall. This proximity includes the physical location of transport modes and amenities, as well as infrastructure like moving walkways or people movers that facilitate transfers.

The data demonstrate that shorter walking distances between modalities positively impacted the passenger experience by simplifying transfers. For example, one researcher-passenger in Case 1 noted: *"The walking distance isn't far. You go up from the train station, follow the signs to departures, go up again, and then you're quickly at the priority lane"* (researcher-passenger, Case 1).

Conversely, in Case 6, the long walking distance was partially mitigated by a people mover, but the waiting time led to a negative overall experience: *"I thought it was a really long walk. We waited for a while, and then two people movers arrived, but we weren't allowed to enter them. I was actually shocked by that, actually, by the staff."* (airport infrastructure manager, Case 6). These findings suggest that proximity can be enhanced by physically moving modalities closer to each other but also by features like moving walkways that reduce the perceived distance.

As discussed under the *'journey preparation and explanation'* and *'multimodal wayfinding'* factors, the hard-to-find location of the MM touchpoints in Cases 1, 2, and 6negatively affected the passenger experience. However, practitioner-passengers in Case 5 observed that the MM touchpoint's proximity to the departing platform was a positive feature: *"The MM touchpoint is really close to the platform, barely a two-minute walk, and I think that's really a big plus."* (airline operator, Case 5).

3.2.5. Multimodal transfer services

Our findings indicate that multimodal transfer services should reduce the friction that arises when transitioning between different transport systems, thereby supporting expectations for fast and efficient baggage check-in and seamless processes during airport transfers. Key touchpoints found that support these expectations include multimodal boarding passes, baggage handling services at MM touchpoints in train or bus stations, and priority lanes at airport security.

Baggage handling emerged as a significant aspect of MJIATs. This finding aligns with existing literature, which identifies baggage as an important factor for the passenger experience during transfers (Allard & Moura, 2016; Avogadro et al., 2023; Durand & Romijn, 2023; Janic, 2011) One researcher-passenger in Case 1 expressed frustration when faced with checking in her baggage after a delayed train journey: *"We only have an hour to go, and I still have to check in my bag. The train didn't say anything at all about checking in; they just said, 'Sorry, we're delayed…'"* (researcher-passenger, Case 1).

In contrast, in Cases 2and 6, passengers were able to check in their baggage at the start of the journey, which was perceived positively. A practitioner-passenger reflected on this benefit: *"I found the baggage handling a real plus, as it allowed me to board the plane feeling relaxed. It was much more relaxing than having to deal with my suitcase, since the number of steps in the transfer was significantly reduced this way."* (airport infrastructure manager, Case 5).

However, a lack of clarity about multimodal transfer services can result in confusion, as illustrated by one researcher-passenger's experience with an MM touchpoint during the transfer: *"I find it a bit strange that you're promised an MM terminal, but it was literally just picking up a label."* (researcher-passenger, Case 3).

3.2.6. Balanced transfer time

A balanced transfer time was found to have an impact on the passenger experience, as passengers desire efficient multimodal transfers. Their expectations include timely transportation and transfer schedules that allow sufficient time for connections without causing excessive waiting.

Tight transfer schedules (also occurring as a consequence of delays) were found to create stress and a sense of lost control, as illustrated by a researcher-passenger: *"It already says it's 20min late, which makes me a bit stressed since we only have a two-hour transfer. Will we make it, or won't we?"* (researcher-passenger, Case 1). Conversely, excessively long waits also negatively impacted passenger satisfaction, as illustrated here: *"It's* *annoying that we have to wait so long now. Thankfully, I'm sitting in comfortable chairs. But I've been here for half an hour already, and boarding is still 1.5h away…"* (researcher-passenger, Case 2).

Informants emphasized that well-organized airport operations and seamless backstage processes are key to creating optimal transfer times. A practitioner-passenger reflected on this efficiency: *"I thought everything went very well at the airport. The transition from the gate to the train was very smooth. It was quick and easy, and it was clear that this airport is really well-organized, especially when compared to a few other airports."* (rail operator, Case 6).

