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Brown, Anne; van Oort, Niels

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Strategies, opportunities, and challenges of integrating shared micromobility with public transport

Anne Brown [a,*], Niels van Oort [b]

[a] School of Planning, Public Policy, and Management, University of Oregon, 1209 University of Oregon, Eugene, OR 97402, United States
[b] Faculty of Civil Engineering and Geosciences, Delft University of Technology, Netherlands

A B S T R A C T

Shared micromobility may enhance accessibility as part of a comprehensive public transport network. A qualitative stakeholder perspective is needed to reflect the practical opportunities and challenges for integrating shared micromobility and public transport. This research synthesizes literature alongside 25 interviews with professionals across North America and Europe to answer: 1) what challenges and opportunities do different integration approaches offer? And 2) what should be prioritized when integrating shared micromobility and public transport? We frame integration efforts in three pillars: 1) institutional, 2) physical, and 3) digital integration. Findings show that integration efforts are effective only when foundational preconditions are met including high-quality public transport, dedicated micromobility infrastructure, supportive land uses, and issue framing. Institutional and physical integration are both necessary to facilitate multimodal travel and create cohesive regional travel networks. Digital tools can support integration but often requires substantial resources, and faces data sharing and privacy, feasibility, and scaling challenges.

1. Introduction

Shared micromobility (including shared bikes, mopeds, and e-scooters) represents a growing middle-ground of mobility straddling the space between private and public transportation. As these modes rise in popularity (see for example NACTO (2024)), cities are grappling with how to leverage shared micromobility to transform urban transport systems (Gössling, 2020). As cities pursue a range of integration efforts, a critical challenge presents itself: with finite resources and many integration options to choose from, what integration strategies should cities prioritize in order to achieve their broad goals through integration? Without clearly identified priorities to maximize integration impact, cities may fall short of their objectives.

Most research into shared micromobility and public transport integration efforts to date focus on quantitative case studies using survey or trip data, although some assess qualitative dimensions of integration (e.g., Ferguson and Sanguinetti (2023), Bruening et al. (2025)). The existing body of research documents dimensions of shared micromobility and public transport integration, but such analyses remain largely siloed into individual geographies, case studies, or integration approaches such as integrated trip planning or co-locating micromobility parking at public transport stations. Additionally, qualitative stakeholder perspectives from across those engaged in integration efforts—governments or public agencies, public transport operators, and shared micromobility companies—are needed to reflect on-the-ground expertise and understand practical opportunities, challenges, and imperatives for integrating shared micromobility and public transport to meet public goals.

This research fills this gap through a synthesis of existing literature and evaluations of public transport and shared micromobility integration efforts alongside 25 interviews with transportation, micromobility, and city professionals across North America and Europe to answer two questions: 1) what challenges and opportunities do different integration approaches pose for stakeholders? And 2) what

* Corresponding author.
E-mail addresses: abrown33@uoregon.edu (A. Brown), n.vanoort@tudelft.nl (N. van Oort).

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efforts should be prioritized to successfully integrate shared micromobility and public transport into a cohesive mobility system? Together, the literature and interviews identify three clear areas of integration, the opportunities and challenges of each, and foundational issues needed to support integration.

Following this introduction, we review the literature search and qualitative methods used to answer the identified research questions. We next present findings from interviews and literature in a thematic synthesis, including an integration framework, to create comprehensive examination of different integration efforts and approaches grounded in both analytical rigor and professional experiences. We conclude with a discussion of implications for transportation policy, planning, and practice, study limitations, and opportunities for future research.

2. Background

Shared micromobility services have expanded around the world to include hundreds of millions of trips per year. A growing literature on shared micromobility and public transport highlights how shared vehicles may fill spatial or temporal gaps in public transport systems, expand catchment areas to improve first/last mile and overall accessibility (Kosmidis and Müller-Eie, 2024; L. Liu et al., 2024; Oeschger et al., 2020, 2023; Spierenburg et al., 2024), enable design of more efficient public transport networks (van Kuijk et al., 2025), create system resiliency during (un)planned disruptions, increase system capacity (TIER-Dott, 2024; UITP, 2023), reduce crowding (Kager and Harms, 2017; van Marsbergen et al., 2022), or provide modal alternatives by season, weather, or topography (Kager and Harms, 2017; Pucher and Buehler, 2009). Integration between micromobility and public transport can yield traveler benefits such as time savings, faster travel, greater choice, reduce trip complexity and costs, and personalize journeys by better supporting trip-chaining or providing more flexible departure times (Flamm and Rivasplata, 2014; Jäppinen et al., 2013; Kager and Harms, 2017).

Excitement and investment in public transport and shared micromobility integration stem in part from previous successes achieved from integrating personal micromobility and public transport. In the Netherlands, for example, 45 % of travelers access train stations by bicycle (Jonkeren and Kager, 2021) with 10 % of people egressing from Dutch train stations using shared micromobility (Shelat et al., 2018). Yet personal micromobility integration faces infrastructural and social limitations that create a ceiling to adoption. Shared modes offer several advantages overal personal vehicles from a transport operator and network perspective: first, they eliminate the need to carry personal vehicles on-board transit or store them at stations, which requires substantial space and specialized infrastructure both at stations on board buses and trains (Kager and Harms, 2017). Second, shared modes eliminate concerns people may have about secure parking at transport stations (Flamm and Rivasplata, 2014). And finally, people who do not own a personal device may be willing to try shared micromobility (Buck et al., 2013) and adopt multimodal travel. At scale and if successful, integrated shared micromobility and public transport may overcome many of the limitations faced by both private mobility integration, as well as public transport and shared micromobility alone. Kager et al. (2016) argue, for example, that combining micromobility and public transport together "constitute a distinctive travel option, both fast and flexible, for short and for long distances, with increased adaptability to individual demand, urban densities and regional conditions" (p. 218). In doing so, integration may be a tool to achieve a wide range of goals that cities across the world have identified such as reducing emissions and car travel while increasing access to jobs and opportunities.

Research to date around shared micromobility and public transport integration efforts has largely focused on quantitative case studies using survey or trip data, with analysis largely focused on singular geographies, case studies, or integration approaches. Additionally, stakeholder perspectives are needed to capture professional experiences and identify practical opportunities, challenges, and needs for successfully integrating public transport and shared micromobility to realize public objectives.

