

Uncovering factors influencing railway passenger experiences through love and breakup declarations

Luce Drouet^{a,*}, Carine Lallemand^{a,b}, Vincent Koenig^a, Francesco Viti^a, Kerstin Bongard-Blanchy^a

^a University of Luxembourg, L-4366, Esch-sur-Alzette, Luxembourg

^b Eindhoven University of Technology, 5612 AZ, Eindhoven, Netherlands

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ABSTRACT

While existing approaches for assessing passenger experience are often limited to surveys of customer satisfaction, societal and technological challenges push the railway industry to adopt a user-centric approach to the design of their service. We used the love and breakup method in a study involving N = 53 passengers making a declaration to their railway company to collect qualitative feedback on the passenger experience. The method allowed to gather personal, emotional, and contextual insights into passengers' experiences that can inform the transportation service design process. We describe 21 factors and 8 needs influencing the passenger experience, thereby consolidating and deepening prior work in the railway context. Using the lens of user experience theories, we argue that the service should be assessed against fulfilling these needs, which can act as guiding principles regarding service improvement. The study also presents valuable insights into the love and breakup method to explore service experiences.

1. Introduction

Societal, environmental, and technological challenges (e.g., privatization, digitalization) push railway companies to innovate. To face these upheavals, they undertake increasing efforts toward a user-centered approach (International Union of Railways, 2023). However, inquiring users about their experience and designing the service for an optimal passenger experience (which we defined as all aspects that form the user experience of the railway service for private passengers) are novel tasks for this industry (Ross et al., 2020). After decades as a freight service, railway companies' paradigm shifted towards a people-centered service. From the first conference on Design for Passenger Transport in the 1970s, the importance of the customer in service design gained traction. It became indispensable to better understand customer behavior and perceptions (Height and Roy, 1979). While mobility research in Human-Computer Interaction (HCI) continues to be mainly driven by the automotive sector (Glöss et al., 2020), railway companies too have established dedicated teams working with passengers. However, because their research activities occur inside the R&D departments, initiatives through which they publicly share their insights stay rare.

Looking into the available research, public transportation service

mainly investigates passenger experience through surveys on service quality and customer satisfaction (dell'Olio et al., 2018). While there is wide agreement on the importance of passenger feedback and emotions (Straker and Wrigley, 2016) in designing transportation services, studies looking into the underlying reasons behind passenger experiences are still scarce (Carreira et al., 2013; Hildén and Väänänen, 2019). They are however indispensable to obtain a *better understanding of the different perspectives on mobility* (Glöss et al., 2020) and an *empathic understanding* (Hildén and Väänänen, 2019) of passenger needs.

This paper presents a qualitative study with railway passengers in Luxembourg (N = 53). Aiming to inform the design of user-centered railway services, our study sought to enhance the current understanding of which factors influence the passenger experience and which needs are prominent in this experience. The findings are discussed in the larger frame of theories of psychological needs and user experience, thereby making a contribution to the literature on user experience in the context of rail travel. In addition to these empirical contributions, the paper makes an interesting methodological contribution by extending the service design toolkit in the transportation domain with the love and breakup method. We present this method and discuss the benefits and limitations for its use in the transportation domain.

* Corresponding author.

E-mail address: luce.drouet@uni.lu (L. Drouet).

2. User research in transportation services

2.1. Passenger experience factors

Previous mobility research points to variegated factors influencing passenger experiences (Table 1). Passengers' motivations for using a transportation service differ across socio-economic backgrounds (Foth and Schroeter, 2010). Depending on their use patterns, passengers have been categorized into *must passengers* (e.g., commuters) versus *lust passengers* (e.g., travelers) (van Hagen, 2011), or depending on their travel experience type (e.g., confident, organized, conscious, social) (van Hagen et al., 2022), or digital skills (Bradley et al., 2021). Part of the literature on passenger profiles focuses on a specific population (e.g., the elderly, passengers with impairments) and investigates their travel needs (Stein et al., 2017; Vollenwyder et al., 2020).

Passenger needs and expectations depend on various service elements such as safety, staff courtesy/skills, on-time performance, cleanliness (Park et al., 2021), information, onboard activities (e.g., reading, working), social interactions (Hildén et al., 2016, 2017). Contextual task factors, contextual environment factors, personal factors (Ross et al., 2020), and specific travel situations affect passenger expectations and result in a broad spectrum of experiences and emotions (Souche-Le Corvec and Zhao, 2020; van Hagen and Bron, 2013).

The service is not limited to the onboard experience but spreads over several locations and times. The service includes multiple digital, analog, and in-person service touchpoints along the passenger's journey (e.g., interactions with the information channels (Foth and Schroeter,

Table 1

An overview of passenger experience factors studied in related literature (public transport and railway literature).

Passenger experience factors	Example of studies (non-exhaustive)
Passenger profiles	Rail passenger profiles (van Hagen et al., 2022; van Hagen and Bron, 2013), bus passenger profiles (Hildén and Väänänen, 2019), passenger profiles related to rail technological innovations (Bradley et al., 2021)
Specific populations	Passengers with impairments (Vollenwyder et al., 2020), elderly mobility (Stein et al., 2017), women's experience (Joshi and Bailey, 2023)
Passenger needs	Satisfaction (Azmi et al., 2018; Barchański, 2023; Cavana et al., 2007; Prousaloglou and Koppelman, 1989), passenger needs and expectations (Blatter and Einsele, 2022; Carreira et al., 2013; Hildén et al., 2016, 2017; Park et al., 2021; van Hagen et al., 2022), contextual and personal factors (Ross et al., 2020)
Passenger experience	Passenger journey and emotions (Souche-Le Corvec and Zhao, 2020; van Hagen and Bron, 2013; van Hagen and de Bruyn, 2015), passenger experience with technological innovations (Bradley et al., 2021), passengers' well-being (Hook et al., 2021), passengers' stress (van Hagen and Vos, 2018), passengers' fall risk due to information search (Larue et al., 2021)
Location-specific	Train stations (e.g., experiencing colors, lights, music, advertising and infotainment) (van Hagen and Heiligers, 2015), transit area (Zhou et al., 2022), first/last-mile (Park et al., 2021), service proximity (Zhai et al., 2021)
Time	Waiting time (van Hagen, 2011), travel duration tolerance (Ermagun et al., 2022), use of journey time (Hildén et al., 2017)
Technology interactions	Information screens and mobile app (Foth and Schroeter, 2010), technological innovation uses (Bradley et al., 2021; Keller and Schlegel, 2019), vending machines (Muhammad et al., 2017), passenger information (Azmi et al., 2018; Beul-Leusmann et al., 2014; Dziekan and Kottenhoff, 2007; Foell et al., 2013; Hildén et al., 2017; Zimmerman et al., 2011; Zorić et al., 2022), audio information (Kostiainen et al., 2011), real-time information (Dziekan and Kottenhoff, 2007)
Human interactions	Cleaning staff in trains (Vos et al., 2019), railway staff in trains (Oliveira et al., 2018, 2020), crowdedness (Kim et al., 2022), social interactions (Camacho et al., 2015)

2010), other passengers (Ross et al., 2020) or the railway staff (Oliveira et al., 2020)).