The integration factors 'multimodal transfer services' and 'the proximity of modalities and services' contribute to minimizing the required transfer time.

3.2.7. Waiting environment

The waiting environment during transfers emerged as a factor influencing the passenger experience, as passengers appreciate a convenient trip. Key touchpoints contributing to a positive experience included comfortable seating, access to (commercial) facilities, and a covered area shielded from weather conditions. The experience of unpleasant waiting conditions caused negative emotions, as illustrated by a practitioner-passenger: *"Well, it is what it is, it's very hot here, makes me feel like fodder."* (rail operator, Case 5).

3.2.8. In-travel comfort

This factor refers to comfort and quality of service when traveling in the vehicles. Touchpoints contributing to in-travel comfort were identified as comfortable seating, catering services, and the availability of work-friendly conditions. For example, researcher-passengers were pleasantly surprised by the quality of train seating: *"I'm on the train and I have a first-class seat!"* (Case 2). Practitioner-passengers noted distinctions between modes; one observed: *"The train wins for me on all fronts for these distances. It's quieter, you sit more comfortably, and there's more space."* (airport infrastructure manager, Case 6).

While catering was available and appreciated on the airplane, its absence on the train left practitioner-passengers dissatisfied: *"I was very disappointed that there was no coffee or bar open, and that I wasn't even offered as an apology, just 'no, there isn't.' I think that's really something that was within your control. Compared to how it went the day before on the flight, with 'oh, we already have a jug of coffee because you have to wait,' it was quite a contrast."* (rail operator, Case 5).

3.3. Grounding of journey integration factors

This section indicates the extent to which the factors are supported by empirical data (Eisenhardt, 1989). Table 7 shows which factors were mentioned (in dark grey) and which were absent (in white) in the data sets. From this, we can conclude that each factor is grounded in the data, with evidence of researcher triangulation (Malterud, 2001; Miles, Huberman, & Saldaña, 2014). We conclude that data saturation was reached in the second round of data collection, as no new information or factors emerged (Fusch & Ness, 2015). To strengthen the credibility of the findings, we applied triangulation by combining multiple methods – autoethnography and reflective interviews – which allowed for convergence of insights across different data sources (Fusch & Ness, 2015). Furthermore, the study included nine participants, which falls within the empirically supported range for reaching saturation in qualitative interviews (9–17; Hennink & Kaiser, 2022). As each participant undertook the same multimodal journey, this yielded 26 data sets, ensuring sufficient breadth and depth of material given the participants' similar level of expertise and the focused study objectives. However, three factors exhibited disparities in their frequency of mention across cases and informants.

First, the factor *'in-travel comfort'* was observed only in cases 2, 5, and 6. In cases 2and 5, which involved a train-to-plane journey with a transfer at CDG, most informants reported a comfortable experience in the train's first class. Although this factor was noted by practitioner-passengers in both cases (Case 5 with train-to-plane and Case 6 with plane-to-train), it was only recognized by researcher-passengers in Case 2. This discrepancy may be explained by the fact that researcher-passengers tended to acknowledge comfort only when it exceeded their expectations and positively surprised them. In contrast, the practitioner-passengers were more focused on the differences in quality levels between transport modes, a perspective shaped by their expertise.