3. Data and methods

The literature utilized in this research includes both academic and grey literatures (e.g., policy briefs and reports, agency evaluations), most of which considers one or a subset of public transport and shared micromobility integration strategies. Keyword searches used combinations of key terms including "transit", "public transport", "public transportation", "shared micromobility", "bikeshare", "e-scooters", and "integration". Only literature published in English were included in the review. In addition to keyword searches, we identified literature using citation-chaining to identify a broad collection of research with bibliographic connections to most-cited literature. Our review focused primarily on literature about public transport and shared micromobility (e.g., shared bikes, e-scooters, mopeds) in North American and European contexts. While European and North American research represent the majority of the literature to date, a robust literature exists across Asia (particularly China, see for example Liu et al. (2025), Kong et al. (2025), and Ma et al. (2018) among others), with more limited findings on personal micromobility and public transport from Latin America (see for example Pritchard et al. (2019) and Sagaris et al. (2017)). Synthesizing literature across these broader geographies with unique transportation, land use, and social contexts remains a topic for future research.

While previous literature on public transport and private micromobility (e.g., personal bikes) integration offer hopeful examples of successful efforts to integrate public transport and micromobility (see for example van Mil et al. (2021), Shelat et al. (2018)), we largely exclude the extensive private micromobility literature from this review as private micromobility faces fundamentally different needs (e.g., infrastructure, contractual) compared to shared micromobility. We did, however, include literature about private micromobility and public transport integration where findings offer implications for shared micromobility (e.g., supportive infrastructure around stations). We prioritized literature that evaluates multimodal integration efforts and/or offers lessons for integration best practices. We therefore largely excluded literature that focuses on a single mode (e.g., only shared micromobility or public transport). Similarly, we examine primarily urban contexts, where most integration efforts have focused to date.

We complemented literature with semi-structured interviews with stakeholders engaged in integration efforts across Europe and North America, which together represent substantial markets for shared micromobility services and offer comparative learning opportunities to advance understanding across contexts. Interviews were conducted between January and April 2025 with 25 professionals who worked for 1) shared micromobility and mobility-as-a-service providers, 2) city or public transport operators, or 3) other organizations (e.g., non-profit or advocacy organizations, research centers, university researchers). This qualitative approach mirrors that taken by Bruening et al., (2025), who focused on stakeholders engaged in integration efforts in Germany, Austria, and Switzerland. Table 1 identifies the mode, context, and geography of each interview. Each interview is coded with letter-number combination to differentiate between roles (shared micromobility or mobility-as-a-service providers (MM); governmental, cities, or public transport operators (G); or other (O)) and provide context within research findings for interviewee perspectives, as well as how shared or unique perspectives were across geographies, modes, contexts, or roles.

Semi-structured interview themes were developed around topics identified in existing literature; Appendix A includes the semi-structured interview script. Interviews were conducted in person or online via Zoom or Microsoft Teams. Each interview lasted between 30 and 90 min. Human subjects research approval was obtained prior to interviews (University of Oregon STUDY00001661). No interviews were recorded to adhere to European General Data Protection Regulations; instead, detailed contemporaneous notes documented interview conversations. Following conversations, all notes were coded using a combination of deductive and inductive coding. Manual deductive coding focused on themes previously identified through literature searches (e.g., technological versus physical integration), while inductive coding catalogued findings that arose organically during interviews (e.g., institutional integration). Appendix B summarizes the key codes used in qualitative analysis. Twenty-five interviews were deemed sufficient to reach thematic saturation across geography (North America vs. Europe), regulatory contexts (e.g., publicly-operated shared micromobility, concession-models, privately operated shared micromobility), and interviewee positionality (e.g., public sector, private sector). We determined we reached saturation after little to no new information was gained from additional interviews.

These methods expand on previous work that has categorized integration efforts to date. The American Public Transportation Association (2024) summarizes practice-based approaches to integration as: *at*, *on*, *to*, and *with* transit. Cui and Zhang (2024) use literature around policy, sustainability, infrastructure, and modal interactions to categorize integration efforts as *physical, payment and fee, informational,* and *institutional* integration. And Bruening et al. (2025) interviewed stakeholders from Germany, Austria, and Switzerland to identify four pillars: *smart operating concept, physical, digital platform,* and *tariff and communication* integration.

Such efforts catalogue dimensions of shared micromobility and public transport integration, but only one (Bruening et al., 2025) captures qualitative considerations. This research synthesizes existing quantitative and (albeit limited) qualitative studies, case studies, and integration elements alongside themes identified by manual inductive and deductive interview coding. Using a combination of literature and qualitative perspectives from stakeholders engaged in integration efforts across North America and Europe we identified three primary pillars of shared micromobility and public transport integration: physical, digital, and institutional integration. We discuss each of these pillars at length in the following sections. Together, the literature and interviews present complementary research evidence alongside on-the-ground expertise to highlight the opportunities, strategies, challenges, and imperatives for integrating shared micromobility and public transport across contexts.

Table 1
Interviewee Geography, Context, and Codes.

Role	Number of interviews	Mode/Context	Geography	Interview Code
Shared Micromobility and Mobility-as-a-Service Providers	9	Mopeds	Netherlands	MM1
		Bikes	Belgium	MM2
		Bikes	Europe	MM3
		Bikes	Global	MM4
		Bikes and e-scooters	Europe	MM5
		Bikes and e-scooters	Global	MM6, MM7, MM8
		Bikes	Canada	MM9
Cities or public transport operators	13	Provincial/state government	Netherlands	G1, G2, G3
		National railway	Europe	G4, G5
		Public transport operator	United Kingdom	G6
		City or public agency	Netherlands	G7
		Public transport operator	Canada	G8
		Public transport operator	United States	G9, G10
		City or public agency	United States	G11, G12, G13
Other	3	Transportation non-profit association	Global	O1
		Transportation non-profit organization	Netherlands	O2
		University transport and governance researcher	Netherlands	O3

4. Physical, digital, and institutional integration: opportunities, challenges, and priorities

4.1. Institutional integration

As regions have grown more fragmented across jurisdictions, land uses, and operators (Buehler et al., 2019), both literature and interviewees highlighted that clear leadership and coordination across stakeholders are critical to successful and sustained integration (G10, MM5) (Buehler et al., 2019; Hansel, 2025; Oeschger et al., 2020). Inaction may reduce accomplishments to be "by accident" (Pucher and Buehler, 2009, p. 95) or stymy progress towards goals (Zhang et al., 2024). Institutional coordination should include municipalities, regional governments, administrative bodies, political decision-makers, shared micromobility operators, and public transport providers (Buehler et al., 2019; Hansel, 2025). Contrary to the united perspective often assumed in literature, intra-governmental perspectives and objectives often vary (Veeneman and Mulley, 2018), meaning that multiple stakeholders are often needed to represent local (e.g., planning, law enforcement, and construction) or regional perspectives (Hansel, 2025; Zhang et al., 2024). Stakeholders may also include private property owners, major employers, or representative from major travel destinations (Northern Virginia Transportation Commission, 2025).

