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User insights into integrated passenger-freight transport

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ABSTRACT

Integrated Passenger-Freight Transport (IPFT) offers a potential solution for reducing reliance on motorised vehicles and the associated costs of last-mile connections. To date, the scientific literature has focused primarily on defining the general framework of IPFT services and addressing operational aspects such as routing, pick-up locations and line scheduling. However, less attention has been paid to evaluating service quality from the users' perspective. To address this research gap, a methodology is proposed to investigate the opinions of Public Transport (PT) passengers regarding potential IPFT services and identify the service characteristics that most influence bus passengers' preferences. A Stated Preference (SP) experiment was designed to elicit the perspectives of PT users on hypothetical IPFT services. The design was based on observations from a previous international Delphi survey which identified the key requirements for the successful implementation of IPFT in urban and rural contexts. The attributes included in the SP experiment were bus service frequency, in-vehicle travel time (IVTT), fare, and passenger comfort, expressed in terms of the available in-vehicle space. Several choice sets were generated using a full factorial design. This formed the basis for administering the SP experiment to PT passengers interested in using IPFT services. The SP experiment was implemented via a Facebook survey to obtain insights from the calibration of a Random Parameter Logit (RPL) model. The RPL model determined the relative importance of each attribute in users' preferences and their Willingness-to-Pay (WtP) for improvements to these attributes. IVTT was found to have a significant impact, with a WtP of EUR 15 for a 30 min reduction. In contrast, service frequency and comfort had a lesser influence on users' choices. These findings are useful for supporting policymakers and practitioners in establishing service performance requirements for new IPFT systems.

1. Introduction

1.1. Integrated passenger-freight transport

Integrating passenger and freight transport into a unified operational framework, also known as IPFT, has been proposed as a potential solution to address operational issues related to last-mile transport (EC, 2007). Costs relating to this final stage of the journey can account for up to 40% of the total costs incurred by both the passenger and freight sectors (Suguna et al., 2022). In urban areas in particular, these sectors are often fragmented and uncoordinated, resulting in vehicle under-utilisation, congestion, environmental externalities, negative community impacts, and increased system costs (Gevaers et al., 2014).

According to Trentini and Malhene (2012), IPFT encompasses three primary facets: vehicular (combining the transportation of goods and passengers in the same vehicle), infrastructural (providing shared infrastructure for freight and passenger vehicles) and nodal (identifying specific network nodes that combine passenger and freight functions). With regard to the first facet, Cavallaro and Nocera (2022) noted that IPFT has been proposed and implemented across different modes of transport, such as air travel, trains and ferries, primarily for long-distance journeys. However, IPFT has received less attention in urban and rural contexts, and in mega-city regions (He et al., 2022). Most contributions related to these contexts consist of conceptual models (e.g., Bruzzone et al., 2023a, 2023b; van Duin et al., 2019; Kopperschmidt de Oliveira et al., 2024) and operational problem-solving approaches, such as stop and station convenience, optimal route identification, and increased travel time owing to combined passenger and freight operations (e.g. Ghilas et al., 2016; Molenbruch et al., 2021; Machado et al., 2023; Manibardo et al., 2026).

Evaluating the service quality offered by IPFT schemes is crucial for determining their potential. The international legislative framework

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explicitly acknowledges this for public transport (PT), with the European 06 (CEN, 2002) recommending that service performance be evaluated from the perspectives of both customers (current and potential PT users) and service providers. From the customer's perspective, both the expected and the perceived quality of service must be considered, bearing in mind the desired and the experienced levels of quality. To date, only a few studies have adopted qualitative and preliminary approaches to this topic related to IPFT (Cochrane et al., 2017), and the issue remains insufficiently addressed (Elbert and Rentschler, 2022).

1.2. Research questions

To address the gap identified in the literature review, this study investigates the opinions of PT passengers willing to use IPFT. Our objective is to identify the service characteristics that most influence passenger preferences and determine their Willingness-to-Pay (WtP) for improvements in a hypothetical IPFT service. Given the innovative and hypothetical nature of IPFT, this study focuses on the segment of potential early adopters (Rogers, 2003). This allows for a more precise estimation of service attribute trade-offs, avoiding the statistical noise that would derive from including individuals with no intention of using such integrated services. Specifically, the main research questions (RQs) are as follows:

RQ1. Which PT service attributes best characterise the new IPFT service?
RQ2. What are the expected levels of variation for selected attributes of the new IPFT service?
RQ3. How can these attributes and ranges be combined into a Stated Preference (SP) experiment?
RQ4. Which public transport service attributes most influence the preferences of potential early adopters of IPFT services?
RQ5. What is the willingness to pay of passengers interested in IPFT services to maintain or improve service quality levels when freight transport is integrated on board?

This study builds upon previous research by Cavallaro et al. (2023), which investigated the design of an IPFT service in urban and suburban contexts using an international Delphi survey. That survey aimed to assess the minimum service requirements for IPFT by evaluating the anticipated impacts on selected Key Performance Indicators (KPIs) and comparing them with those of conventional passenger- and freight-only services. The present study utilises these findings to design an SP experiment, focusing on identifying the service attributes influencing PT users' preferences.

This approach is motivated by the fact that IPFT is a hypothetical transport service not yet available to users. Therefore, rather than asking potential users to evaluate an existing service, we need to ask them what they would choose in a hypothetical scenario. To achieve this, we designed an SP experiment in which PT users chose between two alternative IPFT services, each characterised by specific attributes with varying levels. A Random Parameter Logit (RPL) model was calibrated using data collected through a Facebook survey targeting PT passengers interested in using IPFT services. Finally, the WtP for improvements in the various IPFT service attributes was calculated.

The remainder of this paper is organised as follows. Section 2 provides an overview of studies investigating PT and freight transport service quality, as well as an overview of studies dealing with IPFT services. Section 3 describes the methodology used in this study. Section 4 presents and analyses the results of the RPL model and WtP calculations. Finally, Section 5 discusses the implications of the findings for future managerial practices, as well as their contribution to academic discourse.

2. Literature review on service quality for IPFT

In order to gain a comprehensive understanding of a transport system, its service performance must be evaluated from the perspectives of both customers (i.e. current or potential PT users) and service providers (i.e. operators and transit agencies). In both cases, expected and perceived service quality should be considered by investigating the desired and experienced levels of quality (CEN, 2002). This section summarises the current state of research on this topic, with specific reference to PT (Section 2.1), freight transport (Section 2.2), and IPFT (Section 2.3).

2.1. PT service quality

Recent literature on PT service quality has extensively focused on the customer perspective, whereas the service provider's perspective (including transport operators and agencies) has received less attention (Friman and Fellesson, 2009; dell'Olio et al., 2017). PT service quality is characterised by several attributes linked to various service aspects, such as service availability (frequency and regularity), accessibility, time, comfort, and safety (de Oña et al., 2016a; Nocera, 2010, 2011). Opinions of PT users are generally obtained through conventional customer satisfaction surveys and SP experiments. In the former, passengers rate service attributes or express their level of agreement/disagreement with statements about them (de Oña et al., 2016a). In the latter case, current or potential users are asked to rate or rank the attractiveness of existing or hypothetical services or to select the most preferred option (Hensher and Prioni, 2002; Eboli and Mazzulla, 2008, 2010; Bellizzi et al., 2020, 2021). The literature on service quality evaluation begins with techniques developed in marketing research, among which, SERVQUAL (Parasuraman et al., 1985) and importance-performance analysis (Martilla and James, 1977) are the most widely known. More recently, advanced approaches have been proposed in the PT field, such as structural equation modelling, classification and regression tree approach, and random utility models based on SP techniques (Hensher and Prioni, 2002; Eboli and Mazzulla, 2008, 2010; dell'Olio et al., 2017; Allen et al., 2019; Bellizzi et al., 2020, 2022).