The factor *'journey explanation and preparation'* was more prominent in the first five cases than in Case 6. This difference can be attributed to the context of Case 6, where the journey began at the airport. Airports typically include multiple contact points, such as security and baggage check-in, where passengers receive guidance and information about the next steps of the journey. In contrast, train and bus stations generally lack such procedures and, consequently, touchpoints. However, Cases 1, 2, and 5deviated from this norm, as passengers were required to visit an MM touchpoint at the station. This introduced a new phase and an unfamiliar structure for the upcoming phases of the journey, underscoring

Table 7
Overview of the factors affecting passenger experience in different travel phases of the plane-to-train journey.

	train/bus-to-plane																	*plane-to-train*								
	Case 1		Case 2		Case 3		Case 4		Case 5									Case 6								
	R1	R2	R1	R2	R1	R2	R1	R2	A1	A2	AI1	AI2	R1	R2	RI1	RI2	G1	A1	A2	AI1	AI2	R1	R2	RI1	RI2	G1
1) Journey explanation & preparation	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■		■		■				■
2) Personalized & pro-active assistance	■	■	■	■		■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
3) Multimodal wayfinding	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■
4) Proximity of modalities & facilities	■	■	■	■	■	■	■	■	■		■	■		■	■	■	■	■	■	■	■	■	■		■	■
5) Multimodal transfer services	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■		■	■	■	■	■	■	■
6) Balanced transfer time	■	■	■	■	■		■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■
7) Waiting environment		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			■		■				■
8) In-travel comfort			■	■					■		■			■	■	■	■	■		■	■	■	■		■	■

the need for journey explanation and preparation.

Lastly, the factor *'waiting environment'* was less prominent in Case 6. This was likely due to the travel delay on the plane, which reduced the available waiting time during the transfer and made it less relevant.

4. Discussion

This study explored the integration of MJIATs and their impact on passenger experience across European cases. By analyzing six journeys through major airport hubs (AMS, CDG, FRA, and HEL), we identified eight key journey integration factors that shape the passenger experience. Building on our literature review, this paper presents the findings derived from an autoethnographic approach, in which two researchers and nine practitioners collected data during a total of 26 MJIATs aimed at addressing the research questions: *1) How are MJIATs structured in terms of travel phases?* and *2) Which properties of MJIATs affect the passenger experience, and how?*

4.1. Interpretation of findings

We found a fundamental distinction between air travel and MJIATs, based on the interaction among various transport subsystems. When passengers transfer between flights in Europe, they typically complete the security check, go through customs, and check baggage at the departure node airport, transfer at a hub airport, and then arrive at the arrival node airport. Upon exiting the air system, passengers claim their baggage and pass through customs at the arrival airport. In MJIATs, passengers enter a transport system at the departure node and then transfer to another system at the (multimodal) hub airport.

While air travel encompasses transfers within a single system, MJIATs requires passengers to navigate the boundaries between distinct transport systems, such as rail and air, each governed by its own environment, rules, and regulations (see Fig. 9). This transition introduces friction, primarily due to mandatory air travel procedures. Multimodal passengers must complete these procedures within a limited timeframe, dictated by the minimum connecting time at airports, which is essential for competitive travel propositions. As a result, the airport procedures that already create stress in air-only journeys (Kim et al., 2020) lead to even greater stress for multimodal passengers.

In the *'segmented MJIAT'* structure, the mandatory airport procedures for train/bus-to-plane journeys primarily occur during the transfer. To alleviate transfer-related stress in this journey structure, efforts included MM touchpoints at the departure node or at the airport, providing personal assistance, and facilitating special baggage check-in at the airport.

In the *'partially-integrated MJIAT'* structure the baggage check-in procedure is relocated to the beginning of the journey to streamline the transfer process. However, this modification was found to increase the demands on departure nodes (such as train and bus stations) concerning equipment, staffing, training, physical space, and wayfinding.

From a methodological standpoint this study emphasizes the importance of firsthand experience for transportation researchers and practitioners, demonstrating that personally experiencing MJIATs yields invaluable insights. The (guided) autoethnographic approach provided essential perspectives that can guide improvements in the passenger experience. The practitioners who performed the guided autoethnography emphasized the importance of personally experiencing MJIATs to enhance understanding of how it unfolds in real-world settings. As one practitioner-passenger stated, *"I think it's unanimous that traveling this way brings immense value, especially in terms of insights and understanding"* (airport infrastructure manager, reflective interview). This research illustrates that firsthand experience is essential for identifying opportunities to improve passenger-oriented MJIATs.