Stakeholder coordination and collaboration is necessary across all forms of transportation to "legitimize new ways of framing policy problems and solutions" (Hansel, 2025, p. 325) and ensure a "consistent approach to multimodal transit access" (APTA, 2024, p. 36). The literature and interviewed professionals highlight five dimensions of multimodal integration, including:

1. Identify concrete and consistent goals agreed upon by all stakeholders
2. Designate clear leadership to coordinate diverse stakeholders
3. Align micromobility ownership, contracts, and concessions with public goals
4. Share data to support multimodal service planning
5. Target subsidies or fee waivers to ensure affordable and regional access to shared micromobility

The following sections discuss the challenges and opportunities of each dimension of institutional integration.

4.1.1. Identify concrete and consistent public goals

Cities task public transport and shared micromobility with a wide range of goals. Van Oort and Yap (2021) categorize transport project goals under 5Es: effective mobility, efficient city, equity, environment, and economy. Other researchers highlight that the wide range of goals public transport alone is tasked with can create conflict or limit goal achievement across some domains (Pinski et al., 2025). Given conflict inherent in even public domains, it is therefore unsurprising that private, public, or even cross-jurisdictional interests and expectations often conflict during integration efforts. For example, a private shared micromobility operator seeks to maximize profit, while a regulating body prioritizes regional service availability. Local jurisdictions may also have other goals that supersede transport-micromobility integration. When stakeholder priorities or goals do not align, resistance may limit either the space or funding needed to foster integration (Kask et al., 2022). In particular, aligning goals across public sector stakeholders is critical to creating clear and consistent policy frameworks, regulations, dedicated funding and space needed to support integration. Early agreement on precise objectives, project schedules, and responsibilities and expectations across stakeholders are critical to align efforts and support integration across time and space (G5, G11)(Bruening et al., 2025; Zhang et al., 2024). Agreeing on broad goals does not eliminate the potential for future conflicts as stakeholders may disagree on specific priorities or timelines that support broad objectives (Hansel, 2025). Goal-setting discussions should account for the different levels of readiness, staffing, and financial resources to support shared micromobility-transport integration, which can vary widely across regional actors and potentially impede efforts to create a cohesive regional network (G8, G11).

Goals should be formalized into policy documents to offer a foundation to build conversations, buy-in, and concrete actions across a region (G2). Formalizing shared micromobility into policy documents often takes time, sustained efforts, and clearly articulated vision and leadership. One publicly-owned shared micromobility operator observed that city council support for shared micromobility trickled first from city council to city staff, imbuing the perspective of shared micromobility as an essential service throughout city plans ranging from parks to transportation demand management to zoning bylaws. Now fully developed, shared micromobility is embedded within city policies and plans creating a more cohesive and future-facing approach (MM9). Formalized goals can be leveraged to advocate for concurrent regional infrastructure investments and long-range planning efforts that support integration (Hansel, 2025)(MM9).

4.1.2. Designate clear leadership to coordinate diverse stakeholders

Shared micromobility and public transport integration decision-making authority, ownership, and funding are often fractured across space or level of government, complicating both coordination and governance efforts. Such fractures occur within municipalities and are amplified at a regional-level that include multiple local jurisdictions with varying shared micromobility regulations and/or transport operators. Together, such varied approaches, regulations, and operators create a patchwork rather than cohesive and consistent regional transportation system (G13). Interviewees repeatedly raised cross-jurisdictional coordination as a critical, challenging, and time-consuming aspect of integration (G6, G8, G10, G11, G13).

A clear leader is needed to organize disparate stakeholders and lend stability to efforts across time and space (G10). Effective leaders should precisely identify infrastructure needs, designs, and human or institutional responsibilities and resources needed for integration (Hansel, 2025; Zhang et al., 2024). Identified leaders must have resources and both political and funding support in order to foster success (Hansel, 2025), particularly as they are often tasked with leading efforts across independent actors that may resist direction or have divergent objectives (G6). Political support is key to supporting efforts foundational to integration as well such as infrastructure investment: Buehler et al. (2021) documented how Seville (Spain) achieved robust bike mode shift effects in just 6 years with strong political support compared to Frankfurt (Germany) and Washington, DC (USA), which had tepid political support and only achieved similar mode shift after 20 years.

Interviewees disagreed about who should lead integration efforts, and leadership is certainly context dependent. Several interviewees named regional transport operators as ideal leaders to facilitate and coordinate integration, citing their existing regional operations and working relationships across jurisdictions, and accrued experiences to date (G8, G10). Bruening et al. (2025) similarly identified public transport as key facilitator between cities and private shared micromobility operators. Others suggest that a transport operator should *not* lead integration efforts because it is disconnected from local policy and planning documents that guide land use and infrastructure investments. Instead, a city may play the leadership or management role (G2)(Cui and Zhang, 2024) or create a regulatory framework (Bruening et al., 2025). Interviewees note, however, a single city leader may hold limited influence or relationships with other jurisdictions within the region, impeding efforts to create a cohesive regional network (G11). Likewise, different city, regional, or national contexts or historical precedent may shape who is the most logical leader or facilitator. For example, integrated public transport efforts are tackled at different jurisdictional levels across place, including county-level coordination (e.g., Denmark, Sweden), national coordination (e.g., Netherlands, Switzerland), or regional coordination (e.g., Canada, United Kingdom, United States). In part, this may be due to jurisdictional structures underpinning such coordination; US metropolitan areas, for example, have similar structures to federal structures in Germany, Austria, and Switzerland, but with greater documented independence and rivalry relative to more consensus-seeking characteristic in Europe (Buehler et al., 2019).