2.2. Freight transport service quality

Zeybek (2019) described the most common techniques for measuring service quality in freight transport. Initially, the provider's perspective was predominant in the definition of operational attributes (Bienstock et al., 1997; Mentzer et al., 1999). Logistic service quality is a technique widely adopted for this purpose. However, customer-perceived attributes have also been considered to make evaluations more comprehensive and exhaustive (Cappelli and Nocera, 2006; Chen et al., 2009; Franceschini and Rafele, 2012). The most extensively used techniques are SERVQUAL and SERVPERF (Gulc, 2017). SP techniques have been frequently adopted to simulate modal options (Maggi and Bolis, 1999; Regan and Garrido, 2001; Danielis, 2002; Rudel, 2005; Kök and Deveci, 2019). A few studies have used contingent ranking techniques (e.g. Li and Hensher, 2012; Šimeček and Dufek, 2016), while others have employed contingent ratings (e.g. Bergantino et al., 2013; Kim et al., 2017) or other discrete choice experiments (e.g. Danielis and Marcucci, 2007; Arunotayanun and Polak, 2011; Patterson et al., 2007; Feo-Valero et al., 2016; Larrañaga et al., 2017; Vega et al., 2018). Notably, the most commonly considered attributes in SP experiments are transport time, transport cost, frequency, reliability, risk of delay/punctuality, flexibility, service quality, and risk of loss and damage. However, there is no consensus on their relative importance. According to Danielis and Marcucci (2007), service quality and the risk of loss and damage are the most relevant attributes, followed by cost, transport/transit time, and delivery delays. Kim et al. (2017) indicated that shipment size, cost, reliability, and time are the most relevant. The end-users' perspectives and perceptions of delivery service attributes can be analysed through the relationship between delivery speed and sales (Marino et al., 2018; Fisher et al. 2019; Amorim et al., 2024).

2.3. IPFT service quality

In contrast to research on PT and freight transport service quality, the literature on IPFT service quality is more limited and has not yet been systematised (Antoniou et al., 2023). Only a few studies have adopted SP techniques for crowdshipping, which is a particular form of IPFT service where packages are delivered to customers by leveraging nonprofessional and local courier services, rather than involving PT passengers. In this field, SP experiments have been proposed to evaluate hypothetical shipments using crowdshipping drivers and identify service attributes that influence customer adoption of private vehicle-based crowdshipping platforms (Punel and Stathopoulos, 2017). Gatta et al. (2018) used SP to analyse the willingness of individuals to act as crowdshippers using Rome's (Italy) mass transit network, where crowdshippers pick up or drop off goods in automated parcel lockers located within transit stations. Their SP approach gathered preferences from both the demand side (customers) and supply side (crowdshippers) to quantify the effects of this freight transport strategy on e-commerce. Fessler et al. (2022) used a similar approach to evaluate user preferences for a PT-based crowdshipping concept in the Greater Copenhagen Area (Denmark), and the results were utilised to conduct practical field tests (Fessler et al., 2023). Although related to IPFT, crowdshipping is not fully synonymous with it. To the best of our knowledge, neither the evaluation of service quality nor the use of SP to understand the insights of potential IPFT users has been proposed thus far in the academic literature.

3. Method for evaluating IPFT service quality

To answer the RQs outlined in the introduction, we propose a method based on four phases. First, the attributes and minimum requirements of an IPFT service were obtained through a Delphi survey (Section 3.1). Based on these outcomes, an SP experiment was designed (Section 3.2) and administered to respondents (Section 3.3). Finally, an RPL model was employed to calculate the weights assigned to each attribute by the respondents and to determine the WtP associated with improvements in those attributes (Section 3.4).

3.1. Delphi survey

This part of the methodology is largely based on the findings of Cavallaro et al. (2023). That study investigated the perspectives of key stakeholders involved in IPFT services through an international Delphi survey. The survey aimed to identify the attributes potentially affected by the introduction of IPFT services in urban and suburban/rural areas and to determine the minimum requirements for service viability. Fifty-eight international experts, including representatives from PT and freight operators, public administration, consulting firms, and academia, participated in the survey. Their opinions on selected attributes were collected using computer-assisted web interviewing (CAWI) method on selected attributes.

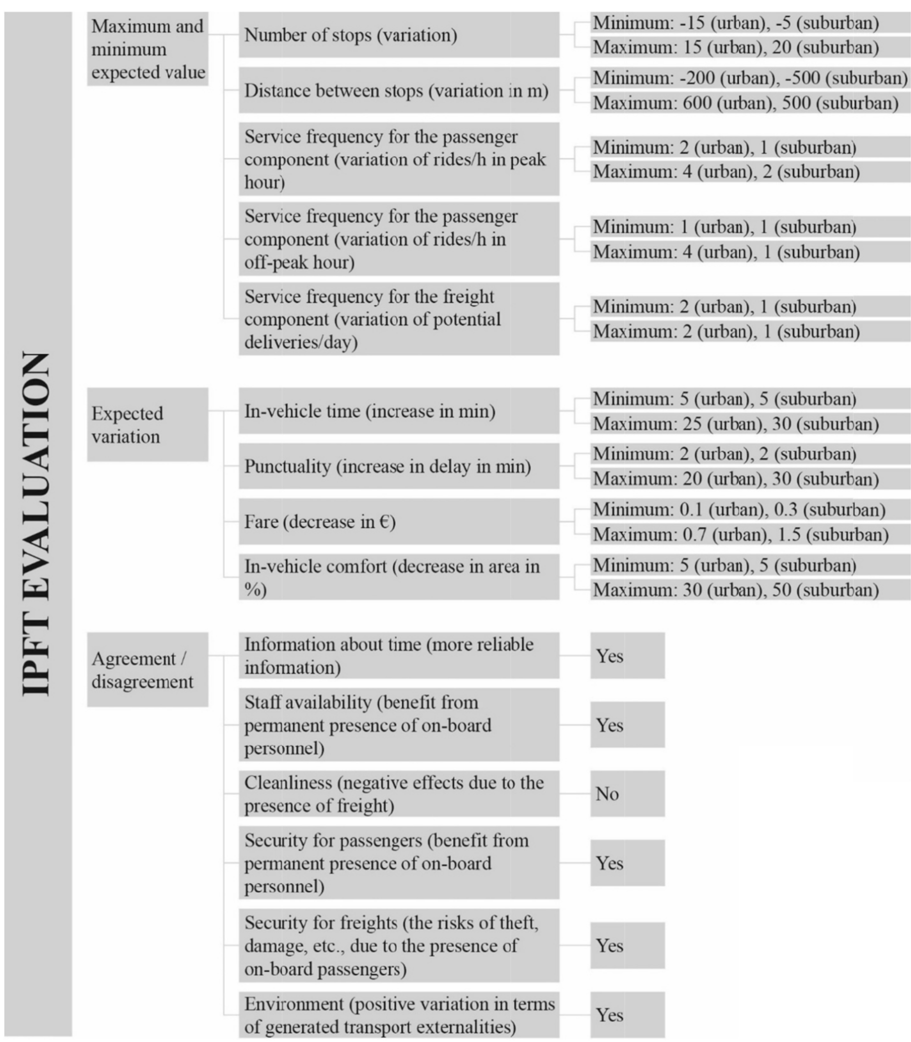

Fig. 1. Attributes considered for defining minimum requirements of an IPFT service.

Selecting appropriate attributes was critical for the survey design, as these attributes needed to define the proposed IPFT service. Eleven attributes were selected from a detailed literature review of studies analysing PT service quality (e.g. Fellesson and Friman, 2008; Eboli and Mazzulla, 2012; Redman et al., 2013; dell'Olio et al., 2017) (Fig. 1). These studies address all aspects that may vary owing to the introduction of IPFT services. We included characteristics of the bus route (e.g. number of bus stops and distance between two consecutive bus stops) and those of the service itself (e.g. service frequency for both passenger and freight components, in-vehicle travel time (IVTT), and fare). In selecting these attributes, we considered that the bus passenger frequency could be affected by the need to deliver goods, and that the number of daily deliveries might increase because of easier passenger access/egress at bus stops. IVTT could also increase owing to various operations related to goods delivery. However, a decrease in fare for bus passengers is likely as a consequence of the potential reduction in the costs for the community but also of the added profits for PT agencies due to the goods delivery. Moreover, we considered punctuality as an attribute describing service reliability, which could be affected by the presence of goods in vehicles. Additional qualitative attributes, such as in-vehicle comfort and cleanliness, were also included. As defined by the European Standard EN13816 (CEN, 2002), comfort evaluation is a multi-criteria problem. Passenger space is one attribute that adequately describes comfort; therefore, comfort was expressed as the available surface area for passengers in the vehicle. Notably, IPFT is likely to reduce available passenger space because of dedicated space for parcels. This could also adversely affect on-board cleanliness, even with separate passenger and freight areas. We also investigated aspects linked to information, staff, security (for both passenger and freight components), and the environment. IPFT could provide more reliable passenger information (such as real-time updates) owing to the use of an information system for freight traceability. The presence of staff managing freight delivery could also enhance passenger experience. With regard to security, passengers might feel safer because of the presence of on-board staff. However, freight security could be adversely affected by the risk of theft or damage owing to the presence of passengers, even with separate passenger and freight areas. Finally, IPFT is likely to positively impact transport externalities, such as air and noise pollution.