2.2. Research approaches to uncover passenger experiences

Finding suitable methodological approaches to investigate the passenger experience is challenging. Related research has been initiated by professionals with various backgrounds ranging from quality management and marketing to HCI. This section gives an overview of applied quantitative and qualitative research methods (Table 2).

As acknowledged by prior work, the transportation field primarily builds on factual findings stemming from quantitative research (Carreira et al., 2013). To this end, researchers adapted the popular standardized questionnaire SERVQUAL (Parasuraman et al., 1988) to the railway context and added the item categories *comfort*, *connection*, *convenience* (Cavana et al., 2007), and *passenger information* (Azmi et al., 2018). More recently Ittamalla et al. (Ittamalla & Srinivas Kumar, 2021) developed the holistic passenger experience (HPE) scale to measure the determinants of HPE. Other surveys have been developed and employed to assess the customer satisfaction with national railways services (Barchański, 2023) or specific aspects like train stations (van Hagen and Heiligers, 2015). Some look closely at public transportation service aspects that enhance or hinder passenger satisfaction, like the duration (Ermagun et al., 2022). Specific experimentations are conducted to investigate service design components by comparing configurations for music, colors, and lights in train stations (van Hagen, 2011). Post-user test questionnaires have also been used to gather feedback on interface prototypes (e.g., for a ticket machine (Muhammad et al., 2017), a smartphone navigation for visually impaired (Vollenwyder et al., 2020)). These studies rarely rely on standardized evaluation scales. As an exception, the System Usability Scale has been used for evaluating existing railway information technologies (Beul-Leusmann et al., 2014).

These studies build on self-reported behavior data and are hence prone to limitations such as the peak-end-rule cognitive bias, showing that intense and final moments of an experience are more vivid in memory (Kahneman et al., 1993). To overcome these, physiological measurements (e.g., eye tracking) have been employed as an objective complement to measure railway passenger stress (van Hagen and Vos, 2018). Quantitative metrics based on aggregated data (Foell et al., 2013), and passenger flow data (Zheng et al., 2023) start to find their way into passenger experience assessments beyond self-reports. While this existing quantitative research allowed gathering feedback from large passenger samples, their drawback is the lack of insight regarding underlying reasons for passenger satisfaction ratings. This is why researchers in the domain strongly advocate for additional qualitative research (Carreira et al., 2013; Grosvenor, 2000).

The few qualitative insights - some of which relate to other transportation modes than rail services - stem mostly from interviews (Hildén et al., 2016; van Hagen and Bron, 2013) or focus groups (Camacho et al., 2015; Heufke Kantelaar et al., 2022). Observations have been undertaken to investigate specific issues such as the passengers' risk of falling at train stations while looking for information (Larue et al., 2021). They are also complementing think-aloud techniques during user tests of interface prototypes (Beul-Leusmann et al., 2014; Pang et al., 2019). Content analysis is another qualitative method employed on email customer complaints (Ross et al., 2020) and social media comments (Blatter and Einsele, 2022) to reveal factors affecting the passenger experience. In diary studies (Hildén and Väänänen, 2019; van Hagen and Bron, 2013), cultural probes (Belloni et al., 2009), and story completion (Joshi and Bailey, 2023), passengers self-documented their journeys and associated feelings, behaviors, and attitudes. Beyond the evaluation aspect, co-design methods slowly find their way into transportation service design. They have been used to address accessibility concerns (Vollenwyder et al., 2020) or to ideate potential digital services for buses (Hildén et al., 2017).

Table 2

An overview of research approaches used to uncover passenger experience in previous work (public transport and railway literature).

Research approach	Example of studies (non-exhaustive)
Quantitative approach	For a synthetic view of quantitative methods to understand service quality in transportation service, see (dell’Olio et al., 2018)
General service satisfaction surveys	SERVQUAL standardized scale (Parasuraman et al., 1988), with additional dimensions: comfort, connection, convenience (Cavana et al., 2007) and passenger information (Azmi et al., 2018)
Questionnaires on specific topics	Holistic passenger experience scale (Ittamalla & Srinivas Kumar, 2021) Satisfaction surveys (Barchański, 2023) Questionnaires on specific topics (e.g., travel duration, use of travel time, technological innovation, satisfaction with commuting) (Bradley et al., 2021; Cui et al., 2021; Ermagun et al., 2022; Heufke Kantelaar et al., 2022; Park et al., 2021; Zhai et al., 2021; Zhou et al., 2022)
Experimentations around service design components	Atmosphere in the station (e.g., light, music, colors) (van Hagen, 2011), cleanliness perception (Vos et al., 2019), announcements in train (van Hagen and Sauren, 2015), real-time information (Dziekhan and Kottenhoff, 2007)
Post-user tests questionnaires	(Beul-Leusmann et al., 2014; Muhammad et al., 2017; Pang et al., 2019)
Psychophysiological measurements	Physiological sensors measuring passengers’ stress (van Hagen and Vos, 2018) Electroencephalogram (EEG), Functional Magnetic Resonance Imagery (fMRI) (Souche-Le Corvec and Zhao, 2020)
Quantitative metrics of passenger behavior (aggregated data)	Behavioral transport data (Foell et al., 2013), passenger flow data (Zheng et al., 2023) Crowd-sourcing data based on commuters GPS trace data using their phones and transit service planned schedule information (Zimmerman et al., 2011)
Qualitative approach	Papers advocating for qualitative approaches in public transportation service research (Carreira et al., 2013; Grosvenor, 2000; Transport Research Board & National Research Council, 1999)
Interview	Interviews (Carreira et al., 2013; Hildén et al., 2016; Stein et al., 2017), in-depth interviews (van Hagen and Bron, 2013), photo-elicitation technique (van Hagen and de Bruyn, 2015)
Focus group	(Camacho et al., 2015; Heufke Kantelaar et al., 2022)
Observation	Observation on field, e.g., in trains like in (Camacho et al., 2015), observation with eye-tracking (Larue et al., 2021)
User tests including observations and think-aloud	User testing prototypes (Beul-Leusmann et al., 2014; Pang et al., 2019)
Analysis of customer complaints and feedback comments	Comments on Facebook (Blatter and Einsele, 2022), complaints on specific platform dedicated to passengers’ feedback (Ross et al., 2020)
Diaries and cultural probes	Diaries (Hildén and Väänänen, 2019), cultural probes (Belloni et al., 2009), online passenger community (van Hagen and Bron, 2013)
Story completion	Online story completion for revealing women’s experience (Joshi and Bailey, 2023)
Co-design methods	Co-design of information solutions (Hildén et al., 2017), co-design accessible solutions for people with impairments (Vollenwyder et al., 2020), co-design of solutions for elders (Stein et al., 2017)

2.3. Research objectives

Most prior work in the railway domain focuses on the passenger experience regarding specific issues, and relies primarily on quantitative insights. Obtaining a holistic understanding of passenger experiences,

requires a wider use of qualitative research. Using a qualitative approach that invites users to share their individual experiences and that looks at what matters most to them when they are not primed on specific issues, the present study thus aims to:

- (1) consolidate and deepen prior empirical evidence of factors influencing railway passenger experience.
- (2) identify the most prominent passengers’ needs which can be used as guiding principles in the choice of solutions to address the factors of concerns or opportunities.
- (3) extend the qualitative research toolkit for transportation service design with the love and breakup method (Gerber, 2011; Hanington and Martin, 2012). To this end, we discuss advantages and limitations of using this method to investigate passenger experiences.