While leaders may institute a purposeful and proactive approach, others may embrace "learning by doing" and iterate their regulatory, management, or operations approach to shared micromobility services in line with public transport and city goals (Kask et al.,

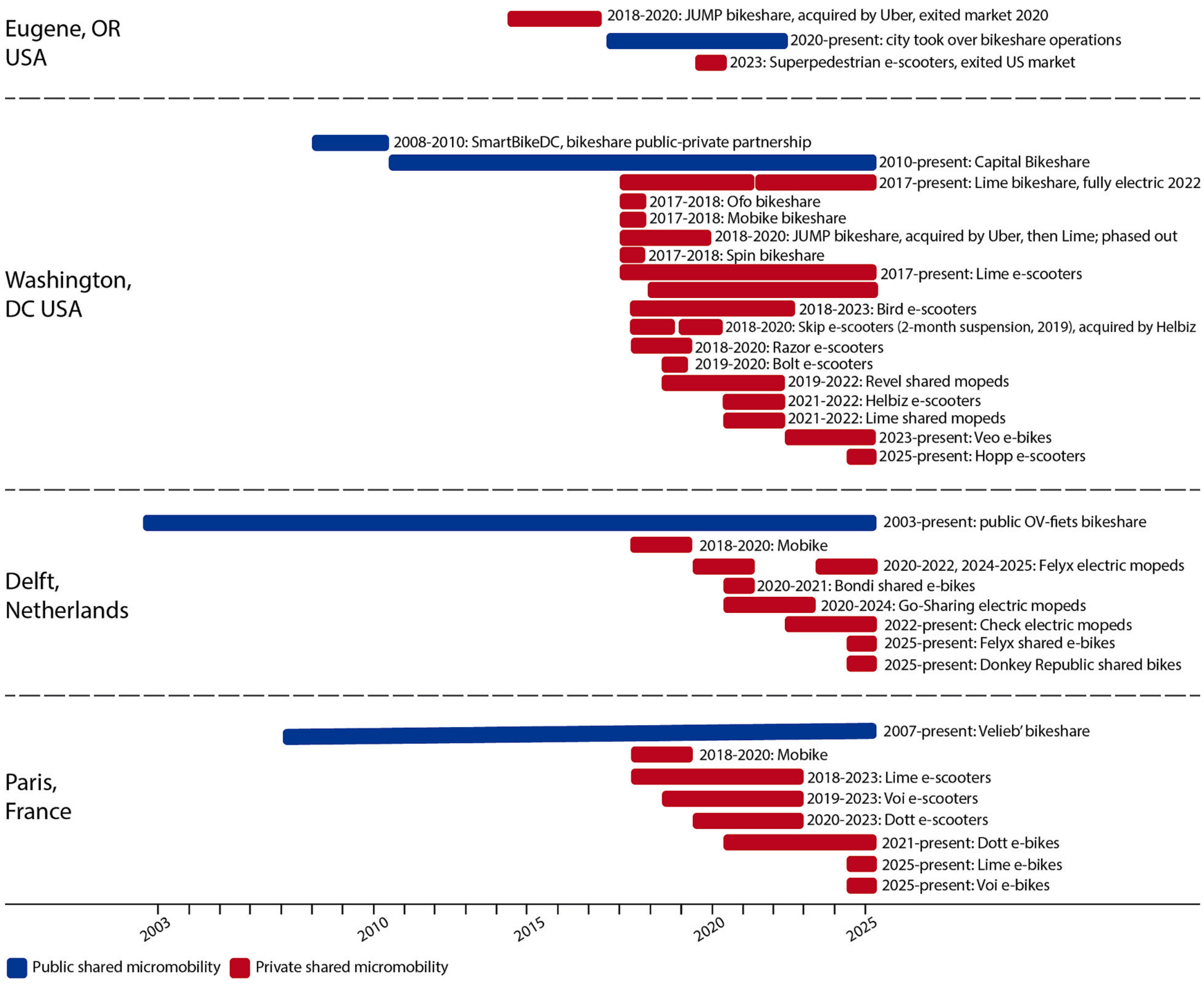

Fig. 1. Shared Micromobility Operators Across Three Select Markets.

2022). Iterative approaches can also help to foster (in)formal communication among relevant stakeholders to overcome initial institutional voids (Hansel, 2025) or use evaluations to adjust programs to meet objectives (Zhang et al., 2024).

4.1.3. Align micromobility ownership, contracts, and concessions with public goals

Shared micromobility regulatory structures have direct implications for integration with public transport. Three common shared micromobility regulatory approaches exist. First, shared micromobility may be publicly-owned and subsidized, although operations may be contracted to private companies (e.g., Divvy Bikeshare, Chicago, USA; OV-fiets, Netherlands; Toronto Bikeshare, Toronto, Canada). Second, cities permit or license private companies (e.g., Bird, Lime, Donkey Republic, Tier-Dott) to operate, often through competitive processes through which they impose a range of regulations such as vehicle and safety standards, service areas, etc. Finally, shared micromobility may be required as part of a public transport concession (e.g., Amstelland-Meerlanden, Netherlands; Louvre, France; Orlean, France). By design, public concessions prioritize integration by mandating that operators use multimodal offerings to meet regional mobility objectives (O3).

Interviewees associate micromobility regulatory structure with reliability, stability, and affordability, each of which is essential to fostering integration and travel behavior changes (G5, G11, G12, MM4, O3)(NACTO, 2022). Frequent changes to micromobility operators due to short contract periods or market dynamics (e.g., bankruptcy, mergers), however, undermine integration by creating instability and confusion for travelers that deters people from changing travel behavior due to future uncertainty (G5, G12). Fig. 1 offers examples of market fluctuations across three select markets, each with long-running public shared micromobility programs, illustrating the unpredictable nature that sometimes defines private micromobility service. Unpredictability is a significant factor that presents barriers and complexities for travelers seeking to make or change behaviors (see for example Bonsall (2004)). While all regulatory structures may achieve stability, reliability, and affordability, each requires specific considerations.

Some interviewees argued that publicly-owned systems provide superior stability over time relative to private operators. They point to longevity of public systems across the globe, highlighting the financial stability due to public subsidy, reliable partnerships created by public leaders, and internal integration of shared micromobility within city policy, plans, and infrastructure investments (G5, G10, G12, MM4, MM9). Research finds that the long-standing Dutch Railways public bikeshare program, OV-fiets, delivers a wide range of societal benefits—including environmental, health, accessibility, reduced road cost—and that such benefits outweigh the public investment (Mbugua et al., 2025). Additionally, both revenues and investments can vary over time (e.g., revenue drops during the COVID-19 pandemic; high intermittent costs every 10 years to replace a shared micromobility fleet). Public financial support can help programs—particularly in their early years—weather disruptions and financial challenges as they seek to establish stable operations (Mbugua et al., 2025).