After identifying these attributes, we asked the interviewed experts about their expectations regarding potential changes within an IPFT context. Depending on the attribute's characteristics, we adopted different assessment methods. For certain attributes, we asked for the maximum acceptable variation for IPFT to be considered a suitable alternative. For other attributes, we requested their level of agreement/disagreement with specific statements about potential changes resulting from IPFT implementation, considering both passenger and freight aspects.

Given the novelty of such services, expert opinions were discordant, particularly concerning certain service attributes. For example, some respondents believed the number of stops and the distances between them would remain unaffected by the new IPFT service, while others predicted a reduction in stops and an increase in inter-stop distance. At least half of the experts predicted an increase in service frequency, implying an improvement in service for PT users and freight clients, who would have more options per day to receive their parcels. Conversely, most experts considered increases in on-board travel time and delays as service deteriorations. Passenger comfort, linked to available in-vehicle space, was also expected to decrease with IPFT implementation. Fares were unanimously considered likely to decrease, representing a service improvement for users. With regard to cleanliness, the experts predominantly disagreed with our initial hypothesis of adverse effects due to freight integration. With respect to other aspects, such as time information, staff availability, and the environment, the respondents generally agreed with our initial hypotheses. For each service attribute, the experts recommended a level of acceptable variation owing to the introduction of IPFT services (Fig. 1).

3.2. SP experimental design

The outcomes derived from the Delphi survey support the proposal of an SP experiment such that a sample of PT passengers willing to use IPFT services could determine the service attributes that affect the choices of passengers to the maximum extent. As suggested by Hensher et al. (2007), the design of the most appropriate SP experiment should begin with the following question: 'Why is this research being undertaken?' Recalling the RQs outlined in the introduction, our aim is to investigate the characteristics of an integrated passenger and freight service, acceptability of PT passengers willing to use IPFT services, considering variations in some PT service characteristics owing to on-board parcels, and their willingness to pay for service improvements or service non-deterioration. Accordingly, the proposed SP experiment aims to identify the service attributes that most influence bus passenger preferences under the hypothetical scenario of using IPFT services. Despite the inherent limitations of SP surveys owing to their hypothetical nature, the literature shows their capability to elicit individual's preferences for 'alternatives' expressed in a choice context (Cherchi and Hensher, 2015). The SP approach entails a specific survey type in which participants are induced to choose, rank, or rate their preferred scenarios based on their personal preferences. Discrete choice experiments are one of the most commonly used methods for obtaining SPs from individuals. In these experiments, alternatives are described as sets of attributes that vary at different levels (Louviere et al., 2000). Thus, the independent contributions of each service component can be separated. Ultimately, SP experiments can be used to measure the expected utility that a passenger obtains from a given service level, and how utility varies across alternative levels (Hensher and Prioni, 2002). For this research, a discrete choice experiment was selected as the most appropriate, and the research outcomes revolved around this experiment. The outcomes specifically established the attributes to be incorporated into SP exercises and determined their levels of variation. Defining attributes and their levels for an SP experiment involves critical decisions by the analyst (Hensher et al., 2007). The responses of the panel of experts participating in the Delphi survey allowed the establishment of attributes to be considered in the SP choice experiment and the variation levels of different service attributes.

The proposed SP choice experiment focused on four attributes, which are a subset of the 11 examined in the Delphi survey described above (Fig. 2). The decision to limit the original set of attributes to four originated from the need to design the simplest feasible experiment to make it user friendly, particularly considering the hypothetical characteristics of the analysed service. Because users have no prior experience with IPFT, these services are unfamiliar to them. We specifically selected four attributes expected to vary significantly between the conventional PT service and new IPFT service, as confirmed by stakeholders' opinions. In this context, each alternative represents a hypothetical bus service characterised by specific levels of service in terms of frequency, IVTT, fare, and comfort. As described in the previous section, the service frequency, IVTT, fare, and in-vehicle comfort (expressed as available space) can vary after the introduction of freight delivery by bus. In addition, they are among the service attributes that mostly affect the overall service quality, i.e. the attributes retained as most important for the users (e.g. de Oña et al., 2013, 2016b). We omitted the attributes linked to the number of stops and distance between stops because they are closely linked to in-vehicle time; in other words, because time is largely dependent of stops (Śmieszek et al., 2023), we chose time as the attribute to be inserted into the experiment, as users perceive it more directly than the number of stops. A similar reason motivated the decision to avoid punctuality. Scheduling a service with increased in-vehicle time to account for delivery times could mitigate punctuality differences between IPFT and traditional PT services. Contrary to our initial expectations, the Delphi survey indicated that IPFT would not significantly affect on-board cleanliness. Moreover, cleanliness can be considered a secondary attribute among attributes more peculiar to PT services, and for these reasons, we excluded it from the SP exercises. Finally, in this exploratory stage of the study, we omitted attributes such as information, staff, security, and the environment. Defining the variation levels of these attributes in the SP choice experiment would be difficult for respondents to perceive and adequately evaluate. As an example, it is expected that IPFT would improve environmental performance compared to PT and freight services owing to the reduction in overall kilometres travelled. However, it is difficult to consider different levels of variation in this attribute. In contrast, concerning peculiar PT attributes such as frequency, time, and fare, IPFT services are more conceivable and programmable. Ultimately, the attributes selected for the SP choice experiment were service frequency, in-vehicle travel time (IVTT), fare, and in-vehicle comfort (Table 1), with comfort expressed as a reduction in available passenger space. This selection allowed us to offer users alternative IPFT services characterised by trade-offs among these four attributes: improvements in some attributes are balanced by declines in others (Ghilas et al., 2016). Specifically, IVTT and in-vehicle comfort are expected to worsen in the IPFT scenario compared to that of traditional PT owing to time spent for loading and unloading parcels and the space occupied by goods. In contrast, frequency and fare are expected to improve, as explained above. Finally, the four selected attributes relate specifically to characteristics changing for PT passengers. Attributes such as freight frequency and security were not considered as they were outside the scope of the survey.

Each attribute was varied at two levels based on the extreme values indicated by the international experts in the Delphi survey (Table 2). Intermediate levels were omitted to streamline the choice experiment thereby preventing unnecessary complexity. Although reducing the number of levels causes some information loss, it significantly decreases the design size. Moreover, according to Hensher et al. (2007), end-point designs are particularly useful if the analyst uses the experiment as an exploratory tool. Having identified the attributes and their levels, the analyst must decide on the design to be used. We adopted a full factorial design, including 16 combinations, each representing a hypothetical IPFT service package. The combinations were reduced by eliminating the dominant and dominated profiles. A full factorial design was chosen to avoid the possible disadvantages associated with non-full designs. For example, full factorial designs mathematically display orthogonality. Parameters estimated from non-orthogonal designs are likely to be incorrectly estimated and, in some instances, have the incorrect sign (Hensher et al., 2007). Accordingly, a total number of 91 choice sets was generated. In the generation of the choice sets, the analyst has to rearrange each combination into a workable choice set that provides information on the attribute levels of the various alternatives, but also allows the decision maker some mechanism for selecting one of the alternatives available (Hensher et al., 2007). In addition, a number of choice sets would have been resulted as foregone. These reasons yielded a final count of 55 choice sets. The total number of choice sets was blocked to propose 11 choice sets to each respondent, to avoid annoying or fatiguing them.

Table 1
Attributes for the SP choice experiment.

Attribute	Indicator
Service frequency (passenger)	Variation (peak and off-peak hours)
IVTT	Travel time increase (min)
Fare	Decrease in fare (EUR)
In-vehicle comfort	Decrease in space for passengers (%)

Table 2
Variation in urban and suburban bus lines under the IPFT scheme.