3. Method

To answer the research question, we deployed the love and breakup method (Gerber, 2011; Vasques et al., 2022). First employed by design practitioners (Smart Design, 2016), it combines approaches from design probes (Gaver et al., 1999), letters to objects and services (McCarthy et al., 2021), and roleplaying (Gerber, 2011). Such emotion-stimulating techniques are often deliberately provocative, reflective, or amusing to stimulate user reactions (Gaver et al., 1999). They invite people to reflect on experiences with products and services (Sanders and Stappers, 2012) and elicit narratives that are difficult to access via more traditional methods (Gaver et al., 1999). Love letters are a particularly interesting technique as they push people towards expressing what matters most to them. The analogy with a partner relationship resonates with passengers as illustrated by the Twitter account *SNCF, mon Amour* (SNCF, my love) (@snfMonAmour, 2012).

3.1. Participants

Our target population were passengers of the railway service in Luxembourg. We recruited passengers using voluntary sampling through the railway company communication channels (social media, website, Wi-Fi portal), passenger communities, and flyers at train stations. The wording of the call for participants read: “Share your train experience! We are looking for participants to take part in a study. Share your train experiences to help us understand how to improve the Luxembourgish railway service.” The method of love and breakup was not mentioned at this stage, to avoid priming participants or inducing a self-selection bias linked to how odd the method can sound. This also safeguarded the spontaneity in their declarations. Interested participants registered via an online form in which they completed (a) demographic information: age, gender, professional status, (b) their railway use frequency and familiarity with the service, and (c) their general satisfaction with the service on a scale from 1 to 10.

Our sample is composed of $N = 53$ participants (25 men, 28 women), residents in Luxembourg ($n = 42$) or cross-border commuters from France, Germany and Belgium ($n = 11$). Their age ranged from 19 to 64 ($M = 35$, $SD = 11.28$). To account for local specificities, our sample included more than 5 participants for each of the six railway lines of the country. Their professional status included workers (66%), students (30%), retired or unemployed (6%). 34% commuted during the week and weekend, 58% only during the week, and 8% only on the weekend. Their train travel frequency was every day for 28%, several times per week for 51%, and sometimes for 21%. 91% had already used the railway service for over six months, and 9% for less than six months. Their general satisfaction with the service is $M = 7.15$ (Min = 4, Max = 10, $SD = 1.5$).

3.2. Procedure

The individual sessions took place between December 2020 and March 2021. They were conducted remotely due to Covid-19 restrictions. The University's ethics review panel approved the study, and we obtained participants' informed consent. The procedure involved five steps (Fig. 1).

Each 45-min session started with a brief introduction of the study objectives: investigating the passenger experience with their local railway service. Participants were then invited to make a love or a breakup declaration to their railway service as if this service was their life partner. They had up to 10 min to prepare the declaration and were free to take notes. The participants made their declaration orally in front of their webcam. The researcher launched the video recording and switched their camera off to avoid being mistaken for the declaration recipient. The participants had no time limitation for the declaration. The recordings ranged from 30 s to 10 min. During a debriefing, participants filled an adapted version of the Geneva Emotion Wheel (GEW) (Scherer, 2005) to indicate the emotions they expressed and explain their ratings. Finally, participants were invited to add any comments before they received compensation.

3.3. Material

Love and breakup declarations. The following instructions, adapted from Ahgharian (2016), were displayed to participants. The experimenter orally mentioned to participants that they were entirely free to express whatever they wanted, notwithstanding the type of declaration chosen.

1. Choose to make a love or a breakup declaration.
2. Prepare your declaration during the next 10 min. Below are some explanations to guide you.
 - *Love declaration to CFL: Talk about what makes you love CFL. What characteristics of CFL would you never want to change?*
 - *Breakup declaration to CFL: Share with CFL the reasons why the relationship didn't work. Talk about the habits that annoyed you. It's the opportunity to write and make it easier for both of you to move on. Feel free to name services you used to cheat on CFL.*

Geneva Emotion Wheel. The GEW is an emotional measurement instrument used to assess emotional reactions to objects, events, and situations (Scherer, 2005). To fit into the digital study setup, we adapted the wheel into a matrix, with the emotion order randomized. The GEW served the respondents to indicate the emotion they expressed via their declaration. They rated 20 emotions on five degrees of intensity using a 6-point Likert scale starting with a "None" option (no emotion felt) and followed by five numeric labels. In addition, an "Other" (different emotion felt) option was provided.

3.4. Data analysis

We transcribed the declarations (examples in Fig. 2) and debriefings and thematically analyzed them. We choose thematic analysis to define the positive and negative aspects of passenger experience per theme, which contributes to consolidating the current literature on passengers'

needs in railway services. This also allows the railway service teams in industry to obtain actionable results.

We developed the codebook through an inductive approach in which we defined five main categories, namely service touchpoints, mediating factors (i.e., external factors impacting the service), company appreciation factors, particular use context (Table 3), and passenger needs (Table 4). We organized code training among three peer researchers and double-coded eight participants (15% of the sample, following the guidelines by O'Connor and Joffe, 2020) using MAXQDA 20.4, leading to a refined coding scheme. Researchers one and two double-coded another set of eight participants, reaching a substantial agreement of 0.76 (Cohen's Kappa) (O'Connor and Joffe, 2020).

In the results section, we illustrate the findings with participants' verbatims, indicating the type of declaration made using a letter (L for love or B for breakup) prior to the participant's number.

4. Results

4.1. Descriptive results

74% (n = 39) of the participants chose to make a love and 26% (n = 14) a breakup declaration. Regardless of the choice, most expressed positive and negative aspects of their service experience (Fig. 3). Based on the content analysis of the declarations, 25 out of 39 love declarations and 10 out of 14 breakup declarations contain positive and negative feedback (n = 10).

The participants rated their satisfaction with the service prior to the experiment (online demographic survey). Fig. 4 presents the link between the choice of declaration (love vs. breakup) and their initial satisfaction rating on a scale from 1 - "Not satisfied at all" to 10 - "Very satisfied". The satisfaction with the service was rated on average as M = 7.15 (Min = 4, Max = 10, SD = 1.5), with a significant difference between the love group (M = 7.54, SD = 1.33) and the breakup group (M = 6.07, SD = 1.44) (t (51) = 3.46, p = 0.001). A few participants who rated the service as satisfactory (i.e., between 7 and 10) did nonetheless make a breakup declaration.

Following their declarations, the participants filled in the adapted Geneva Emotion Wheel indicating the conveyed emotions and their intensity. Overall, the top three selected emotions are interest, pleasure, and disappointment (Fig. 5), all selected by more than three-quarters of the participants. The top three selected emotions by the love declarers have a positive valence: pleasure, joy, and interest. The emotions rated as most intense in this group were contentment (M = 3.94, SD = 1.01), interest (M = 3.89, SD = 1.06) and admiration (M = 3.67, SD = 1.05). In the breakup group, the top three selected emotions had a negative valence: disappointment (M = 3.71, SD = 1.38), anger (M = 3.15, SD = 1.21), and sadness (M = 2.75, SD = 1.29). All breakup declarers chose disappointment. This emotion had the highest intensity level in this subgroup (M = 3.71, SD = 1.38). Anger was selected by all but one breakup group participant (M = 3.15, SD = 1.21).