Others argue that the stability can also be achieved through private contract permits or concessions (in addition to or in lieu of publicly-owned shared micromobility). Permitting processes can provide another avenue to encourage integration with public transport, such as emphasizing and scoring integration efforts in competitive permit applications (Barnes, 2019). Most crucial to supporting sustained integration between public transport and private shared micromobility are tender or contract lengths and the number and types of shared micromobility operators.

Public transport, shared micromobility, and city interviewees agreed that, following an initial period of pilot experimentation, longer-term shared micromobility permits, contracts, or concessions yield stronger integration results compared to shorter agreements. Longer-term agreements improve market attractiveness for operators to invest in, simplifies user experiences, can reduce the administrative burdens on cities (Ferguson and Sanguinetti, 2023; NACTO, 2022). Longer contracts help private operators to recoup physical, staff, and financial investments made to integrate transport and shared micromobility, a process that operators report typically requires several years (MM6). Longer tender periods can also incentivize companies to invest in local partnerships, and are more efficient than moving full fleets of vehicles between markets every few years (MM3). Public transport operators are also more willing to adjust their own long-term service or capital planning to support integration with the knowledge that shared micromobility will be reliably operating over long-term (G13, MM9).

While interviewees agree that longer agreement periods yield a range of benefits, they disagree about the ideal contract length. Public transport operators argued for 3 to 4-year shared micromobility tenders or contracts to ensure sufficient time for private investment while offering flexibility for the public sector to adapt its operating requirements to changing technologies and market needs (G6). Shared micromobility operators argued for tenders at least five years due to infrastructure and asset investments and time-intensive integration efforts (MM5, MM6). Some argued shared micromobility should be integrated into standard 10 to 15-year public transport tenders, which would require coordination between bus/rail operators and shared micromobility to create a cohesive system that facilitates cross-subsidies across space, times, and modes (MM7).

4.1.4. Share data to support multimodal service planning

Sharing data between public transport and shared micromobility operators is critical to managing, growing, improving, and integrating both services (G5, G6)(Attard and Balbontin, 2024). Public transport data (including route, stop, timetable, and/or ridership data) may be used in shared micromobility operations to create a complementary and fluid mobility ecosystem, such as adjusting micromobility vehicle deployment based on changing public transport routes (MM7)(Oeschger et al., 2020). Shared micromobility data (including trip origin/destination, routes, and/or travel times) can identify gaps in transport service (MM8), aid in transport network redesign (MM7), or identify streets with road safety concerns that cities can target with additional infrastructure investment (G6). Both micromobility trip data and user surveys may also help transport agencies in identifying when/why people are making multimodal trips; better understanding these contexts and purposes could help agencies to identify and justify additional funding needed to invest in integration efforts (G13).

Many transport operators already publish feeds of real-time and scheduled vehicle and route information. The majority of shared micromobility programs operating in North America also require companies to share data with cities (Berjisian, 2025; Brown et al., 2024). Some cities offer broad data sharing statements while others detail specific variables and intervals of required data sharing; most commonly, micromobility operators are required to share the number of trips, origins, destinations, timestamps, and distances. Some require additional data reporting (such as enrollment in discount ride programs, incidents and collisions, and trip routes) or require operators to administer surveys to micromobility riders where they often ask about multimodal travel and integration between micromobility and transport (G6) (Brown and Howell, 2024; Staben et al., 2024).

Despite its importance, data sharing can also challenge integration efforts. Data privacy protections, including GDPR in the European context, may prevent transport agencies from examining trips or individual-level data. Private operators also express data privacy concerns. Data privacy concerns can challenge coordinated planning or operations efforts, but especially digital integration that may require sharing personally identifiable information in order to sync fare systems (MM4). Shared data must be standardized APIs or formats including GTFS, MDS, and GBFS to ensure smooth ingestion into platforms, tools, or apps (Murphy et al., 2021) and reduce complexity and cost of engineering and legal approaches across markets (MM6). Self-reported or irregular data may also undermine or be insufficient to answer integration-related questions (APTA, 2024). Researchers also caution that data monopolies could block additional providers from entering the market or result in high-prices that generate profit rather than reinvested into the mobility ecosystem (Pangbourne et al., 2020).

4.1.5. *Target subsidies or fee waivers to ensure affordable and regional access to shared micromobility*

Public transport subsidies are critical to creating affordable and comprehensive transport coverage across a metropolitan area (Buehler et al., 2019). Some shared micromobility, particularly docked and publicly-owned likewise receive public subsidies. By contrast, subsidies are rare among dockless shared bikes, mopeds, or e-scooters (Murphy et al., 2021), which are often taxed rather than subsidized[1] (MacArthur et al., 2024). As a result, most shared micromobility remains considerably more expensive than public transport (NACTO, 2024).

High prices are particularly prohibitive to repeat use; interviewees and reports estimate that commuters using shared bikes for about 30-minutes during each work day would spend about \$250–280 per month under current pricing schemes (MM3) (NACTO, 2024).[2] Interviewees frequently highlighted that trip price is closely, and inversely, linked with ridership (G11, MM2).

Interviewees emphasized that pricing should be affordable and predictable (MM2) and suggest a range that public subsidy for shared micromobility services would foster successful integration. First, subsidies could shift travel behaviors and may encourage people to try a new mode (MM4), reduce the costs for people earning limited incomes (Murphy et al., 2021), or accelerate ridership growth or development of a shared micromobility network (MM3) (Buehler et al., 2019; DDOT, 2025). Second, subsidies can support operations in less dense or profitable areas to solidify a comprehensive regional transportation network (Buehler et al., 2019) and to sustain a reliable micromobility system across time and space (G12, MM9). Interviewees observed that publicly-subsidized systems represent some of the earliest, and most consistently-run systems (e.g., BIXI, Montreal, Canada (2009); Blue Bikes, Belgium (2011); Capital Bikeshare, Washington, DC, USA (2010); OV-fiets, Netherlands (2000)) while many private systems have declared bankruptcy over the same time period. Some private operators argue that current requirements to serve wide geographies without subsidies undermines their overall financial viability (MM5). Privately-owned systems create risks for cities if they declare bankruptcy or exit a market (Murphy et al., 2021) and have previously motivated new public subsidies to take over defunct private micromobility operations (e.g., Cincinnati, OH; Houston, TX; Chicago, IL (USA) (NACTO, 2024).