	Urban service		Suburban/rural service	
	Min. variation	*Max. variation*	*Min. variation*	*Max. variation*
Service frequency (peak hours)	+2 runs/h	+4 runs/h	+2 run/h	+4 runs/h
IVTT	+5 min	+25 min	+5 min	+30 min
Fare (one-way ticket)	No variation	Reduction by 50%	No variation	Reduction by 40%
Comfort (space for passengers)	−5%	−30%	−5%	−30%

(a)

OPTION 1 □	OPTION 2 □
Service frequency **2 additional runs per hour (peak hours)**	Service frequency **2 additional runs per hour (peak hours)**
In-vehicle time **5 additional minutes**	In-vehicle time **25 additional minutes**
Fare **Current (one-way ticket)**	Fare **Reduced by 50% (one-way ticket)**
In-vehicle comfort **Space for passengers reduced by 5%**	In-vehicle comfort **Space for passengers reduced by 5%**

(b)

OPTION 1 □	OPTION 2 □
Service frequency **2 additional runs per hour (peak hours)**	Service frequency **4 additional runs per hour (peak hours)**
In-vehicle time **5 additional minutes**	In-vehicle time **5 additional minutes**
Fare **Current (one-way ticket)**	Fare **Current (one-way ticket)**
In-vehicle comfort **Space for passengers reduced by 5%**	In-vehicle comfort **Space for passengers reduced by 30%**

Fig. 2. (a, b). Examples of SP choice experiment for an urban service.

Figs. 2 and 3 illustrate each two examples of SP choice sets for urban and suburban IPFT services, respectively.

The SP exercises were designed to reflect variations in attribute levels. In Fig. 2, the first exercise (part a) presents users with a choice between an IPFT service involving a 2 run/h increase in service frequency, 5 min increase in on-board time, and 5% reduction in the available vehicle space for passengers. The alternative option features a more significant increase in on-board time (an additional 25 min). However, it compensates for this with a 50% reduction in ticket costs compared to the current service. The users were thus asked to weigh travel time against fare, whereas the other two attributes remained constant across the options. In this case, users were required to decide whether a substantial increase in travel time was reasonable in exchange for a reduced ticket cost. The second exercise (Fig. 2b) considered frequency and in-vehicle comfort. In this option, the users were required to determine whether a significant reduction in available passenger space was justified by a substantial increase in service frequency.

Fig. 3 presents a similar example for a suburban service. Here, a larger increase in on-board travel time is proposed compared to the urban service, but with a smaller reduction in ticket costs. The variations in the levels of the other two attributes (service frequency and in-vehicle comfort) reflected those considered for the urban service.

By proposing 55 choice sets of hypothetical IPFT services, the indication of preferences by respondents can provide feedback regarding the PT service attributes that best characterise the new IPFT service (RQ1) and their expected levels of variation (RQ2), helping to establish service performance requirements for successful IPFT implementation in both urban and rural contexts. The proposed SP choice experiments also show how attributes and levels can be combined, thus addressing RQ3. However, their reliability and efficacy need to be demonstrated by implementing appropriate surveys and analysing the collected data. These are the next two research phases, aimed at understanding the real attractiveness of IPFT among users.

3.3. Survey design

This study employed an online survey with participant recruitment carried out randomly through a Facebook campaign. Recruiting respondents via social media advertising is a well-established approach, used not only in the social sciences but also in fields such as medicine (Franz et al., 2019). Notwithstanding certain relevant limitations, Schneider and Harknett (2022) emphasised certain unique strengths, including rapid data collection, rich and flexible sample targeting, and low cost. Although non-probabilistic approaches are subject to significant selection bias, administering questionnaires through social networks has become increasingly common in post-COVID-19 pandemic research because of the convenience of obtaining an adequate number of responses without in-person contact (Jou et al., 2022; Rahman Fatmi et al., 2022; Olde Kalter et al., 2021).

The participants were selected by adopting the following method. First, we identified Italian municipalities with over 50,000 inhabitants according to the Italian National Statistics Office (ISTAT, 2024a). These urban conglomerations, labelled as 'cities', were characterised by high-density population clusters and extensive PT networks, making the IPFT proposal relevant to these contexts. We then selected groups called '*sei di x, se*' (English translation: 'you are from *x* , if'; *x* is one of the cities defined above) or similar. A total of 140 groups were identified. After two rounds of contact attempts, 89 groups accepted our request to participate. Thirty groups declined our profile, and 26 groups had not responded by the end of the contact period. After this phase was completed, we posted a message introducing the project and providing a link to the questionnaires, inviting interested PT users willing to use IPFT services. Using Google Forms, we prepared five different questionnaires, each containing 11 choice sets and a section on the general socioeconomic characteristics of the respondents. The message and link to the questionnaire were posted twice: once during a working day and once during a holiday.

The online survey ran from March 2024 to May 2024, with 75 respondents agreeing to participate. However, two of them were excluded from the analysis as they were not current or past PT users (a pre-

(a)

OPTION 1 □	OPTION 2 □
Service frequency **2 additional runs per hour (peak hours)**	Service frequency **4 additional runs per hour (peak hours)**
In-vehicle time **5 additional minutes**	In-vehicle time **30 additional minutes**
Fare **Reduced by 40% (one-way ticket)**	Fare **Reduced by 40% (one-way ticket)**
In-vehicle comfort **Space for passengers reduced by 30%**	In-vehicle comfort **Space for passengers reduced by 30%**

(b)

OPTION 1 □	OPTION 2 □
Service frequency **2 additional runs per hour (peak hours)**	Service frequency **2 additional runs per hour (peak hours)**
In-vehicle time **30 additional minutes**	In-vehicle time **30 additional minutes**
Fare **Current (one-way ticket)**	Fare **Reduced by 40% (one-way ticket)**
In-vehicle comfort **Space for passengers reduced by 5%**	In-vehicle comfort **Space for passengers reduced by 30%**

Fig. 3. (a, b). Examples of SP choice experiment for a suburban/rural service.

requisite for completing the questionnaire), leaving 73 respondents for analysis. The relatively small sample size can be attributed to an indirect preselection of the sample through the survey's introductory message. We specifically targeted 1) current PT users particularly interested in or receptive to the idea of goods delivery via PT and 2) individuals aware of the potential advantages (e.g. reduction in fuel consumption) and transport externalities (e.g. air and noise pollution and road congestion) of such as system. Being interested in conducting the survey using a motivated sample, we chose a small group of engaged respondents over a larger group of less engaged ones. Moreover, experience indicates that when revealed preference (RP) choice data are collected, the best strategy for sampling is to have a minimum sample size of 50 respondents selecting each alternative (e.g. two alternatives indicate a minimum sample size of 100 respondents). However, for SP choice data, experience suggests that the most commonly used criterion for establishing a minimum sample size is the number of observations required to estimate robust models. Here, the term 'observations' refers to choice sets rather than rows of data. In addition, where the alternatives are unlabelled (meaning all parameters are generic across all alternatives), the sample size can be smaller because the variability required is significantly lower. Hensher et al. (2007) suggested that a sample of 50 individuals, each with 16 choice sets and fully generic parameter specifications for design attributes and without contextual or covariate effects, may be reasonable.

Moreover, the SP experiment was specifically administered to a sample of motivated users. While general transport planning studies often include non-users to analyse potential modal shift, investigating a radically innovative and hypothetical service like IPFT requires a more targeted approach, focusing on potential early adopters (Rogers, 2003). Including respondents who have no intention of using the service would have introduced significant statistical noise, due to a lack of familiarity or perception of non-interested users. Such participants, being unable to realistically weigh the trade-offs between service levels, might have provided inconsistent responses (Hensher et al., 2007). This could have compromised the reliability of the Random Parameters Logit (RPL) model in accurately estimating the marginal utilities of attributes like in-vehicle travel time and comfort, as uninformed respondents often fail to produce stable preference structures (Bliemer and Rose, 2011). Therefore, the survey focus was intentionally narrowed to identify the specific requirements and preferences of the most likely market segment: the potential early adopters.