4.2. Factors influencing passenger experience

We identified 21 factors that influence the passenger experience, corresponding to four themes (Table 3).

Service touchpoints. The participants reflected primarily on service

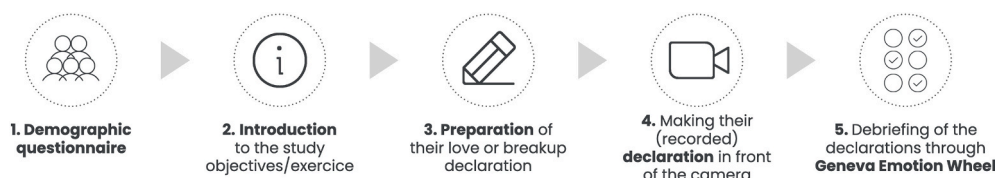


Fig. 1. Steps of the study procedure.

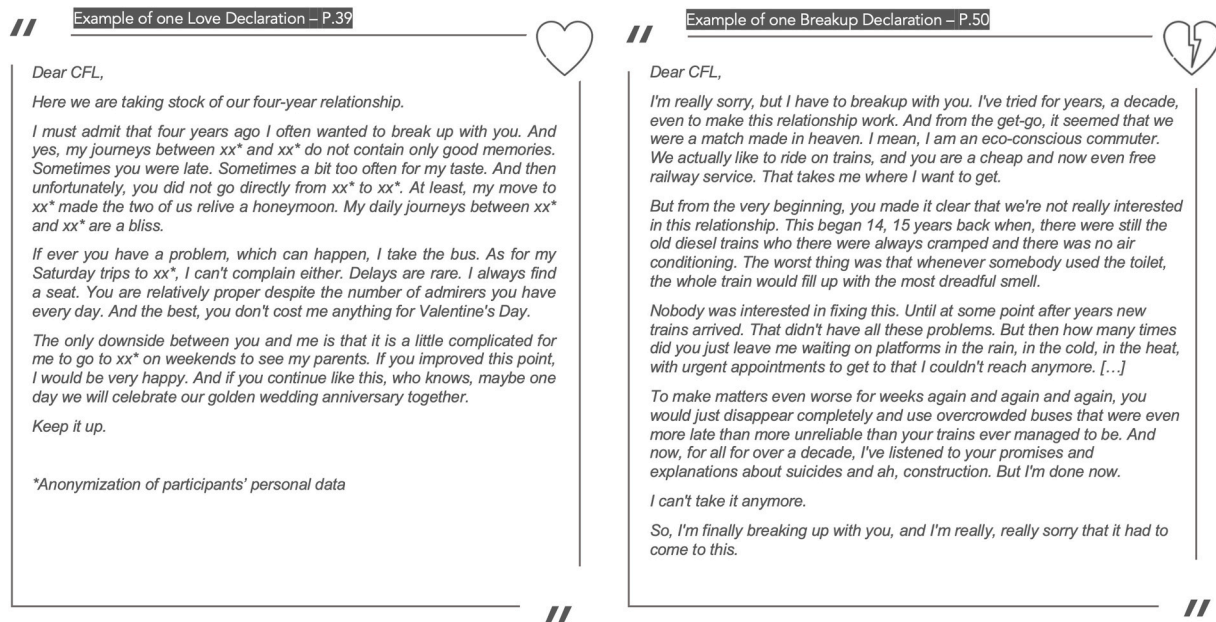


Fig. 2. Examples of love and breakup declarations transcribed.

touchpoint factors (393 occurrences) such as passenger information, trains, stations, staff, and how those factors directly impact on their experience. Unsurprisingly, the train was at the center of their remarks. Participants mentioned the quality and configuration of trains and their feeling of comfort onboard. *"The material, it's very recent and very well maintained."* L.18. Passenger information was the second most commented factor. Respondents highlighted the crucial role of information to reach their destination efficiently. *"This is not all about the trains, but also information around the train."* L.30. They request transparency (e.g., precise delays and disturbance information, including transparency about uncertainty) to feel empowered and confident in their journey decisions. *"If we only have some information about a delay, we might be anxious."* L.44. Respondents expressed that they can accept delays and cancellations but not that information is withheld. *"When it's last-minute issues, it's not always easy. But at least communicating would be good."* L.10. Moreover, the behavior of the staff impacts their service perception. Friendly, helpful, multilingual staff triggers empathic, admiring, and grateful comments. Bad experiences with the staff commonly result from rare but remembered unpleasant encounters. *"Sometimes you feel like you're being treated like a child in a somewhat condescending way."* B.49.

External mediating factors. Mediating factors go beyond the service offer and are difficult to control for the service organization. Yet, they play a crucial role as they are part of the overall mobility experience and often used as a basis for comparison. These factors can be split into two subcategories.

- (a) passengers' personal experience. The majority of our participants commute regularly and hence report familiarity with the service. They comment on specific service improvements, share anecdotes of rail service failures, and express their appreciation: *"There are many things that can be improved, but for the size of the country. I think they're trying their best to provide the best service they can."* L.46. Participants who commute on lines with recurrent rail service failures share a less optimistic view. *"I see the efforts being made, but I don't see the results."* L.21. Familiarity plays a role in the service dependence perception. Passengers know that the service does not always meet their expectations and they have to adapt to it. Many take the train by obligation (e.g., no driver's license). Transport choice is mainly guided by efficiency. Taking

the train allows them to relax and do personal activities (e.g., reading, working) during the journey. *"It's less tiring to take the train than to focus [on the road] in the car."* L.44. However, if the journeys are not perceived as efficient, the car is preferred. *"I sometimes regret having chosen the train when nothing works."* L.26. Passengers' experiences with foreign public transportation services raise expectations: *"Ireland is much poorer, but the trains are in better condition; they all have Wi-Fi."* B.32. One-third of participants put their experience with the service in perspective with personal characteristics, e.g., personality traits, *"It goes with my personality because I like to observe nature."* L.04, life philosophy, *"My approach to life is more functional."* L.46, or passions, *"I really like the train; it's a passion."* L.24.

- (b) external factors. The predominant external factor in our sample was free transportation in Luxembourg (since March 2020). Participants unanimously expressed admiration for the initiative and relief for not having to purchase a ticket or subscription. Free transport has become a new tolerance factor towards the service. *"When criticizing, you have to think that first of all; it's free."* B.01. Railway experience is part of a broader mobility context. Participants mentioned opportunities or challenges arising from multi-modality and services used in combination with the train. Recurrent topics relate to the synchronization and availability of those services: *"When I arrive at the station, I always have a tram."* L.19, *"You even have to take a train beforehand to ensure you have a place in the parking."* L.26. Another external factor addressed by one-third of participants are the other passengers described, e.g., as sometimes *"noisy and disturbing"*.