European transport operators argued that shared micromobility *requires* long-term public subsidy or cross-subsidies across stations to support integrated multimodal regional networks (G5). While some shared micromobility systems may eventually reach financial sustainability (some after a decade or more of public subsidy) (G5), other systems may continue to require public subsidies due to rising operation expenses or desires to expand services into target areas (Murphy et al., 2021). Prolonged financial support requires sustained political buy-in (G12) (Hansel, 2025). Bruening et al. (2025), argue that within competitive tenders and concessions (more common in Europe than North America), waiving or reducing concession fees can be a more politically palatable alternative to publicly subsidizing private operations while yielding a similar effect in practice.

Some researchers argue that blanket public subsidies to shared micromobility *or* public transport operators is inefficient: rather, they argue that public subsidies should target groups or locations aligned with public goals (O3). Others, however, argue that current prices are unaffordable to the broad public and that *all* riders need some form of subsidy to ensure broad affordability and modal adoption (NACTO, 2024). Subsidies may still be set to target specific users even while lowering costs for all residents. Boston (USA), for example, charges \$133 for an annual Bluebikes membership, but just \$5 per year for residents who meet specified income criteria (Bluebikes, 2025b, 2025a). Interviewees across sectors advocated for using subsidies to support subscription models—such as unlimited 30-minute rides for a fixed price per month—to support long-term travel behavior changes, eliminate marginal travel costs, and incorporate shared micromobility more seamlessly into a full trip itinerary (G1, MM2, MM3, MM6).

Current funding mechanisms highlight different approaches—and challenges—to subsidizing shared micromobility as part of an

[1] Taxes and fees across Europe, North America, and Australia range from \$0.22 to \$2.16 per mile, compared to public transport that operates with a \$0.67 to \$2.24 public subsidy (MacArthur et al., 2024).

[2] In Europe, a person using a shared bike for 30-minutes per day 20 days per month (each weekday) would spend about €220 [\$250] per month on shared micromobility travel (MM3). NACTO (2024) estimates that a commuter would pay \$280 per month to use an e-bike (\$14/day x 20 workdays assuming \$0.22/minute for 30–35 min per day each way on an e-bike).

integrated public transport network. In Europe, shared micromobility is often subsidized by public transport operators to support connections to/from stations (e.g., Dutch National Railways, which operates the OV-fiets bikeshare program) or through subsidies outlined in a concession process (e.g., Donkey Republic e-bike subscriptions are subsidized through a concession in Antwerp, Belgium). In North America, by contrast, many cities seek to *generate* revenue from micromobility to fund infrastructure, staff, or unspecified city activities (Gössling, 2020; MacArthur et al., 2024). In part, these differences may stem from divergent framing of shared micromobility within the broader transportation funding ecosystem and implications for available funding. Within North America, for example, Canada classifies shared micromobility as public transport, while the United States does not (with few exceptions such as bikeshare station infrastructure). This greatly affects funding available for cities seeking sustained subsidies for micromobility operations (G8) (Murphy et al., 2021). Some cities or transport agencies have identified alternative subsidy funding sources including countywide sales tax revenues (e.g., Metro Bikeshare, Los Angeles, CA, see Murphy et al. (2021)), foundation support or long-term sponsorships (NACTO, 2024), or employer-based subsidies (Oeschger et al., 2020).

4.2. Physical integration

Interviewees across continents agreed that physical co-location throughout a transport network is essential to create consistent and reliable access to shared micromobility across a transport network to facilitate multimodal trips (G8, G9, G12, MM3, MM4, MM5, MM6) (Cui and Zhang, 2024). Physical co-location through dedicated shared micromobility parking and mobility hubs also solidifies public perceptions that shared micromobility is part of the public transport network (G4, G6, G12, MM6). Despite its clear benefits, complex coordination required across stakeholders, limited available space, and competing goals can hamper physical integration efforts. The following sections present considerations to:

1. Identify appropriate mix and number of shared modes
2. Co-locate shared micromobility parking at public transport stations
3. Develop mobility hubs
4. Co-branding shared micromobility and public transport

4.2.1. Identify the appropriate mix and number of shared modes

In addition to contract or tender length, interviewees argued that several dimensions of shared micromobility operations affect integration efforts. First, while many interviewees were agnostic to one versus multiple operators, most agreed that offerings should be consistent across time and space to create stability and reliability. Systems with many operators (more than 3) could risk these goals if they have more operator flux (i.e., enter/exit market) or if operators do not coordinate vehicle deployment, leaving gaps in vehicle availability. Many argued that multiple forms of shared micromobility (e.g., different vehicle types; fare structures such as subscription, daily, or per-minute rental; one-way versus round-trip rental; docked versus free-floating) were beneficial to travelers by providing greater choices to meet variable traveler needs (G1, MM6). Research similarly suggests that different demographic groups may be more or less receptive to use shared micromobility in combination with public transport (Geržinič et al., 2025; Loudon et al., 2023; Montes et al., 2023), suggesting that micromobility options tailored to community needs is important for integration.

Several interviewees in both Europe and North America argued that docked or hub-based shared micromobility services were best for public transport integration by reducing operating costs (and thus costs to riders) and providing more stable trip planning for regular travelers by removing the uncertainty about where to find a vehicle or if a vehicle will be available (G1, G5, G11, MM4). Others, however, argued that point-to-point, while more operationally challenging, can offer the flexibility often desired by travelers and can complement both public transport and dock-based micromobility (G5, G13).

4.2.2. Co-locate shared micromobility parking at public transport stations

Both transport operators and shared micromobility operators across geographies argue that proximity between shared micromobility parking and public transport is the most critical component of co-location (G8, MM4, MM5). While Oeschger et al. (2020) document that people are willing to walk up to 220 m to transfer between shared micromobility and public transport, interviewees argue that shared micromobility should be located at or immediately adjacent to public transport stations. They observe that micromobility parked across the street or one block away can deter transfers or reduce modal competitiveness (G8, G10, MM4, MM5).