4.2. In relation to existing research

This article offers qualitative insights into MJIATs, enriching the previous primarily quantitative research, and providing additions to it. In addition to confirming existing findings, it deepens the understanding of the "how" and "why" behind factors affecting the passenger experience.

The results indicate that, in addition to three previously identified defining properties of MJIATs, namely, the connection of an alternative mode of transport to flights, a single integrated ticket, and connection insurance (Babić et al., 2022; Li et al., 2018; Román and Martín, 2014), MJIATs in practice show variability in the integration of modalities.

The identified journey integration factors *'journey explanation and preparation*, *'personalized and pro-active assistance'*, and *'multimodal wayfinding'* highlight the significance of the type, timing, and delivery of journey information in MJIATs. This is crucial not only because MJIATs are new to many passengers, but also due to differing rules and standards between transport systems. Passengers often rely on airlines for booking and may not be fully aware of the specifics of the train/bus part of the journey. This aligns with previous research emphasizing the importance of providing holistic journey process information to give passengers a sense of autonomy and support them in managing their journey (Allen et al., 2020; Antwi et al., 2020; Babić et al., 2022; Hernandez Bueno, 2021).

Our findings suggest that, rather than passengers wanting to "manage the journey" (as operators control the itinerary) it is more

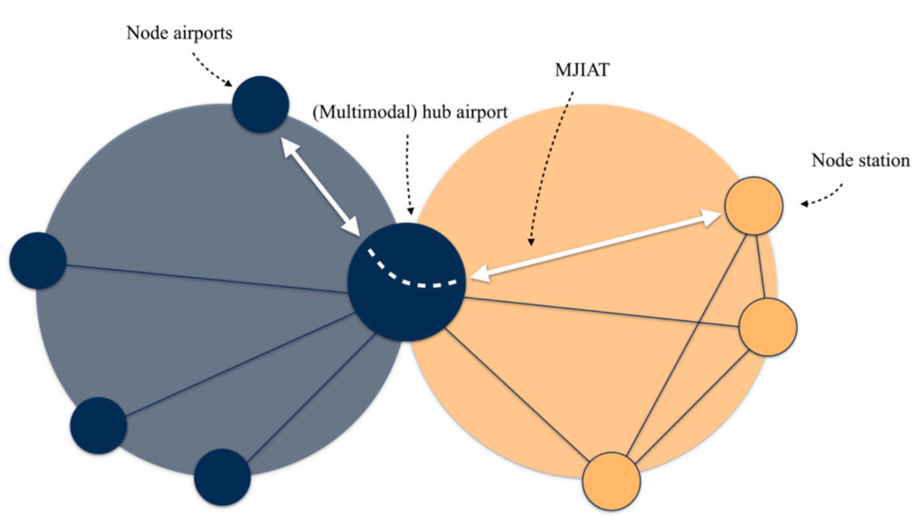

Fig. 9. A visual representation of how two transport systems in MJIATs connect in both directions: train/bus-to-plane and plane-to-train/bus.

about "expectation management", with passengers seeking clarity and confidence that the journey will proceed smoothly. Our study highlights the importance for MJIATs of providing information at train and bus stations, such as referencing the "air" leg via screens or staff. The positive impact of airport staff interaction on passenger satisfaction is well-documented (Antwi et al., 2020; Lubbe et al., 2011), but our findings extend this to train/bus station and airline staff, indicating they need to be informed and trained about MJIATs. Similarly, wayfinding and signage, critical for passenger experience at airports and stations (Allen et al., 2020; Nielsen et al., 2021; B. Wang et al., 2020), should clearly reference the MJIAT and be present at every phase. Furthermore, our findings suggest that information preparing passengers for specific steps of the journey can also be communicated during the journey itself, allowing passengers to receive information as needed without having to plan too far ahead.