Appreciation. The passengers' overall appreciation of the company was positive. *"Since we moved in, the service never stopped improving."* L.07. Nevertheless, participants made some remarks about additional stops and weekend timetables. Beyond these general comments, participants pointed at the railway company's difficulties in innovating. *"It just takes too long to understand and think further. You need ways to think differently."* L.17. Moreover, corporate communication was criticized: *"Your repeated media that the average delays have improved over the last few years ... It does not cheer me up because I'm having problems again today."* B.09. However, participants commented on the challenges faced by the company and the staff with empathy, *"I know that you're trying."* B.40.,

Table 3
Identified factors influencing passenger experience.

Categories		Factors	Factors description	% of participants	No of occurrences			
					Total	Positive	Neutral	Negative
Service touchpoints (393 occurrences)		Trains	Equipment (models, obsolescence), ambiance (comfort, space, light), functional aspects (number of seats, temperature, Wi-Fi, toilettes, bike/strollers), cleanliness, safety	91	112	75	4	47
		Passenger information	Messages (content, tone), type of information (timetable, train capacity), temporality (frequency and synchronicity), channels (displays, apps, audio, social media, external)	79	144	49	17	83
		Staff	Staff (in the stations or supporting services): perceptions of kindness, caring, availability, listening, and helping, perception of their job mission	64	82	46	5	38
		Train stations	Ambiance (comfort, color, materials), environment (elevators, stairs), functional aspects (cooling, heating, dedicated spaces like waiting room), cleanliness, renovations, parking	49	55	19	10	39
Mediating (351 occurrences)	Passengers' personal experience	Familiarity with the service	Habits and past experiences with the service: use frequency, comparison between time periods, perception of routines, recurring problems, service history	75	73	33	16	34
		Reasons for using a transport or another	Reasons for traveling by train or not (often compared to cars and buses): time optimization and perception, preference, environmental, financial reasons, tourism	72	85	52	7	28
		Experience with other services	Comparisons with other public transportations used: advantages and limits	42	43	29	2	18
	External factors	Personal characteristics	Personality (degree of patience), passion for trains, contexts (traveling with relatives, home locations), motivation to contribute in the experience quality (keep clean spaces)	34	27	20	5	1
		Free of charge	The benefits of democratizing public transportations, satisfaction of no longer paying and managing the subscription, the service quality always provided despite free of charge	57	60	51	3	6
		Multi-modality actors	Parking facilities (existence, occupancy), other public transportations (tram, bus) used in combination with trains, bike facilities (spaces for bikes in trains, parking for bikes)	32	44	27	4	20
		Other users	The other users in trains and stations: behaviors, passenger-to-passenger help	25	19	4	1	15
Appreciation (339 occurrences)		Service perception	Appreciation of the company and the service, generic comments about the service, e.g., service improvements, branding, attractiveness of the service in the region	91	143	100	18	43
		Empathy (towards the company)	Expressing empathy towards the company and staff: noting the efforts to improve the service, understanding the service complexity and job difficulties, flexibility of the staff	72	100	55	21	29
		Service offer	Appreciation and wishes regarding the offer: possible destinations and journeys, connections, time-tables, trains frequency, direct lines, international offer, touristic paths	58	64	33	11	21
		Innovation	Innovation ability and differentiation ideas to stay competitive: capability for thinking out of the box, time for taking decisions, investing and improvements and works	21	20	4	5	12
Particular use contexts (260 occurrences)		Communication	Corporate communication through media and press (news about works, punctuality), communication of contents to promote the railway transportation	13	12	1	5	5
		Rail service failures	Management of service failures (delays, cancellations, works) with reasons among others like technical problems and accidents, the alternatives offered	81	164	31	17	126
		Particular weather	Experiences of weather: waiting time during winter, journey in train during summer	38	31	10	3	21
		Times of rush hours	Crowded trains in rush hour: experience with the crowd, trains capacity, trains frequency	36	29	7	0	24
		Covid-19 situation	Management of the Covid-19 situation and sharing concerns regarding the future	23	24	11	2	13
		Cross-border journeys	Specific experience as cross-border passenger: tickets purchase, passenger information between the foreign railway services, cross-border connections	9	12	3	2	7

N.B. The occurrences could be coded positive and negative depending on the occurrence meaning.

Table 4
Identified passenger needs influencing passenger experience.

Passenger needs	Description	% of participants	No of occurrences			
			Total	Positive	Neutral	Negative
Psychological needs (811 occurrences)	Control/ Independence	85	163	46	23	95
	Care/Empathy (toward users)	79	120	47	10	66
	Physical safety	32	41	26	3	18
	Pleasure	66	87	77	7	4
Pragmatic needs (112 occurrences)	Effectiveness	89	151	54	9	90
	Efficiency	81	137	43	14	83
	Utility	77	89	56	15	21
	Accessibility	25	23	7	1	20

N.B. The occurrences could be coded positive and negative depending on the occurrence meaning.

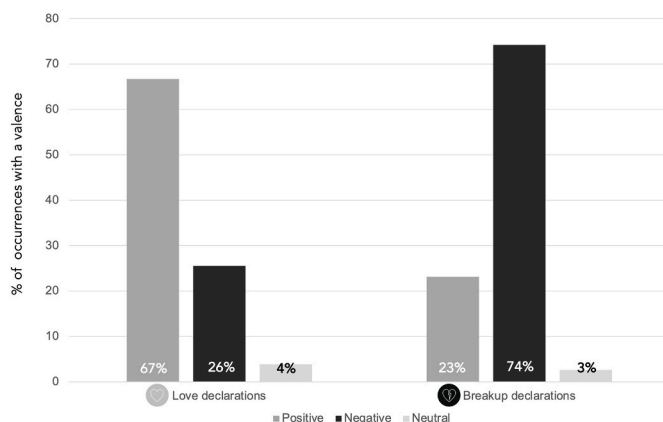


Fig. 3. Valence distribution of occurrences per type of declarations (N = 53, some occurrences have been coded with positive and negative valence).

“I know you’re not perfect, but you have been a vital part of my daily life.” L.45.

Particular use contexts. Our participants reflected on their experience in five particular situations: rail service failures, particular weather conditions, rush hour, Covid-19 situation, and cross-border journeys. Rail service failures were the most mentioned. Participants did not always specify the type of failure, yet all expressed not understanding the reasons for these problems, which leads back to the concerns about passenger information transparency. “We don’t know why we stopped.”