Co-located shared micromobility parking should be 1) physically marked, 2) easy to navigate, and 3) facilitate multimodal transfers through clear wayfinding. Physical signs, striping, or stickers can facilitate transfers and wayfinding signage should be clear throughout a station area (G5, MM7). Physical signage—as opposed to just digital geofencing—yields multiple benefits including increasing awareness of shared mobility as part of public transport options (particularly among non-riders) and making it easier for people to quickly identify parking locations (G9, G13, MM1, MM3). Parking locations should minimize conflicts between people biking/scooting to a station with cars, transit vehicles, or pedestrians (APTA, 2024). Shared micromobility can be incorporated into existing bike parking, which people are already accustomed to using (G5, G9, G13). Some cities that construct new parking first using temporary materials to test for issues and demand before installing more permanent infrastructure (G9, G13). Co-located parking should be large enough to meet parking demand and ensure that shared vehicles are reliably available for people exiting public transport stations (G11, MM5)(Oeschger et al., 2020).

In addition to design considerations, physically integrating micromobility parking at public transport stations presents substantial logistical hurdles, particularly when the entity that contracts, operates, or regulates shared micromobility does not own or control land around stations (G8, G10, MM5, O1) (APTA, 2024). When this is the case, parking may be instead located on the nearest available municipal land, although the added distance can deter multimodal transfers (G8, MM5). Other times, operators or regulators form agreements or receive permits from public or private landowners around stations to site parking (G8, MM5). Because private landowners are rarely invested in shared micromobility's success, they may be resistant, reluctant, or unmotivated to permit or provide space for shared micromobility parking. Private landowners may also worry about liability or aesthetics. Because they typically own few parcels, each parking agreement with a private landowner is unique, complex, and time-consuming (MM5).

When transport agencies *do* own land around or at stations, complexities and practical challenges still arise. Some stations are physically limited, such as being too small (Ferguson and Sanguinetti, 2023) or constrained by emergency-use curbs, driveways, or utility placements (G10). Non-spatial constraints such as labor agreements to provide exclusive maintenance or installation work at public transport stations can also complicate physical integration at stations (G10). In other cases, transport agencies seek pragmatic decisions that reflect multiple competing goals, such as wanting to eliminate potential obstructions near station entrances while also wishing to minimize walking distances between micromobility and public transport (G9, G13, O3).

4.2.3. Develop mobility hubs

Like co-located parking, mobility hubs aim to physically integrate shared micromobility and public transport. Mobility hubs, however, typically represent a broader effort to create multimodal nodes while also providing a sense of place through intentional interfaces and amenities to attract users and catalyze development, activities, and/or shift travel choices (G3) (Torabi et al., 2022). Previous research categorizes or creates typologies of hubs, which can vary greatly across built environment and community need (see for example Blad et al. (2022)), although some mobility hub managers argue that social elements and amenities (such as seating, restroom facilities, and dining), not mobility, are foundational to mobility hub success (G3). Hubs typically have a public transport station or stop as a backbone, but work well when they develop around known community locations such as a bus station, school, or library. By using locations already integrated in peoples' daily travel patterns, hubs can more organically develop where people already are (G3).

Hubs have proven effective physical integration tools across continents and across built environments ranging from dense urban areas and small towns. Regardless of the context, European case studies highlight the need for clear leadership and political support to drive implementation (Hansel, 2025). While some interviewees argued that standardization is critical to achieving scale (O1), others argued that no hub or parking should be identical and should instead reflect user characteristics and built environment variations (G2, MM9) (Oeschger et al., 2020). Many argued that community engagement—including meetings, flyers, or canvassing neighbors—was important to successful physical integration using hubs including to design hub amenities, build support, and reduce opposition to removing car parking to site a mobility hub (G2, G10, MM9).

4.2.4. Co-branding can be useful but should be used carefully

Interviewees are divided on the importance of branding, although all agree it is less important than physically co-locating shared micromobility and public transport. Some argue that branding is unnecessary (G2), while others believe co-branding shared micromobility as public transport is a low-cost way to create a more unified regional mobility system (G10, MM7). Co-branding may include stickers on shared vehicles or more customized vehicle or station design efforts. Yet co-branding can also create confusion. One operator reported a system that branded shared micromobility vehicles as public transport, but the associated app was branded as the private mobility operator. They stated that the branding disconnect between the vehicles and the app created substantial rider confusion (MM5).

4.3. Digital integration

Digital integration includes a spectrum of efforts ranging from mapping public transport alongside shared micromobility docking stations for wayfinding purposes to Mobility-as-a-Service, which integrates multiple modes into a single trip planning and payment platform. Research highlights potential benefits of digital integration including: avoiding the hassle of paper tickets and maps; saving time on trip planning, ticketing, and boarding; reducing the need for multiple apps across modes; and simplifying system complexity into a more user-friendly experience and more competitive alternatives to car (G11) (Bian et al., 2022; Bruening et al., 2025; Cui and Zhang, 2024).

Over the past two decades, transport agencies and cities across the world have energetically piloted and launched digital integration efforts including various combinations of trip planning and/or payment via either smartphone application or RFID-chip enabled card. Despite keen attention and substantial resources dedicated to digital integration, most interviewed cities, public transport, and micromobility operators across North America and Europe agreed that digital integration was supportive rather than essential to integration and should be secondary to both physical or institutional integration (G1, G8, G10, G12, MM1, MM3, MM4, MM5, MM6, MM8, O3).

This section considers the potential opportunities and challenges of three dimensions of digital integration:

1. Trip planning
2. Integrated fare cards and payment methods
3. Combined or discounted fares for multimodal trips

4.3.1. Trip planning

Digital trip planning tools can reduce wait anxiety and times and increase passenger satisfaction (Brakewood and Watkins, 2018). Trip planning platforms include 1) private sector apps (e.g., Transit, Citymapper) that enable people to use a single app across regions, modes, and agencies; and 2) agency-branded apps that are used to promote services or run targeted marketing campaigns (Bian et al., 2022). Interviewees were divided in the relative importance of trip planning as an integration approach. Some argued its benefits including raising awareness of multimodal travel options (G6) and responding dynamic events (e.g., an integrated trip planning tool could highlight nearby bikes or e-scooters during a public transport disruption) (MM7). Others stated that integrated trip planning is important only for occasional travelers rather than habitual travelers like commuters (G8) and that scarce public resources can hamper robust digital trip-planning efforts (G6). Literature concludes that app-based trip planning to shift travel behavior have significant, but small, effects in practice (Sunio and Schmöcker, 2017), and primarily affect younger traveler behaviors or people visiting new places (Jamal and Habib, 2019).