3.4. Model specification

The final step was to identify the weights assigned to each attribute in user preferences and determine the WtP associated with an improvement in the attributes introduced in the SP exercises. To achieve this, we used RPL models based on respondent choices among the IPFT service combinations. The RPL model was obtained from a MultiNomial Logit (MNL) model. Certain parameters considered in the MNL model were assumed to follow a probability distribution with a given mean and standard deviation. The distribution of such random parameters was considered continuous in the sampled population. Accordingly, the RPL model utility function can be expressed as shown in Equation (1):

$$V_{nsj} = \beta'_n x_{nsj} \tag{1}$$

where

$$\beta'_n = \beta + \Delta z_n + \Gamma v_n \tag{2}$$

Here, x_{nsj} represents the generic attribute of alternative j in choice situation s for individual n, z_n is the characteristic of the individual that influences the mean taste parameter of the user, and v_n is a random variable with zero mean, unit variance, and zero covariance. That is, Δz_n and Γv_n denote the observed and unobserved heterogeneity among user tastes, respectively. β, Δ, and Γ are the parameters to be estimated, representing constants, parameters associated with the variables considered, and non-zero elements of the lower triangular Cholesky matrix, respectively. These models compare unlabelled alternatives 1 and 2 across different options posed to respondents, as illustrated in Figs. 2 and 3. The utility functions associated with Options 1 and 2 include the variables listed in Table 2. The parameters associated with these variables can be fixed or follow a probability distribution. These variables were determined from the attributes identified during the design of the SP choice experiment (as listed in Tables 1 and 2). The value of each variable was determined based on the level associated with each attribute.

The specifications of the proposed model include only the four attributes introduced in the SP choice experiment. These values vary between two levels, as listed in Table 2. For calibrating the model, the values '0′ and '1′ were assigned to the two levels of the attributes linked to service frequency and comfort, with '0′ representing the lowest level and '1′ the highest. The attributes linked to IVTT and fare were expressed in minutes and euros, respectively. Additionally, the time and cost coefficients were assumed to have a normal distribution, whereas the other two coefficients were considered fixed. We also attempted to express the levels of service frequency and comfort according to their units of measure (frequency in runs per hour and comfort in terms of surface area in square metres); however, this approach yielded models with incongruent or insignificant results.

4. Results

4.1. Participants

The socioeconomic characteristics of the respondents were as follows. In terms of gender, most respondents were female (46 of 73, 63%), 24 were male (33%), and the remaining three preferred not to disclose. In terms of age, most respondents were less than 35 years (47; 65%), 25 (34%) were middle-aged (35–65 years), and one was elderly (above 66 years). This age distribution aligns with expectations, as social media usage and web survey participation are more common among younger individuals (Kaplowitz et al., 2004). This demographic also facilitated our analysis because younger individuals are more likely to use integrated services. Regarding occupation, 35 (49%) were students and 21 were workers (including self-employed, employees, and labourers). Five were unemployed and 10 preferred not to disclose. The high percentage of students may be related to the large number of young respondents. In terms of education, 20 (26%) were undergraduates, 41 (56%) had bachelor's degrees, 7 (10%) had master's degrees, and 5 (7%) held PhDs. The family units of the respondents were as follows: one member in 7 cases, two in 5 cases, three in 19 cases, and at least four in 42 cases. Compared with the average value at the national level (2.3 members per household) according to ISTAT (2024b), the number per household is high. However, this finding is consistent with the high percentage of students who responded to the survey. The final answer influenced the number of cars available per household and introduced transport-related aspects. The available number of cars was zero for three respondents (thus fully depending on PT, sharing solutions, and other forms of alternative transport), one for 16 cases, two for 32 cases, and at least three for the remaining 22 cases. Regarding the type of PT services adopted, 46 mostly used urban services, whereas 17 used suburban services. The SP exercises presented were carefully selected to reflect the type of services commonly used and familiar to the respondents.

4.2. Model parameters and WtP

The RPL model was calibrated considering the entire database, including both urban and suburban users, using the NLogit software (Econometric Software, Inc.). The database included 803 observations corresponding to 73 users, each answering 11 SP exercises (see Section 3.2).

The coefficients of IVTT and fare are highly significant, whereas those of service frequency and comfort are significant at the 5% level (Table 3). The standard deviations of the random coefficients are also significant. All signs are congruent with the hypotheses. Finally, the goodness-of-fit statistics demonstrate an excellent model fit, with values falling within the range of 0.2–0.4, considered remarkable according to Hensher and Stopher (1979). Therefore, the model results can be considered and interpreted to obtain effective observations for organising IPFT systems. Specifically, IVTT and fare follow a normal distribution. Fare appears to be more heterogeneous than IVTT, with a standard deviation approximately 40% larger than the average value of the coefficient.

For a more intuitive interpretation of the results, we calculated the WtP for various attributes. Since the fare coefficient is not fixed and follows a normal probability distribution, a different WtP value is associated with each user. However, as Bliemer and Rose (2013) commented, drawing different values for each distribution of the coefficients and computing the ratio does not take into account the uncertainty of the parameters (Hess et al., 2005). Therefore, they advised the adoption of Krinsky and Robb's method (Krinsky and Robb, 1986, 1990) or the Delta method (Oehlert, 1992). By applying the Delta method (Table 4), we obtained more stable values in terms of standard error and confidence intervals, which allowed us to assess the statistical significance of the different estimated WtP values. The WtP value for saving 1 min of time on board was approximately EUR 0.30 (Table 4). This means that to save 30 min of IVTT, users are willing to pay an average of EUR 9. This represents a substantial amount of money for a run by an urban or suburban bus. Furthermore, the results in Table 4 indicate that users are willing to pay approximately EUR 0.35 on average for an increase in service frequency: one additional run for the suburban service and two runs for the urban service. However, users are willing to pay EUR 0.25 on average to save 25% of the on-board space for passengers.

From the WtP calculation, we can conclude that the attribute with a more relevant influence on users' choices is IVTT (Table 4). The lower and upper values of confidence intervals suggest that users are willing to pay up to EUR 0.50 to save 1 min of on-board time. Moreover, for having a higher frequency and more space for passengers, the largest spending user is willing to pay marginally over EUR 0.70 for an increase in frequency by one run for the suburban service and two runs for the urban service, and EUR 0.50 for saving 25% of on-board space. However, some users are unwilling to pay for these services. For example, the stingiest user is willing to spend less than EUR 1 to save 30 min of on-board time and only a few EUR cents for an increase in service frequency and saving on-board space (Table 4).

4.3. Discussion

According to our results, IVTT is the most relevant attribute in user preferences, followed by fare. This indicates that users are unwilling to spend additional time on buses to accommodate goods delivery. This factor should be considered when designing an IPFT service, its schedule, and loading and unloading of parcels. The importance assigned by respondents to IVTT is somehow an expected result. It confirms the outcomes of other studies that attempted to separate the contribution of IVTT from other attributes (e.g. Frank et al., 2008; Schmid et al., 2021; de Vos et al., 2022a; Luh et al., 2024). However, a comparison of these results should always consider the specificities related to each study. The value assigned to IVTT depends on several characteristics such as the road type (Flügel et al., 2022), trip purpose (Kato et al., 2024), time of day (Tveter, 2023), income levels (Börjesson et al., 2012), activities performed during the trip (Jara-Díaz, 2024), and the chosen mode of transport (Fosgerau et al., 2010). This study represents a pioneering effort to quantify IVTT specifically within the context of IPFT services.

Conversely, users assigned less relevant weights to other service characteristics investigated in the SP choice experiment. For instance, an increase in the service frequency by one or two runs per hour was considered less important by respondents. This result partially contrasts with those of previous studies (e.g. Le et al., 2020; de Vos et al., 2022b), which emphasised service frequency as another important factor affecting modal choice. This disparity can be partially explained by the high frequency provided by urban and suburban services in the area of the respondents during peak hours, where an additional 2–4 runs per hour is not perceived as important compared to reductions in IVTT or other characteristics. This is in line with the experiment conducted by Hu et al. (2015), who determined that the reliability and comfort of bus services are more important than perceptions of availability and safety. In our experiment, the participants did not perceive an eventual reduction in passenger space because of the necessity of transporting parcels, which was considered a less critical concern.

Table 3
RPL model results.

Variable	Parameter	Standard error	z	Prob. |z| > Z*
IVTT	−0.134***	0.0188	−7.119	0.0000
std. dev. IVTT	0.132***	0.0271	4.853	0.0000
Fare	−0.643***	0.1924	−3.343	0.0008
std. dev. fare	0.884***	0.1883	4.699	0.0000
Service frequency	0.124**	0.0645	1.929	0.0538
In-vehicle comfort	0.143**	0.0700	2.050	0.0403
No. of observations	803			
Log likelihood function	−379.1463			
McFadden pseudo R-squared	0.821			

*** Significant at 1% level ** Significant at 5% level.

Table 4
WtP calculation (euros).