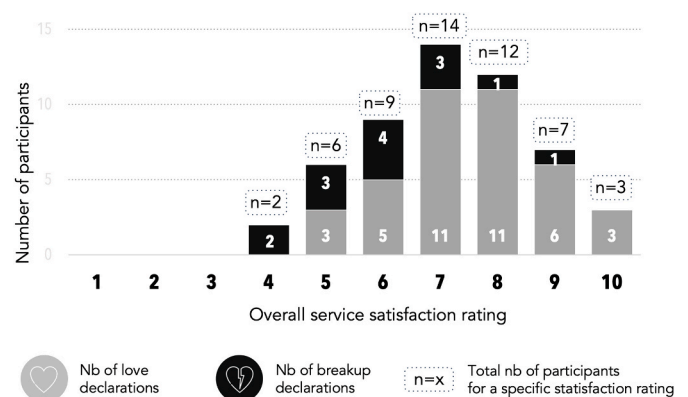
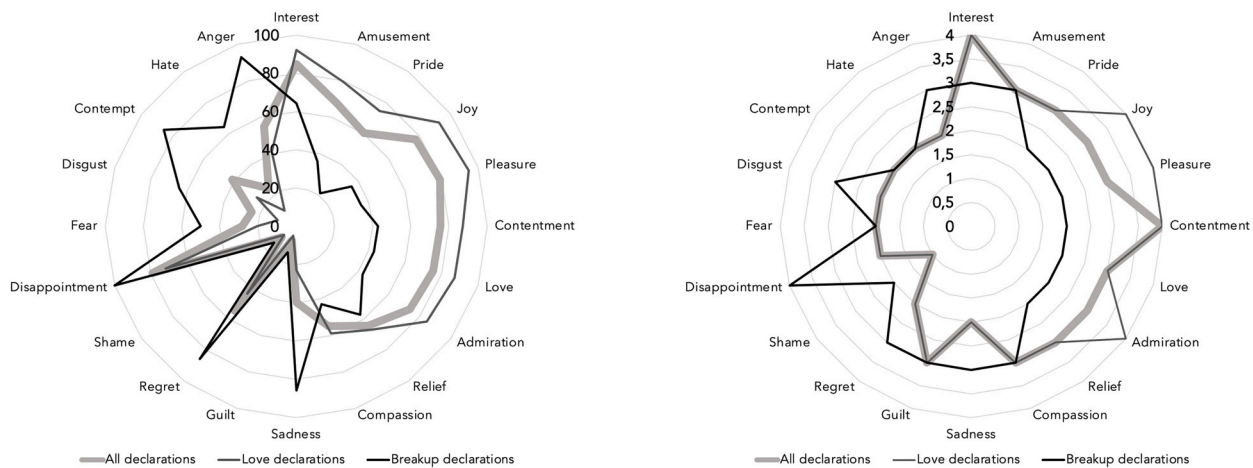


Fig. 4. Service satisfaction rating by declaration type: love (n = 39) or breakup (n = 14).

L.34. Too generic passenger information generates a negative impression of the service management. “You get the impression that the possibilities are put under a hat, and one will come out at random.” L.53. Proper information in critical contexts is crucial and missed: “Too busy dealing with your various problems; perhaps, you are never on the platform when I need information.” B.25.

The weather was the second context factor. Winter weather stood out specifically with issues such as ice on footbridges and waiting in the cold. Participants, furthermore, commented on the discomfort they experience during rush hour. A quarter of them also expressed concerns



N.B. « All declarations » and « Love declarations » have similar means from « Pride » to « Relief » emotions

Fig. 5. Emotions selected (left figure; percentage of participants who selected the emotion) and their intensity (right picture; means rounded of emotions selected) as rated by the passengers for love, breakup and all declarations (N = 53) (Scherer, 2005).

about Covid-19. They emphasized the importance of hygienic measures and related information such as the train occupation rate. Lastly, participants commented on synchronization issues related to cross-border commutes. “I feel that there is not good communication with CFL although it is a cross-border line.” L.30.

4.3. Identified passengers' needs influencing passenger experience

In addition to the factors identified in section 4.2, passengers' narratives reflect eight needs categorized in psychological needs and pragmatic needs (Table 4).

Psychological needs. Most participants seek control over their experience and wish to feel autonomous instead of dependent on the service. “Not being able to do anything. Powerlessness.” L.52. They expect to be able to choose when to take the train according to their schedule and the travel options offered. More than half of the participants commented on information shortcomings and the service failures. Transparent and consistent information supports passengers' feeling of control; it helps them feel more confident and generates fewer negative emotions: “If you only have the information about the delay, you can be anxious, but when you have the time delay, then you can feel relief.” L.44.

The need for care/empathy reflects the importance of demonstrating attention to passengers. Three-quarters of participants expressed the need to be care for by the service. The lack of listening and understanding impacts their experience negatively and can trigger deception or even blame. “I gave up. The collaborative mode doesn't work. I felt a bit misunderstood, it's just a shame.” L.53. Passengers' want to be treated with equity. Not taking care their well-being inevitably leads to a poor experience: “They know it's at least 2 h late. [...] They don't give us a bottle of water.” L.46. Their empathy towards the service and its challenges reaches its limit when the consideration they receive does not meet their expectations. “I don't know what they mean when they say, ‘technical problems’, there is some compassion, but not too much.” L.33.

Several participants commented on the benefits of traveling by train and underlying pleasure. “I gave 4 to pleasure because [...], I was remembering and thinking of all the time I spent on the train and using the service in general. I really liked it.” L.46. This notion of pleasure is primarily associated with the personal activities that participants can have on-board or in stations: “Have the pleasure of meeting friends, with whom I take the train, and with whom I sometimes share a coffee.” L.30.

Security is railway companies' top priority. Every precaution is taken to avoid accidents. As a result, there was little input from participants on this need. The few participants who mentioned security emphasized their appreciation, “the security criteria are guaranteed.” L.04. For the

participants security mainly relates to the feeling of safety. They explained when, how, and why they feel safe, “Your material is so clear and well-lit that it already gives a feeling of safety.” L.05, or unsafe (e.g., deteriorated material, lack of reassuring human presence).

Pragmatic needs. Effectiveness is the reason why most participants choose the train over the car. It is often expressed in terms of reliability: the service should provide reliable rolling stocks, trustworthy information, and competent staff that attends to customer questions, reassures, and handles unexpected situations. Passengers expect a reliable service that ensures punctuality or proposes effective alternatives during rail service failures, “I should look for a new girlfriend, a bit more flexible than you, more reliable.” B.09, “Because my dear service, you are never on strike, you work 24/7, you transport me everywhere I need to go and never leave me.” L.06.

Passengers frequent comments on time echo their need for efficiency regarding which good connections and punctuality are key factors. They count on the reactivity and flexibility of the service. “They are still reactive.” L.10.

The utility need was often mentioned in combination with other needs. 77% of the participants shared expectations of functional needs like Wi-Fi and clean toilets. It also refers to the utility of the service overall. “It has always been useful in my daily life to have this service.” L.38.

A quarter of participants (mostly frequent users, aged between 25 and 54) referred to accessibility, although none of them identified as a person with special needs. They put themselves in other passengers' shoes or projected themselves when they get older, “There aren't many lifts at the stations.” L.13. Others share personal experiences of situational accessibility difficulties, e.g., carrying a bike, luggage, or stroller. “Putting the bike up like that on a hook. It's not easy.” L.33.

5. Discussion

The study aimed to uncover the prominent factors and needs influencing railway passenger experience, using a qualitative research approach that invites participants to share their service experiences. We discuss how our results consolidate and deepen previous work by highlighting four categories of factors and key passengers' needs. Putting our findings into perspective with the literature on user experience, we provide new insights into the user experience in the context of rail travel. We also discuss the relevance of the original love and breakup method to gather engaging and emotional passenger feedback, and reflect on its use in the transportation domain.

5.1. Factors influencing passenger experience

Most of the findings align with prior work. Service satisfaction and the dimensions of the SERVQUAL questionnaire (Parasuraman et al., 1988) were mentioned by participants in the form of appreciation factors. For instance, the *tangibles* dimension aligns with our service touchpoints, as well as the *comfort*, *reliability* and *assurance* with the effectiveness (Cavana et al., 2007). Beyond service satisfaction surveys, our results overlap with factors assessed in studies on service design components, e.g., atmosphere (van Hagen, 2011), staff (van Hagen and Sauren, 2015; Vos et al., 2019).

