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Editorial

The integration of passenger and freight transport: Trends, gaps and future research challenges



1. Introduction and background

Integrated passenger freight transport (IPFT) has gained recent attention as an option to support policymakers' efforts to negative impacts of passenger transport and logistics and to help them to reach the Carbon Net Zero target.

In particular, IPFT has been considered as a solution towards reducing the inefficiencies for the first and last mile (FLM) of both people and goods transport chains. The FLM (i.e., the first and last leg of each trip, between the starting point or final destination and a transport/logistics hub) is in fact among the most costly and time-consuming legs of each journey, especially in relation to its length, and produces relevant inefficiencies and negative externalities. Typically, the FLM faces customers and operators with long waiting and idle time, congestion, delays, and other contingencies. As a consequence, freight FLM operations generate irritation among residents and workers, whereas passengers tend to increase their reliance on private transport modes in an effort to reduce the unpredictability of their trip (Nocera et al., 2021).

So far, the debate on IPFT business models and performances regarded limited cases. Researchers highlighted how integration can have different declinations according to the context and to characteristics of mobility systems: IPFT can mean sharing vehicles (e.g., by allocating to freight spare capacity on local busses), infrastructure (e.g., by operating freight trams on urban tram tracks, within regular passenger services), or other assets, like mobility-related public space (e.g., by placing small consolidation facilities or parcel lockers at transit stops). More types of integration can also be promoted (Bruzzone et al., 2021).

Long-distance transport traditionally adopts IPFT: airlines, ferries and even buses commonly transport goods together with passengers. In short-haul movements, however, the passenger and freight sectors are normally independent. In 2007, also in response to the registered and foreseeable growth of e-commerce and logistics movements in general, the European Commission (EC) published the Green Paper on Urban Mobility, the first strategic document to explicitly consider IPFT as a concurring solution to contemporary urban FLM challenges. Such hint by the EC started a research stream exploring IPFT's potential not only in urban operations, but also in rural contexts. In urban environments, the potential of IPFT lies mostly in the reduction in the number of vehicles deployed for logistics operations, and thus driving and idling. Besides environmental benefits, the reduction of the impacts of urban logistics increases its social sustainability. This is due to less conflicts for the use and allocation of the limited urban space, less noise, fewer crashes, and higher use of flexible delivery and collection solutions, such as parcel lockers and pickup-delivery points.

2. Positioning of the special issue

This special issue has enriched and further pushed the debate on IPFT in urban areas by providing a state-of-the-art overview of literature (Fehn et al., 2023) and by discussing business model canvas and technical capabilities of co-modal journeys (Zhu et al., 2023). Moreover, it hosted the debate on highly innovative concepts like crowdshipping through urban transit (Cebeci et al., 2023; Fessler et al., 2022; Tapia et al., 2023), the integration of parcel deliveries and on-demand ride-pooling (Fehn et al., 2023), and the potential of demand-responsive transport (Cavallaro and Nocera, 2023) and urban platooning (Hatzenbuehler et al., 2022). Finally, a broad multi-perspective on freight integration on mass rapid transit is provided for 16 Chinese cities in Hu et al. (2022).

In rural environments and peripheral areas, IPFT can enhance local competitiveness and attractiveness, by allowing more frequent transit services and freight deliveries at sustainable additional costs from the perspective of transport suppliers and financing

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authorities. The contextual transport of passengers and goods can help overcome financial unsustainability induced by low demand for both services, in turn favoring the retainment of local attractiveness for businesses, artisans and younger and weaker population groups. IPFT's potential in contributing to territorial management policies is thus among the most relevant points of interest for its study and application in rural contexts (Cavallaro and Nocera, 2023; Feng et al., 2023). In this special issue, a method to support decision-makers in correctly designing a IPFT system has been presented by Machado et al. (2023). Cavallaro and Nocera (2023), instead, provided a comprehensive literature review on IPFT in rural areas and focus on performance and impacts assessment, suggesting a method based on indicators.

This special issue fits in the literature context, adding to a research stream which in the last decade studied commonalities among drivers to short-haul urban and rural applications (i.e., operational performance, financial sustainability, environmental benefits, social impacts) and explored the use of IPFT to satisfy specific objectives of stakeholders of the transport sector. Meanwhile, it also joins the debate on IPFT's ability to contribute to common policy objectives, its relevance to local needs, and its ability to respond to political priorities highlighted in transnational, national and local strategies of the third millennium, in line with the overarching goals of European institutions. Most notably, the articles in this special issue propose a departure from this framework, exploring innovative concepts like crowdshipping and platooning, and further discussing business models and performance implications needed to support decision-makers and IPFT stakeholders in general.