WtP	Average value	Standard error	95% confidence interval	
			Lower	Upper
IVTT	0.291***	0.10545	0.084	0.498
Service frequency	0.356**	0.17527	0.012	0.699
In-vehicle comfort	0.246**	0.12568	0.000	0.492

*** Significant at 1% level ** Significant at 5% level.

5. Conclusions

5.1. Main findings

Integrating passenger and freight transport into a unified service is a promising area of interdisciplinary research, incorporating engineering, transport planning, urban planning, geography, economics, policy, and social and behavioural sciences. Our approach aimed to understand the willingness of PT passengers to use the service, thus covering the behavioural sciences, and the technical characteristics of the integrated service, which cover the engineering and transport planning dimensions.

To evaluate the applicability of this technical solution, we conducted an SP choice experiment involving analysis and simulations to compare hypothetical IPFT services. Although SP techniques have been widely used in freight and passenger transport separately, they have not previously been employed to evaluate IPFT services. We initiated an SP choice experiment targeting PT passengers interested in using IPFT services to identify the service attributes that influence their choices. The key RQs addressed the definition of PT service attributes characterising the proposed integrated service, expected attribute variations, and formulation of the SP choice experiment. Drawing on insights from a Delphi survey involving stakeholders experienced in integration, we identified the attributes for the SP choice experiment, along with their variation levels. Four service attributes were selected, each with two defined levels of variation. This SP choice experiment was administered to a sample of PT users selected through Facebook who were willing to adopt IPFT services. We found that users assigned relevant weights to IVTT when forming their preferences for IPFT services. Users were willing to pay an average of EUR 9 to save 30 min of on-board time, they were willing to pay an average of approximately EUR 0.35 for a marginal increase in frequency and approximately EUR 0.25 for a 25% increase in passenger on-board space.

5.2. Policy and practice

Cost variations should also be considered in the context of the wider transport system. Initial investments in infrastructural equipment, such as consolidation centres and parcel lockers at bus stops, as well as adaptation costs for vehicles, are necessary aspects that must be incorporated into a robust business model. Cost variations should also be taken into account specifically for the passenger and freight components. Passengers' fares must be considered within the broader context of the entire transport system. Tariff adjustments in IPFT are not isolated events. Instead, they have repercussions that extend beyond individual bus lines. It is therefore crucial to assess the potential impact on the entire PT system by considering the interconnected nature of transport networks. Adopting this broader perspective ensures that fare variations are evaluated holistically. In the freight sector, the potential introduction of subsidies for parcel delivery adds complexity. Accurate management of stakeholder relationships is therefore necessary to prevent competition imbalances, particularly with established conventional transport distributors operating under market law. From this perspective, it is imperative to strategically balance competitive playing fields. This requires a complete understanding of how subsidies could affect the dynamics of IPFT and conventional operators. Effective management is crucial to ensure that subsidies do not distort the competitive environment or potentially disadvantage conventional distributors. A prudent approach to competition management involves delineating IPFT into specific freight categories, such as those defined by parcel size and delivery timeframes (e.g. deferred and time-definite deliveries). This categorisation can mitigate potential conflicts with conventional distributors by minimising direct competition. By focusing on specific freight categories, IPFT can streamline operations and potentially reduce operational and personnel costs, while also increasing efficiency (Bruzzone et al., 2023b; Cavallaro and Nocera, 2023).

Ultimately, the successful implementation and sustainable operation of IPFT depend on a comprehensive understanding of the operational and financial intricacies and the delicate balance required to manage relationships among stakeholders. The perceptions of potential users, as discussed in this study, are crucial to this evaluation. To guarantee an effective, customer-tailored service, policymakers should consider these factors adequately.

5.3. Limitations and future research directions

Although this study provided interesting findings, it has some limitations. From a methodological perspective, the rigorous initial approach to panel selection (submission to all groups of Italian cities with over 50,000 inhabitants) encountered practical difficulties in both the acceptance phase and involvement of respondents. However, we collected responses from 73PT passengers, corresponding to over 800 observations, which allowed for the calibration of the RPL with good results in terms of goodness-of-fit statistics and the calculation of statistically significant WtP values. Moreover, the sample comprised motivated people with specific characteristics; that is, PT passengers willing to use IPFT services. We acknowledge that such a sample is not representative of the general population, and therefore, the models cannot be considered for predictive purposes, although they effectively serve the explorative purposes of our research. Focusing on potential early adopters is a recognized approach for investigating innovative services (Rogers, 2003), as it ensures that the estimated parameters reflect the priorities of the most likely market segment. A further limitation could be the absence of a control group comprising PT passengers uninterested in IPFT. While this choice was consistent with the exploratory nature of the research, aimed at service optimization rather than general market expansion, it also prevented the inclusion of inconsistent responses from passengers who, lacking a clear perception of the service utility, might have introduced statistical noise (Hensher et al., 2007). Future research could, however, adopt a comparative framework to clarify whether the identified preferences (e.g. high sensitivity to travel time and space availability) are unique to potential IPFT adopters or are shared by a broader population. Nevertheless, the current findings provide a robust baseline for defining the quality standards necessary to attract the first wave of users.

Furthermore, the appropriateness of the selected attributes for evaluating IPFT services should be discussed. As explained in Sections 3.1 and 3.2, the four attributes considered in the SP experiment (i.e. service frequency, in-vehicle time, fare, and passenger space) were extracted from a more comprehensive analysis that included 11 attributes (Cavallaro et al., 2023). This was the result of a detailed literature review of studies that analysed PT service quality. The appropriateness of these indicators stems from the fact that IPFT implies changes in the quality of these attributes (e.g. increased in-vehicle time due to loading/unloading activities or punctuality). Far from being a limitation, the choice of these attributes allows for analysing IPFT services among potential users, thus providing useful insights for stakeholders regarding the attractiveness and potential use of this solution.

Our research focuses on the evaluation of the IPFT service from the passengers' perspective, which is considered the primary component in determining the success of the integrated solution. However, future research should extend beyond passenger perspectives to encompass the freight component. The potential advantages of IPFT for freight transport should also be estimated using operational attributes (through selected KPIs). In parallel, and similarly to what has been done here for passenger transport, future studies should also be geared towards investigating the opinions of freight customers interested in utilising IPFT services for their parcel deliveries. Through an SP choice experiment similar to the one presented in this study, but with relevant and targeted attributes specific to freight services, a comprehensive understanding of the implications arising from the introduction of integrated services can be obtained.

CRediT authorship contribution statement

Gabriella Mazzulla: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Laura Eboli:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Federico Cavallaro:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Silvio Nocera:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

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.

Data availability

Data will be made available on request.

References

Allen, J., Eboli, L., Forciniti, C., Mazzulla, G., Ortúzar, J.d.D., 2019. The role of critical incidents and involvement in transit satisfaction and loyalty. Transp. Policy 75, 57–69. https://doi.org/10.1016/j.tranpol.2019.01.005.

Amorim, P., DeHoratius, N., Eng-Larsson, F., Martins, S., 2024. Customer preferences for delivery service attributes in attended home delivery. Manag. Sci. https://doi.org/10.1287/mnsc.2020.01274.

Antoniou, C., Nocera, S., Susilo, Y., 2023. The integration of passenger and freight transport: trends, gaps and future research challenges. Transp. Res. A Policy Pract. 173, 103724.

Arunotayanun, K., Polak, J.W., 2011. Taste heterogeneity and market segmentation in freight shippers' mode choice behavior. Transp. Res. Part e: Logist. Transp. Rev. 47 (2), 138–148.

Bellizzi, M.G., dell'Olio, L., Eboli, L., Mazzulla, G., 2020. Heterogeneity in desired bus service quality from users' and potential users' perspective. Transp. Res. A Policy Pract. 132, 365–377.

Bellizzi, M.G., Eboli, L., Mazzulla, G., Postorino, M.N., 2022. Classification trees for analysing the satisfaction with airlines' services. Transp. Policy 116, 199–211.

Bellizzi, M.G., Forciniti, C., Mazzulla, G., 2021. A stated preference survey for evaluating young pedestrians' preferences on walkways. Sustainability 13 (22), 12434.

Bergantino, A.S., Bierlaire, M., Catalano, M., Migliore, M., 2013. Taste heterogeneity and latent preferences in the choice behavior of freight transport operators. Transp. Policy 30, 77–91.