Beyond these overlaps, the present study adds new insights into important topics such as passenger information. Tools for measuring passengers' satisfaction with information (Azmi et al., 2018) highlight the passengers' need to get information at a glance (Hildén et al., 2017) and in real-time (Dziekhan and Kottenhoff, 2007). Our results strengthen passengers' request for appropriate information, particularly during service failures. Beyond easier access to information, passengers desire transparent communication. They expect to be informed by the service even when the company does not have definitive answers, e.g., displaying that the duration of a delay is unknown. According to the expressed needs, particular attention should be paid to the messages' content and tone. Enhancing information stands out as a key aspect to address passengers' needs for control/independence, effectiveness, efficiency, utility, and care/empathy.

Mediating factors influence passengers' regard for the service. Prior experience with other transportation services raises expectations, which, if not satisfied, generate negative experiences and frustration. On the contrary, reasons for using the train that resonate with personal values (e.g., sustainability) generate positive emotions. Our passengers' personal experience and external factors in Table 3 are close to Ross et al.'s (Ross et al., 2020) personal, contextual and task factors impacting passenger experience during rail service failures. Participants referred to personal characteristics to explain their understanding of service challenges or their level of patience (e.g., daydreaming personality). We noticed that the familiarity with the service plays a crucial mediating role. Participants taking the train several times per week expressed more controversial, variegated, and detailed opinions about the service. They also mentioned anecdotes regarding the usefulness of aspects of the service and were able to make plausible hypotheses about how the service works. Participants who took the train daily over a long time seemed more tolerant towards the service and followed the improvement over time. Finally, free transport appeared as a singular external factor that positively influences passengers' experience, which aligns with studies on the zero-prices effect (Cools et al., 2016).

5.2. The central role of passengers needs

Currently, transportation research recognizes that passengers have needs and experience positive and negative emotions throughout their journey. These factors are however still under-considered in decision-making about the design of the service. As implications for the railway industry, identifying and addressing the needs and the emotions expressed is key for designing positive passenger experiences. Users' needs "serve to anchor a wide variety of motivational and functional analyses." (p.325) (K. M. Sheldon et al., 2001). Some of the needs identified in our study resonate with those from van Hagen et al.'s studies (van Hagen, 2009; van Hagen et al., 2022), which distinguish functional needs, social values, and emotional needs.

Our participants emphasized several pragmatic needs: effectiveness, efficiency, utility, and accessibility. Accessibility has been evoked as a concern for all. The participants mentioned several situational limitations, for example crowded or loud contexts, traveling with heavy luggage or a stroller. These situational impairments, defined as a mismatch between the environment and the interaction that creates a temporary exclusion (Microsoft Design, 2022), are rarely studied as

such. Mobility research mainly focuses so far on accessibility for specific populations like the elderly (Stein et al., 2017) or passengers with impairments (Vollenwyder et al., 2020). Looking at disability as "mismatched human interactions" rather than a "personal health condition" could bring inclusion to a new level in the transportation area.

Interestingly, our findings can also be put into perspective with the psychological needs inspired by the Self Determination Theory (K. M. Sheldon et al., 2001) and user experience models (Hassenzahl et al., 2010), and pragmatic needs inspired from (Batra and Ahtola, 1991). Eight psychological needs are usually described as the main drivers for a positive user experience (Hassenzahl et al., 2010; R. Sheldon, 2011): competence/effectiveness, autonomy/independence, security/control, pleasure/stimulation, self-actualizing/meaning, relatedness/belongingness, influence/popularity, physical thriving. In our analysis, we identified control/independence, care/empathy, pleasure, and physical safety as predominant psychological needs in the railway context. They all overlap, partially or entirely, with the psychological needs. Effectiveness (and by extension efficiency) can be understood as both a pragmatic and a psychological need, defined in this context as the feeling to be capable and effective in your actions (K. M. Sheldon et al., 2001). In our sample, this need is closely related to the need for being autonomous and in control of the journey. Companies' infrastructure investments to solve service failures might appear as insufficient if they are not combined with, e.g., adapted passenger information fulfilling passengers' need for control of their journey.

Despite their seemingly important role, other needs such as care/empathy, are still under-researched in the transportation domain. These appear close to the empathy and responsiveness dimensions of the SERVQUAL questionnaire (Parasuraman et al., 1988), which entails the caring individualized attention the firm provides its customers and willingness of employees to help customers. Aligned with research on customer relations in other domains, care and empathy from the service provider motivates passengers to be, in return, more tolerant towards rail service failures and empathic towards the service organization overall (Wieseke et al., 2012). This illustrates the bi-directional nature of empathy, where passengers are both part of- and partners in the service experience (Ngo et al., 2020). Some recent work has explored ways to trigger railway employees' empathy towards customers, by using original ways of sharing customer insights within the company (Lallemant et al., 2022).

The findings have implications for the design of user-centered railway services. The identification of passenger experience factors offer opportunities to ideate solutions to improve the quality of the service. As a myriad of solutions can potentially address a specific concern or opportunity, the passengers' psychological needs should be used as a lens under which the suitability of solutions can be scrutinized. The needs are thus to be used as guiding principles in the choice of solutions.

5.3. Suitability of the love and breakup method for investigating passenger experience factors

In this study, we employed the love and breakup method as a way to investigate passenger experiences. Although not yet used - to the best of our knowledge - in the railway domain, the method has been insightful in different contexts, e.g., users' emotional attachment to technologies (Gerber, 2011), or the identification of pain points and satisfaction with services or products (Vasques et al., 2022). It was used in varying formats: letters (McCarthy et al., 2021), e-mails (Koskinen et al., 2003), or oral declarations (Gerber, 2011). We chose the oral format to encourage spontaneity in the comments shared.

Our study confirmed that the concept of declarations is easily understandable (Gerber, 2011) and playful. It motivated the participants to share constructive feedback. "I liked it. It was a nice approach to get more passionate feedback. It was a lot less dry than I anticipated. It was fun." B.50. It also elicited emotions that triggered memories and made them reflect on their experience more emotionally. Most participants commented

that the method helped them to step back from their overall experience and share authentic lived experiences beyond quick factual feedback: "It forced me to reflect on my perception of the service because I usually don't wonder about this." L.06, "It was exciting to ask people to express their feelings. I think it makes everything more personal, and people can organize their ideas better." L.47.

In contrast with transportation research on service satisfaction, the love and breakup method allowed passengers to share their feedback in a non-constrained fashion. By telling their stories, participants depicted a more detailed representation of passenger experiences and a contextual understanding, which are essential to the field (Carreira et al., 2013; Grosvenor, 2000; Ross et al., 2020). The method pointed at factors of which the company was unaware (e.g., control/independence, empathy/care needs). Similar to van Hagen and Bron's in-depth interviews (van Hagen and Bron, 2013), our study unveiled the underlying reasons behind passengers' satisfaction or dissatisfaction.