The factor *'proximity of modalities and facilities',* supported by Li et al. (2018b), is confirmed by our study, showing that short distances can also be achieved with moving walkways and that the location and visibility of MM touchpoints are integral to this factor.

The importance of treating multimodal passengers like regular air transfer passengers is emphasized by the factor *'multimodal transfer services'*. This can be done through special transfer services such as priority at critical points like baggage check-in, security, and customs, as noted by Babić et al. (2022). While airport hubs often manage automatic baggage transfers, our findings suggest that MJIATs benefit from dedicated MM touchpoints and trained staff at train/bus stations and node airports.

The factor *'balanced transfer time'* aligns with existing studies (Abenoza et al., 2019; Babić et al., 2022; Hernandez Bueno, 2021; Jiang et al., 2022; Román & Martín, 2014; B. Wang et al., 2020). Tight schedules were found to cause stress early in the journey, while long layovers led to dissatisfaction as passengers had to pass the time. This was particularly evident in cases 2and 5, where baggage check-in was shifted to the train station at the start of the journey. Combined with long transfer times at the airport, this unnecessarily prolonged the total travel time.

The research shows that the quality of the *'waiting environment'* can enhance the passenger experience, aligning with the findings of Eboli and Mazzulla (2015). We extend this knowledge by emphasizing that passenger expectations also play a significant role in this factor. When traveling in the train/bus-to-plane direction, the longest wait occurred at the airport, where facilities were generally adequate and met expectations. Due to the short connection time caused by the flight delay in Case 6, there was limited data on the waiting environment in the plane-to-train direction. Further investigation into this situation would be valuable.

Lastly, the factor of *'in-travel comfort'* revealed that passengers expect a certain level of comfort during their journey, and exceeding these expectations contributes to a positive experience. These expectations are partly shaped by the service level of the airline with which the booking is made. To our knowledge, this is discussed in studies on in-flight comfort and expectations (Vink, 2016) but not in the literature on MJIATs.

4.3. Limitations and future research

First, the study focused on four specific airport hubs in Europe. This approach ensured similar contexts, as the same EU regulations applied to all four cases, allowing for comparisons between observations. However, our approach cannot be replicated under exactly the same conditions. The focus of this study was to identify which factors play a role, rather than to capture variability across contexts. Future research could build on these insights by conducting passenger interviews in varying contexts (e.g., across different routes, times of day, seasons, and traveler types).

Second, intercontinental flights often involve customs procedures during transfers, higher financial stakes (adding pressure to make connections), and longer flight durations, all of which can affect passengers' mental states. Consequently, the findings may not be generalizable to all multimodal travel connections or to all airport hubs globally. Replicating the study in different contexts, including airports outside Europe and journeys that encompass an intercontinental leg, could yield deeper insights into the passenger experiences for these journeys.

Third, future research could undertake a comparative benchmark between major airport hubs worldwide on the level of service integration. This could yield valuable insights into similarities and differences in multimodal integration at leading airport hubs, highlighting best practices and contextual factors that shape passenger experience and policy development.

Furthermore, in studying MJIATs, the unit of analysis could extend to the pre-trip phase, including travel choice and booking, as these stages shape passengers' overall perceptions. Incorporating these elements could complement our findings with a more comprehensive understanding.

While the autoethnographic approach yielded rich insights, it also carries the risk of bias, as the experiences of researcher- and practitioner-passengers may not fully represent the broader passenger population. To address this, the analytical framework was designed to surface passengers' concerns (focusing on their goals, attitudes, and standards) and these were explicitly incorporated into the analysis to ensure transparency. Furthermore, although the study generated 26 data sets from nine participants, the relatively small and homogenous sample may limit the extent to which saturation was achieved across more diverse passenger groups. Future research should therefore broaden the participant pool, and apply quantitative approaches such as Delphi tests and surveys, to test the transferability of these findings.