Bienstock, C.C., Mentzer, J.T., Bird, M., 1997. Measuring physical distribution service quality. J. Acad. Mark. Sci. 25 (1), 31–44.

Bliemer, M.C.J., Rose, J.M., 2011. Experimental design influences on stated choice outputs: an empirical study in air travel choice. Transp. Res. A Policy Pract. 45 (1), 63–79.

Bliemer, M.C.J., Rose, J.M., 2013. Confidence intervals of willingness-to-pay for random coefficient logit models. Transp. Res. B Methodol. 58, 199–214. https://doi.org/10.1016/j.trb.2013.09.010.

Börjesson, M., Fosgerau, M., Algers, S., 2012. On the income elasticity of the value of travel time. Transp. Res. A Policy Pract. 46 (2), 368–377. https://doi.org/10.1016/j.tra.2011.10.007.

Bruzzone, F., Cavallaro, F., Nocera, S., 2023a. Environmental and energy performance of integrated passenger-freight transport. Transp. Res. Interdiscip. Perspect. 22, 100958. https://doi.org/10.1016/j.trip.2023.100958.

Bruzzone, F., Nocera, S., Pesenti, R., 2023b. Feasibility and optimization of freight-on-transit schemes for the sustainable operation of passengers and logistics. Res. Transp. Econ. 101, 101336.

Cappelli, A., Nocera, S., 2006. Freight modal split models: data base, calibration problem and urban application. WIT Trans. Built Environ. 89, 369–375.

Cavallaro, F., Eboli, L., Mazzulla, G., Nocera, S., 2023. Design of integrated passenger-freight transport: a multi-stakeholder perspective. J. Public Transp. 25, 100069.

Cavallaro, F., Nocera, S., 2022. Integration of passenger and freight transport: a concept-centric literature review. Res. Transp. Bus. Manag. 43, 100718. https://doi.org/10.1016/j.rtbm.2021.100718.

Cavallaro, F., Nocera, S., 2023. Flexible-route integrated passenger–freight transport in rural areas. Transp. Res. A Policy Pract. 169, 103604. https://doi.org/10.1016/j.tra.2023.103604.

CEN. (2002). *European standard EN 13816: Service quality definition, targeting and measurement*. https://tpbi.ro/file/2021/02/EN-13816-standard-Service-Quality-Definition-Targeting-and-Measurement-EU-2002.pdf.

Chen, K., Chang, C., Lai, C., 2009. Service quality gaps of business customers in the shipping industry. Transp. Res. Part e: Logist. Transpo. Rev. 45, 222–237.

Cherchi, E., Hensher, D.A., 2015. Stated preference surveys and experimental design: an audit of the journey so far and future research perspectives. Transp. Res. Procedia 11, 154–164.

Cochrane, K., Saxe, S., Roorda, M.J., Shalaby, A., 2017. Moving freight on public transit: best practices, challenges, and opportunities. Int. J. Sustain. Transp. 11 (2), 120–132. https://doi.org/10.1080/15568318.2016.1197349.

Danielis, R., 2002. Freight transport demand and stated preference experiments. Franco Angeli.

Danielis, R., Marcucci, E., 2007. Attribute cut-offs in freight service selection. Transp. Res. Part e: Logist. Transp. Rev. 43, 506–515.

de Oña, J., de Oña, R., Eboli, L., Mazzulla, G., 2013. Perceived service quality in bus transit service: a structural equation approach. Transp. Policy 29, 219–226.

de Oña, J., de Oña, R., Eboli, L., Mazzulla, G., 2016a. A composite index for evaluating transit service quality across different user profiles. J. Public Transp. 19 (2), 128–153.

de Oña, J., de Oña, R., Eboli, L., Mazzulla, G., 2016b. Index numbers for monitoring transit service quality. Transp. Res. A Policy Pract. 84, 18–30.

de Vos, J., Le, H.T.K., Kroesen, M., 2022a. Does commute duration attenuate the effect of travel mode choice on commute satisfaction? Travel Behav. Soc. 28, 13–21.

de Vos, J., Waygood, E.O.D., Letarte, L., et al., 2022b. Do frequent satisfying trips by public transport impact its intended use in later life? Transportation 49, 1245–1263. https://doi.org/10.1007/s11116-021-10209-0.

dell'Olio, L., Ibeas, A., de Oña, J., de Oña, R., 2017. Public transportation quality of service: Factors, models, and applications. Elsevier.

Eboli, L., Mazzulla, G., 2008. An SP experiment for measuring service quality in public transport. Transp. Plan. Technol. 31 (5), 509–523.

Eboli, L., Mazzulla, G., 2010. How to capture passengers' point of view on a transit service. Transp. Rev. 30 (4), 435–450.

Eboli, L., & Mazzulla, G. (2012). Performance indicators for an objective measure of public transport service quality. *European Transport, 51*.

EC. (2007). *Green paper on urban mobility*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52007DC0551&from=EN.

Elbert, R., Rentschler, J., 2022. Freight on urban public transportation: a systematic literature review. Res. Transp. Bus. Manag. 45, 100679. https://doi.org/10.1016/j.rtbm.2021.100679.

Fellesson, M., Friman, M., 2008. Perceived satisfaction with public transport service in nine European cities. J. Transp. Res. Forum 47 (3), 92–102.

Feo-Valero, M., García-Menéndez, L., Del Saz-Salazar, S., 2016. Rail freight transport and demand requirements. Transportation 43, 101–122.

Fessler, A., Cash, P., Thorhauge, M., Haustein, S., 2023. Public transport-based crowdshipping concept. Transp. Policy 134, 106–118.

Fessler, A., Thorhauge, M., Mabit, S., Haustein, S., 2022. A public transport-based crowdshipping concept. Transp. Res. A Policy Pract. 158, 210–223.

Fisher, M.L., Gallino, S., Xu, J.J., 2019. The value of rapid delivery in omnichannel retailing. J. Mark. Res. 56 (5), 732–748. https://doi.org/10.1177/0022243719849940.

Flügel, S., Halse, A.H., Hartveit, K.J.L., et al., 2022. Value of travel time by road type. Eur. Transp. Res. Rev. 14, 35. https://doi.org/10.1186/s12544-022-00554-1.

Fosgerau, M., Hjorth, K., Lyk-Jensen, S.V., 2010. Between-mode differences in the value of travel time. Transp. Res. Part D: Transp. Environ. 15 (7), 370–381. https://doi.org/10.1016/j.trd.2010.04.005.

Franceschini, F., Rafele, C., 2012. Quality evaluation in logistic services. Int. J. Agil. Manag. Syst. 2 (1), 49–54.

Frank, L.D., Bradley, M., Kavage, S., Chapman, J., Lawton, T.K., 2008. Urban form, travel time, and cost relationships with tour complexity and mode choice. Transportation 35, 37–54. https://doi.org/10.1007/s11116-007-9136-6.

Franz, D., Marsh, H.E., Chen, J.I., Teo, A.R., 2019. Using Facebook for qualitative research: a brief primer. J. Med. Internet Res. 21 (8), e13544. https://doi.org/10.2196/13544.

Friman, M., Fellesson, M., 2009. Service supply and customer satisfaction in public transportation. J. Public Transp. 12 (4), 57–69.

Gatta, V., Marcucci, E., Nigro, M., Patella, S.M., Serafini, S., 2018. Public transport-based crowdshipping for sustainable city logistics. Sustainability 11, 1–14.

Gevaers, R., Van De Voorde, E., Vanelslander, T., 2014. Cost modelling and simulation of last-mile characteristics. Proce. Soc. Behav. Sci. 125, 398–411. https://doi.org/10.1016/j.sbspro.2014.01.1483.

Ghilas, V., Demir, E., Van Woensel, T., 2016. An adaptive large neighborhood search heuristic. Comput. Oper. Res. 72, 12–30.

Gulc, A., 2017. Models and methods of measuring logistic service quality. Procedia Eng. 182, 255–264. https://doi.org/10.1016/j.proeng.2017.03.187.

He, Z., Liu, Q., Zhao, P., 2022. Challenges of passenger and freight transportation in mega-city regions. Transp. Res. Interdiscip. Perspect. 16, 100730.

Hensher, D.A., Prioni, P., 2002. A service quality index for contract performance assessment. JTEP 36 (1), 93–113.

Hensher, D.A., Rose, J.M., Greene, W.H., 2007. Applied choice analysis: a primer. Cambridge University Press.