Relevant for the study of passenger experiences, the love and breakup method might be used for longitudinal purposes (Karapanos et al., 2012) and echoes the popular critical incidents technique (Flanagan, 1954). It has the potential to explore passengers' concerns in a retrospective fashion while being cost-efficient enough to fulfill industry standards (Vermeeren et al., 2010). It carries inspirational value from the nuanced understanding of passengers' perceptions and expressions about the service from perspectives that quantitative methods do not provide.

6. Limitations and future work

Our study involved several limitations. First, the data collected covered only one European country (Luxembourg), with specific characteristics (free transportation, high ratio of cross-border commuters). The research methodology is nevertheless transferable to other locations and can be used in future research.

Our study took place during the Covid-19 pandemic, whose impact likely altered the passenger experience in some ways. Besides the comments directly related to the Covid-19 management, the perception of social factors might have been influenced. There were no restrictions on the rail travel in the country neither during the study period nor the 6 months prior to it. People were solely required to wear a mask. Due to home office agreements, the passenger volume was lower. Similarly, the weather conditions in winter period can result in some factors being more prominent.

Our sampling through the company channels limited us to service users and did not allow reaching people who do not use the service for reasons of dissatisfaction. The sample might therefore overrepresent passengers with a favorable attitude. Nevertheless, the obtained feedback seems balanced and not overly positive because several passengers saw their participation as an opportunity to get their concerns heard. Using voluntary sampling also possibly introduced a self-selection bias which could exclude people who have reflected less on their travel experiences. As the study was conducted online, our sample also likely excluded less IT-literate passengers.

Making a love or breakup declaration is not natural to everyone. Four participants did not engage with this approach: they did not employ any relationship expressions and solely enumerated the strengths and weaknesses of the railway service. Last, we observed a discrepancy between the overall positive feedback gathered via the love and breakup method compared to the satisfaction rated in the survey. Possibly the forced choice between the love or breakup tended to push people toward more well-meaning feedback, frequently choosing love over breakup. This effect was attenuated by the debriefing stage (negative points were mainly added at this stage), allowing in part to collect nuanced user feedback.

In future work, the valorization of positive aspects might help

increase stakeholders' motivation to listen and believe users' feedback. The love and breakup method shares passengers' input through a new lens as compared to complaints or satisfaction surveys. Typically used for designers' inspiration (Smart Design, 2016) the passenger declarations might catch the attention of the service staff, hence raising their awareness and likely triggering their empathy towards passengers (a key element for an empathy-centric design process (Koskinen et al., 2003) and UX maturity (Chapman and Plewes, 2014)). The use of the method for this purpose remains to be explored in future work. It could be done by sharing the anonymized audio recordings of the declarations with employees, or having a group discussion on the individual declarations. Railway staff strongly impact passengers' perception of their travel experience, as evidenced by prior research (Oliveira et al., 2020; van Hagen and Sauren, 2015; Vos et al., 2019) and our findings. It is thus crucial to guide them on how to understand and improve passenger experience.

7. Conclusion

This paper identifies 21 factors influencing railway passenger experience categorized into four themes: service touchpoints, mediating factors (e.g., external factors), company appreciation factors, and particular use contexts. We uncovered them through the love and breakup method, an unusual user research tool for the transportation domain. The study points out to eight passengers' needs and their influence on passengers' experiences: psychological needs – control/independence, care/empathy, physical safety, pleasure, and pragmatic needs – effectiveness, efficiency, utility, accessibility. These needs were discussed with regards to theories of user experience. The study also gathers valuable insights into the love and breakup method to explore service experiences. Thanks to the originality of the method in this context, this study reveals new perspectives and opportunities in passenger experience studies. The factors and needs identified support a user-centered approach in the transport domain. Finally, this work is a new step toward more dialogue between service customers and stakeholders. Qualitative approaches such as the love and breakup method create a favorable environment to trigger service stakeholders' empathy towards users, which is an essential condition to deliver customer-centric services.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendices.

Table 5
Emotions selected by the participants in all declarations.

Emotions	Nb of participants choosing this emotion		Min	Max	Mean	Std. Deviation
	n	%				
Admiration	39	74	1	5	3.38	1.31
Amusement	36	68	1	5	3.22	1.31
Anger	29	55	1	5	2.34	1.40
Compassion	29	55	1	5	2.79	1.01
Contempt	22	42	1	4	1.95	1.09
Contentment	40	75	1	5	3.57	1.32
Disappointment	42	79	1	5	2.38	1.46
Disgust	13	25	1	4	2.23	1.01
Fear	15	28	1	4	1.93	1.03
Guilt	4	8	1	4	2.75	1.5
Hate	13	25	1	4	1.92	1.04
Interest	45	85	1	5	3.67	1.13
Joy	41	77	1	5	3.44	1.27
Love	40	75	1	5	3.17	1.38
Pleasure	42	79	1	5	3.43	1.27
Pride	32	60	1	5	3.19	1.06
Regret	29	55	1	5	1.9	1.15
Relief	34	64	1	5	2.68	1.25
Sadness	21	40	1	4	2.29	1.23
Shame	5	9	1	2	1.4	0.55

Table 6
Emotions selected by the participants in love and breakup declarations.

Love declarations group						Breakup declarations group							
Emotions	No of participants choosing this emotion		Min	Max	Mean	Std. Deviation	Emotions	No of participants choosing this emotion		Min	Max	Mean	Std. Deviation
	n	%						N	%				
Pleasure	37	70	1	5	3.59	1.19	Disappointment	14	26	1	5	3.71	1.38
Interest	36	68	1	5	3.89	1.06	Anger	13	25	1	5	3.15	1.21
Joy	36	68	1	5	3.64	1.18	Sadness	12	23	1	4	2.75	1.29
Contentment	34	64	1	5	3.94	1.01	Regret	12	23	1	5	2.5	1.45
Love	34	64	1	5	3.35	1.28	Contempt	12	23	1	4	2.17	1.12
Admiration	33	62	1	5	3.67	1.05	Interest	9	17	2	5	2.78	0.97
Amusement	31	58	1	5	3.32	1.28	Disgust	9	17	1	4	2.56	0.88
Pride	29	55	1	5	3.28	1	Hate	9	17	1	4	2.11	1.17
Disappointment	28	53	1	4	1.71	0.98	Relief	8	15	1	4	2.25	1.17
Relief	26	49	1	5	2.81	1.27	Fear	7	13	1	4	2.43	1.13
Compassion	23	43	1	5	2.87	1.06	Contentment	6	11	1	3	1.5	0.84
Regret	17	32	1	3	1.47	0.62	Love	6	11	1	5	2.17	1.60
Anger	16	30	1	4	1.69	1.20	Admiration	6	11	1	5	1.83	1.60
Contempt	10	19	1	4	1.7	1.06	Compassion	6	11	2	4	2.5	0.84
Sadness	9	17	1	3	1.67	0.87	Amusement	5	9	1	4	2.6	1.52
Fear	8	15	1	3	1.5	0.76	Joy	5	9	1	3	2	1
Disgust	4	8	1	3	1.5	1	Pleasure	5	9	1	4	2.2	1.30
Hate	4	8	1	2	1.5	0.58	Pride	3	6	1	4	2.33	1.53
Shame	3	6	1	2	1.33	0.58	Guilt	2	4	2	4	3	1.41
Guilt	2	4	1	4	2.5	2.12	Shame	2	4	1	2	1.5	0.71

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