3. The main contributions

Motivated by the concerns of IPFT setting and performance evaluation, operative researchers developed several variants of routing and pickup-delivery problems, deepening operational aspects of IPFT systems. In parallel, other scholars developed performance metrics and indicators for assessing environmental and social impacts of IPFT, alongside operational performances. This approach enables the incorporation of multiple perspectives, including these of the different public and private stakeholders as well as of final users. Open gaps remain, however, in the understanding of the context- and mobility-related preconditions needed to ensure and foster the efficacy of IPFT in improving the status quo. Scholars have not yet comprehensively approached the matter of what elements determine the convenience of IPFT compared to conventional segregated passenger and freight transport (Hu et al., 2022), a topic which also finds space in the special issue (Machado et al., 2023). Addressing the presented problematical aspects of IPFT, Cavallaro and Nocera (2023) discussed IPFT in rural areas and proposed an integrated demand-responsive transport system. Their method consists of an environmental, operational, and social assessment framework based on selected key performance indicators. Through the performed analysis, they find that the system allows for better coverage and more frequent services, while ensuring a reduction of the environmental impact and, in a 5-year horizon, cost reductions. Whereas their conclusions are encouraging, the authors highlight some legislative and processual issues, also linked to informed and participated decision-making.

Processual innovation is at the core of article of Zhu et al. (2023), which studied the possibility for co-modality in city logistics. The paper presents the key components, delivery process, business model canvas and technical capability of co-modal journeys, also introducing the main opportunities, challenges and potential benefits and proposing an appropriate approach for their future detailed investigation. Alongside processual innovation, technological innovation plays a prominent role in the special issue. Hatzenbuehler et al. (2022) investigated -through ad-hoc variants of the multi-purpose pickup and delivery problem and through CPLEX and ALNS techniques- the potential of modular vehicle concepts and passenger/freight integration and consolidation. Their experiments indicate that modularity and platooning can lead to 48% cost reduction, whereas consolidation counts for a further 9%. The applicability of the proposal is highlighted for a large-scale study in Stockholm, that also stresses the operative benefits, mostly consisting in significant reductions of empty vehicles kilometers (-60%). While platooning and modular, autonomous vehicles are necessarily based on technological advancements and intelligent transport systems, crowd-shipping, i.e., the delivery of parcels by users while performing other movements and activities, is an alternative solution, requiring less advanced technology and showing good margins of feasibility.

In this special issue, urban crowdshipping through different transport means was debated by several authors. Tapia et al. (2023) used a disaggregate activity-based model for a crowdshipping setting in The Hague (NL), where parcels are randomly assigned to car and bike users based on a simulated random utility discrete choice model. Six different scenarios are simulated, showing that bike-based crowdshipping does not provide significant advantages, especially in operative and environmental terms. Car-based and dual-mode scenarios are found to cause increases in both driven kilometers and CO₂ emissions. Tapia et al.'s (2023) results contrast with other literature, including other contributions in this special issue. Crowdshipping through public transport, in particular, is regarded as promising in terms of environmental impact reduction. Moreover, large distribution companies, like Walmart in the United States of America, have opted for crowdshipping schemes to perform part of their deliveries (Boysen et al., 2022). Fessler et al. (2022) contributed to the special issue by presenting a stated choice experiments studying determinants for uptake in crowdshipping, providing a framework for informing the design of a crowdshipping system and related engagement efforts. In their case study in Copenhagen (Denmark), the scholars find that younger individuals and students are more likely to participate in the concept, whereas older respondents show higher marginal disutility of time spent retrieving and delivering parcels. They also noted that time invested in crowdshipping is valued better than waiting time, but worse compared to travel time delay. A separate stated choice experiment, complemented by a hybrid choice model, was provided by Cebeci et al. (2023). They study trust as an attribute of the choice of crowdshipping, together and in relation to service, time, and price conditions. Their comprehensive findings stress that trust in crowdshipping decreases with delivery cost increase, and that a significant role on trust in the service depends on its reputation and on the possibility of damage, besides on-time, fast delivery. All in all, trust is found to have a fully mediating effect on the service choice for these attributes. In more general terms, however, trust has a partially mediating effect on service choice. The results of such an approach allow for better understanding of drivers for successful uptake of crowdshipping projects, thus aiding policymakers at

identifying suitability and characteristics of such options.

Non-conventional transport options, whose uptake is favored by technological development, include ride pooling. [Fehn et al. \(2023\)](#) contributed to the special issue by studying the integration of parcel deliveries into a on-demand ride-pooling service, using Munich (Germany) as a case study area. They look in depth at the policy framework to support such a service and use an agent-based simulation integrating three heuristic parcel assignment strategies into a ride-pooling fleet control algorithm. Their results are incentivizing: for parcel penetration rates of around 10% (meaning that the freight to passenger demand ratio is 1:10), passenger transport is not deteriorated and nearly all demand for parcel delivery can be satisfied by the new service, reducing fleet kilometers compared to independent passenger and freight movement.