Hensher, D.A., Stopher, P.R., 1979. Behavioural travel modelling. Taylor & Francis.

Hess, S., Bierlaire, M., Polak, J.W., 2005. Estimation of value of travel-time savings using mixed logit models. Transp. Res. A Policy Pract. 39, 221–236. https://doi.org/10.1016/j.tra.2004.09.007.

Hu, X., Zhao, L., Wang, W., 2015. Impact of perceptions of bus service performance on mode choice preference. Adv. Mech. Eng. https://doi.org/10.1177/1687814015573826.

ISTAT. (2024a). Cities & functional urban areas. https://www.istat.it/statistiche-per-temi/focus/informazioni-territoriali-e-cartografiche/statistiche-sul-territorio/cities-functional-urban-areas/.

ISTAT. (2024b). Popolazione e famiglie. https://www.istat.it/storage/ASI/2022/capitoli/C03.pdf.

Jara-Díaz, S., 2024. The value(s) of travel time savings considering in-vehicle activities. Transp. Res. A Policy Pract. 184, 104092.

Jou, R.C., Yeh, C.S., Chen, K.H., Nourinejad, M., 2022. Travel behavior changes after COVID-19 outbreak in Taiwan. J. Adv. Transp. 1–18.

Kaplowitz, M.D., Hadlock, T.D., Levine, R., 2004. A comparison of web and mail survey response rates. Public Opin. Q. 68 (1), 94–101.

Kato, H., Sanko, N., Ishibe, M., Sakashita, A., 2024. Value of travel time savings for leisure trip in autonomous vehicles. Transp. Res. Interdiscip. Perspect. 24, 101080.

Kim, H.C., Nicholson, A., Kusumastuti, 2017. Analysing freight shippers' mode choice preference heterogeneity. Transp. Res. Procedia 25, 1109–1125.

Kök, G.T., Deveci, D.A., 2019. Freight transport mode choice with stated preference method. Mersin Univ. J. Maritime Faculty 1 (1), 17–29.

Kopperschmidt de Oliveira, I., Herszon Meira, L., Kelli Oliveira, L., 2024. Key factors for integrated transport systems in Brazil. Res. Transp. Econ. 104, 101425. https://doi.org/10.1016/j.retrec.2024.101425.

Krinsky, I., Robb, A.L., 1986. On approximating statistical properties of elasticities. Rev. Econ. Stat. 68, 715. https://doi.org/10.2307/1924536.

Krinsky, I., Robb, A.L., 1990. On approximating statistical properties of elasticities: a correction. Rev. Econ. Stat. 72, 189. https://doi.org/10.2307/2109761.

Larrañaga, A.M., Arellana, J., Senna, L.A., 2017. Encouraging intermodality. Transp. Res. A Policy Pract. 102, 202–211.

Le, H.T.K., Carrel, A.L., Li, M., 2020. How much dissatisfaction is too much for transit? Travel Behav. Soc. 20, 144–154.

Li, Z., Hensher, D., 2012. Accommodating risk attitudes in freight transport behavior research. Transp. Rev. 32 (2), 221–239.

Louviere, J.J., Hensher, D.A., Swait, J.D., 2000. Stated choice methods: Analysis and application. Cambridge University Press.

Luh, S., Kannan, R., McKenna, R., Schmidt, T.J., Kober, T., 2024. Quantifying the impact of travel time duration and valuation on modal shift. Appl. Energy 356, 122412.
Machado, B., Pimentel, C., de Sousa, A., 2023. Integration planning of freight deliveries into passenger bus networks. Transp. Res. A Policy Pract. 171, 103645. https://doi.org/10.1016/j.tra.2023.103645.
Manibardo, E.L., Laña, I., Olabarrieta, I., Nocera, S., Del Ser, J., 2026. Multi-criteria integration of passenger and freight transport. Transp. Res. Interdiscip. Perspect. 36, 101887. https://doi.org/10.1016/j.trip.2026.101887.
Maggi, R., & Bolis, S. (1999). Adaptive stated preference analysis of shippers' transport choice. In *World Transport Research Proceedings (8th WCTR)*. Pergamon.
Marino, G., Zotteri, G., Montagna, F., 2018. Consumer sensitivity to delivery lead time. Int. J. Phys. Distrib. Logist. Manage. 48, 610–629. https://doi.org/10.1108/IJPDLM-01-2017-0030.
Martilla, J.A., James, J.C., 1977. Importance-performance analysis. J. Mark. 41 (1), 77–79.
Mentzer, J.T., Rutner, S.M., Matsuno, K., 1999. Logistics service quality model. Int. J. Phys. Distrib. Logist. Manage. 27 (10), 230–243.
Molenbruch, Y., Braekers, K., Hirsch, P., Oberscheider, M., 2021. Integrated mobility system benefits. Eur. J. Oper. Res. 290, 81–98.
Nocera, S., 2010. Operational approach for quality evaluation in public transport. Ingegneria Ferroviaria 65 (4), 363–383.
Nocera, S., 2011. The key role of quality assessment in public transport policy. Traffic Eng. Control 52–9, 394–398.
Oehlert, G.W., 1992. A note on the delta method. Am. Stat. 46, 27–29. https://doi.org/10.1080/00031305.1992.10475842.
Olde Kalter, M.J., Geurs, K.T., Wismans, L., 2021. Post COVID-19 teleworking and car use intentions. Transp. Res. Interdiscip. Perspect. 12, 100498.
Parasuraman, A., Zeithaml, V.A., Berry, L.L., 1985. Service quality model. J. Mark. 49, 41–50.
Patterson, Z.R., Ewing, G.O., Haider, M., 2007. Shipper preferences and rail mistrust. Transp. Res. Rec. 2008, 67–74.
Punel, A., Stathopoulos, A., 2017. Acceptability of crowdsourced deliveries. Transp. Res. Part e: Logist. Transp. Rev. 105, 18–38. https://doi.org/10.1016/j.tre.2017.06.007.
Rahman Fatmi, M., Mehadil Orvin, M., Thirkell, E.C., 2022. Future of telecommuting post COVID-19. Transp. Res. Interdiscip. Perspect. 16, 100685. https://doi.org/10.1016/j.trip.2022.100685.
Redman, L., Friman, M., Gärling, T., Hartig, T., 2013. Public transport quality attributes. Transp. Policy 25, 119–127.
Regan, A., & Garrido, R. (2001). Freight demand modelling. In D. Hensher (Ed.), *Travel behaviour research: The leading edge*. Pergamon.
Rogers, E.M., 2003. Diffusion of innovations, (5th ed.). Free Press.
Rudel, R. (2005). Freight transport quality attributes. *European Transport, 25*, 52–60.
Schmid, B., Molloy, J., Peer, S., et al., 2021. Value of travel time savings in Zurich. Transp. Res. A Policy Pract. 150, 186–215. https://doi.org/10.1016/j.tra.2021.06.015.
Schneider, D., Harknett, K., 2022. Facebook for survey data collection. Sociol. Methods Res. 51 (1), 108–140. https://doi.org/10.1177/0049124119882477.
Šimeček, M., Dufek, J., 2016. Freight modal shift model. Transp. Res. Procedia 14, 2814–2819.
Śmieszek, M., Mateichyk, V., Kostian, N., Tarandushka, L., Mościszewski, J., 2023. Bus line operational analysis. Transp. Res. Procedia 74, 164–171. https://doi.org/10.1016/j.trpro.2023.11.126.
Suguna, M., Shah, B., Raj, S.K., Suresh, M., 2022. Last-mile delivery factors during COVID-19. Oper. Manag. Res. 15 (1–2), 399–412. https://doi.org/10.1007/s12063-021-00214-y.
Trentini, A., Malhène, N., 2012. Passenger and goods flow management. Procedia Soc. Behav. Sci. 39, 807–817.
Tveter, E., 2023. The value of travel time: a revealed preferences approach. Transportation 50, 2273–2297. https://doi.org/10.1007/s11116-022-10308-6.
van Duin, R., Wiegmans, B., Tavasszy, L., Hendriks, B., He, Y., 2019. Participative city logistics concepts. Transp. Res. Procedia 39, 565–575.
Vega, A., Feo-Valero, M., Espino-Espino, R., 2018. Brexit impact on shipping demand. Transp. Policy 71, 1–13.
Zeybek, H., 2019. Service quality in rail freight. Int. J. Transp. Eng, 7 (2), 115–126.