In this study the plane-to-train journey direction was explored in one case. While nine data sets were collected, the specific context of this case likely influenced the results, limiting the generalizability of the findings. We recommend studying this journey sequence at other airport hubs to gain a broader understanding of the phases involved and the factors influencing them.

A limitation of this study is that the primary purpose of our trips was exploratory and learning-oriented rather than driven by a pressing travel need. Although reaching the destination was still important, the stakes were lower than for typical passengers. In addition, factors such as whether someone travels alone, with colleagues, or with children may influence the experience. Future research should therefore take trip purpose and travel party composition into account.

Another important aspect to consider is the experience of passengers requiring special assistance. Their needs may differ substantially from those of other passengers, and future research should therefore pay particular attention to how multimodal integration accommodates this group.

Investigating the potential and impact of new technologies could provide valuable insights into improving the multimodal passenger experience. Emerging technologies such as mobile apps, digital wayfinding tools, AI assistance, biometrics, and autonomous baggage trolleys could significantly enhance MJIATs. Additionally, upcoming travel modalities, such as electric vehicles, autonomous transport, and possibly future options like hyperloop and electric vertical take-off and landing aircraft (eVTOLs) (Nikitas et al., 2020), promote new travel perspectives. These perspectives include ride-sharing, on-demand mobility services, and multimodal travel, focusing more on passengers and their journeys than on the means of transport (Docherty et al., 2018; Jittrapirom et al., 2017). This makes research on MJIATs experiences increasingly relevant, and incorporating new modes of transport in future studies would enhance this development.

5. Conclusion

The MJIATs examined in this study show varying degrees of integration. While varying journey structures observed aim to streamline the MJIAT for the passenger, friction arises during transfers due to certain mandatory processes at the airport, regardless of the direction of the journey. Our research shows that MJIATs differ significantly from traditional air-to-air travel, as multimodal passengers must navigate different transportation systems, each marked by boundaries that increase friction. A key takeaway is that MJIATs must be studied and designed as cohesive units, as passengers book the entire trip from the departure node (station/airport) to the arrival node (station/airport). The passenger experience cannot be understood in isolated segments, as each phase impacts subsequent phases.

Eight journey integration factors were identified that influence the passenger experience in MJIATs: 1) journey explanation and integration, 2) personalized and pro-active assistance, 3) multimodal wayfinding, 4) proximity of modalities and facilities, 5) multimodal transfer services, 6) balanced transfer time, 7) waiting environment, and 8) in-travel comfort. The extent to which these factors positively contribute to the experience in part depends on passengers' expectations.

Additionally, the analytical framework applied expands on passenger emotions, incorporating surprise, instrumental, and social emotions, thereby enriching the understanding of passenger satisfaction and offering actionable recommendations for transport operators and hubs.

The overlap in travel phases of MJIATs highlights the shared responsibilities among different actors and the need for collaboration. While airlines provide MJIATs, stations and airports play a crucial role in offering the infrastructure and services necessary for facilitating smooth transfers and cohesive journeys.

Declaration of generative AI in scientific writing

During the preparation of this work the first author used EditGPT for readability and grammar checks. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

CRediT authorship contribution statement

Aniek Toet: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jasper van Kuijk:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Conceptualization. **Klaas Boersma:** Writing – review & editing, Supervision, Formal analysis, Conceptualization. **Suzanne Hiemstra-van Mastrigt:** Writing – review & editing, Validation, Methodology, Funding acquisition, Formal analysis, Conceptualization.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships that may be considered potential competing interests: the first author of the study, Aniek Toet, reports receiving financial support from Royal Schiphol Group and performing her research as an embedded researcher in the organization, and the third author, Klaas Boersma, is employed by Royal Schiphol Group.

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Data availability

Due to the data collected including personal elements and judgments that can be traced back to the researchers and practitioners to whom the transcripts belong, this study treats the data as confidential.

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