Whereas several authors approach IPFT through mathematical modelling studying a single simulated or real-life case, [Hu et al. \(2022\)](#) contributed to this special issue by providing a multi-perspective analysis for mass-transit based IPFT in several Chinese cities, identifying critical factors influencing IPFT adoption and discussing possible supportive top-down policies from aspects of planning, regulation, funding, marketization, and innovation. Their approach is based on a SWOT analysis combined with a multi-criteria assessment model driven by real-world data and 11 quantified metrics. Results show that major cities, like Shanghai, Beijing, and Chengdu, are first-tier candidates for mass-transit IPFT. The alignment of IPFT strategies with development goals, the stakeholders' interest and social-environment benefits are found to be among the most significant drivers for IPFT strategies, whereas public attitude could be a threatening aspect. In any case, strong and coordinated policies are needed to integrate the strategy into urban planning. The availability to decision-makers of appropriate decision models for IPFT is one of the factors hindering its diffusion and successful uptake. [Machado et al. \(2023\)](#)'s paper enriched the special issue by providing models aimed at supporting the decision-maker in selecting the minimum number of vehicles and services that must be adapted for freight transportation in a hypothetical IPFT setting. They propose an exact method based on an integer linear programming and two heuristic algorithms based on a greedy randomized adaptive search procedure. They claim that the proposed optimization methods are efficient, giving valuable insights to stakeholders and decision-makers, allowing for informed and strategic decisions. Moreover, they specify the type of instances for which a method outperforms the others, and clarify that in the early stages of IPFT services the main issue to address is the capacity of the last-mile operator to deliver parcels from transit hubs to final customers, while other factors such as delivery time windows and location of final recipients do not have a significant impact on the optimal number of transport services to be adapted.

4. Conclusion

The special issue thus allowed for a broad coverage of IPFT governance and assessment, tackling business, environmental, operational and socioeconomic aspects. Previous literature, as well as contributions to the special issue, stressed how among the most significant factors holding the diffusion of IPFT is the unpreparedness of the normative and regulatory framework and of sectorial bargaining, until now worsened by the poor understanding of effective IPFT business models ([Zhu et al., 2023](#)). In fact, logistics and passenger transport are in most cases ruled and controlled by different authorities and legislative tools and contracts. Several obstacles must be overcome to successfully implement a real-life IPFT system. A non-exhaustive list includes setting liability issues, ensuring compliance with passengers and workplace safety protocols, and discussing moral and physical responsibility over transported property. Other challenging aspects faced by IPFT include stakeholders' reticence to unbranded delivery operations (particularly within the food and beverage sector), the computation of time penalties for transit users (due to freight pickup and drop-off), and the necessity of consistent initial investments for consolidation and pickup-delivery facilities and processes as well as for adapting vehicles and assets. Many of these challenges and drivers holding back the development of IPFT have been object of studies and pilot tests. European funds and projects, national and private-corporate initiatives, all have explored IPFT solutions in both urban and rural contexts, providing real-life support to theoretical research. Although full-scale IPFT implementation is not envisioned through the project approach, several relevant steps forward have been made towards comprehensive IPFT assessment (e.g., project NOVELOG¹), research and modelling (e.g., project Cargo Hitching²), setting study and preparation (e.g., project SMILE³), and innovative pilot tests (e.g., TramFret⁴). More structured and long-lasting IPFT projects, such as the KombiBus⁵ in Germany and the cargo trams experiences, are usually backed by strong motivation by the subsidizing public authorities and/or by private stakeholders. There is evidence for most of these settings that high costs are faced for operations, but promoters value positive impacts (e.g., in terms of social value, corporate image, and green transition) more than the expenses ([Cavallaro and Nocera, 2022](#)). Where stakeholders' engagement is less prominent, IPFT struggles to take off ([Arvidsson et al., 2016](#)). This conclusion calls for the need to identify the proper instruments to serve as containers for integrating the needs and availabilities of all actors. In this regard, in Europe the Sustainable Urban Mobility Plans (SUMP), with its strategic capacity and multifaceted and multidisciplinary approach, can be an appropriate planning base for setting the ground for IPFT. The wide debate opportunity implicitly offered by SUMP preparation and approval process, indeed, can be fruitfully used to merge and shape the requirements, expertise, and know-how, on the one side, and the doubts and reticence, on the other side. The SUMP platform can successfully set the ground for financially sustainable and socially welcome IPFT.

In preliminary phases of IPFT diffusion, the promotion of small-scale IPFT and of the dialogue and cooperation among stakeholders,

¹ <https://civitas.eu/projects/novelog> (accessed 13/04/2023).

² <https://cargohitching.wordpress.com/research/> (accessed 13/04/2023).

³ <https://smile.adrioninterreg.eu/> (accessed 13/04/2023).

⁴ <https://tramfret.com/> (accessed 13/04/2023).

⁵ <https://www.mobilikon.de/praxisbeispiel/kombibusse-im-landkreis-uckermark> (accessed 13/04/2023).

including users, are undoubtedly effective tools to address normative issues, corporate requests, users' needs, and policy requirements. This is needed to ensure that IPFT can effectively contribute to those environmental and social sustainability goals of the mobility sector expressed by the EC in the Green Paper and, later, in the Mobility Strategy and Action Plan, as well as in the European Green Deal, including the post-COVID-19 NextGenerationEU Recovery Plan.

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