Operators highlight that the steps required to move from integrated trip-planning to integrated ticketing present substantial barriers (MM5). Most current trip-planning apps employ deep-link integration in which travelers can plan a multimodal trip, but are then redirected to an operator-specific platform via in-app hyperlinks to purchase fare tickets (MM6). While the least complex approach to digital integration, deep link integration also requires travelers to take additional steps and still requires multiple app downloads, creating additional friction and reducing the likelihood of booking a multimodal trip (MM6).

4.3.2. Integrated fare cards and payment

Integrated fares via mobile payment apps can reduce time spent purchasing fares, increasing peoples' flexibility, and reduce boarding times (Brakewood et al., 2020). It also means that people can ride a bus or a shared bike using the same mobile app or physical fare card, reducing the number of payment methods travelers need to juggle within the expanding transportation ecosystem.

Additional account registration and data requirements complicate integration between existing transit fare cards and shared micromobility systems. Many public transport agencies issue anonymous transit cards that can be refilled at ticket vending machines or stations using cash, debit, or credit cards. Both private and public micromobility operators view anonymous fare cards as creating liability for damaged, lost, or stolen vehicles (G1, G5, G10, MM4); this perspective was held in both Europe and North America despite varied legal contexts. As a result, shared micromobility riders must create personalized accounts with associated bank account or credit card information. The added data requirements hold even for public transport agencies that operate their own shared micromobility services. Dutch Railways (the national rail operator in the Netherlands), for example, permits people to travel with an anonymous OV-chip transit card. One can use an OV-chip card to rent a publicly-owned OV-fiets (bikeshare) as well, but one must first register the account and input bank account information (Nederlandse Spoorwegen, 2025). A nearly identical process exists in Los Angeles (USA) with LA Metro (the largest public transport authority in the Los Angeles region) and its bikeshare program (LA Metro, 2025). Integrating fare payment can also be complicated by data sharing restrictions or company, agency, or traveler concerns around personal data privacy information (MM4)(see for example Golub et al. (2022)).

Some operators also seek to bypass fare card integration entirely by adopting open loop systems that allow people to pay with a standard credit or debit card. While public transport agencies have positive perceptions of open-loop systems, technological challenges and equipment costs remain barriers (Pike et al., 2024). Additionally, implementing subscriptions, passes, or linking trips within open loop systems remains an area of ongoing development (G5).

4.3.3. Combined or discounted fares for multi-modal trips

Currently, most systems require people to pay separate fares for separate modes, including different legs of a single multimodal trip. In a combined fare integration scenario, practitioners envision travelers paying a single—potentially discounted—fare per journey, even one that is multimodal. Combined ticketing and fares are most often discussed as "end to end integration" or as Mobility-as-a-Service (MaaS), which integrates trip planning in addition to ticketing within a single app (for a more robust discussion of MaaS broadly, see Li and Voege (2017)). Such efforts seek to solve fragmentation (O3) and increase competitiveness against cars through more transparent pricing, seamless ticket purchasing, and by reinforcing the links in peoples' minds of shared micromobility as public transport (MM6, MM7). Integrated ticketing may also reduce total multimodal trip costs, which can become expensive if people must pay for shared micromobility unlock fees and fares on both ends of a bus or train trip (G6). Combined fares can also bundle monthly passes or public transport subscription together with set number of shared micromobility rides or minutes, distribute specific mobility budgets, or provide shared micromobility discounts during public transport service disruptions (MM7). Interviewees highlight that a one-stop-shop for mobility would ideally be compatible across regions to achieve scale, such as European Union-wide apps developed during the COVID-19 pandemic (MM6).

Although many acknowledged potential benefits of full end-to-end integration, others called it a "wishful scenario", and both operators and public transport agencies raised questions about feasibility. Current revenue models for end-to-end integration efforts typically include app platforms collecting a set amount of revenue per trip. At scale, this is financially sustainable; the constant flux of both shared micromobility and integration apps entering and exiting the market, means that providing stable returns on investments remains questionable (MM7). With currently limited MaaS adoption (e.g., 1–3 % of micromobility rides in select markets), many interviewees questioned the tradeoffs between high effort and investment relative to limited outcomes (G4, G12, MM5, MM6, MM7). Operators in particular are hesitant to invest substantial resources in individualized markets each pursuing their integration strategy, limiting scalable potential (MM5, MM7). Micromobility operators question scalability given current market customization, and the substantial efforts needed not only to build fully integrated digital systems, but also the ongoing engineering and maintenance needed as fares or service schedules shift, app updates such as bug fixes alter coding needs, etc. (MM6). Some question more fundamentally if (or how much) full digital integration would increase multimodal travel or ridership particularly if viewed as an opportunity cost against other efforts to integrate public transport and shared micromobility (MM2). A paradigm and cultural shift may be needed to realize scaled MaaS systems that fully integrate trip planning, payment, and combined fares across modes (Mulley, 2017).

Finally, combined fare or MaaS adoption may be challenged by potential costs of subscription models, lack of available services, or infrequent travel behaviors that limit adoption by would-be occasional users (Xi et al., 2024). Additionally, shared micromobility companies are hesitant to turn customer relationships and communications over to an external company, raise contract complexity concerns, and note challenges in ensuring that revenues collected by a third-party app are correctly returned to the company on which a ride was made (MM7).

5. Discussion

Public transport and shared micromobility integration is not itself a goal. Instead, integration should aim to create a reliable and accessible mobility network across time and space, providing affordable and competitive alternatives to car travel that together offer robust access to work, school, leisure, and other activities. While integration is context specific, synthesis of literature and professional interviews suggest a priority hierarchy for successful and impactful integration. Fig. 2 shows that successful shared micromobility and public transport integration efforts depend first on a robust foundation of high-quality public transport, micromobility infrastructure, supportive land uses, and issue framing. Foundational elements are grounded in both interview findings (G5, G6, G10, G11, G12, MM1, MM4, MM5, MM9) and decades of both theoretical and empirical transportation and travel behavior research as discussed in the following sections. Following foundational investment, institutional and physical integration strategies are necessary to foster a

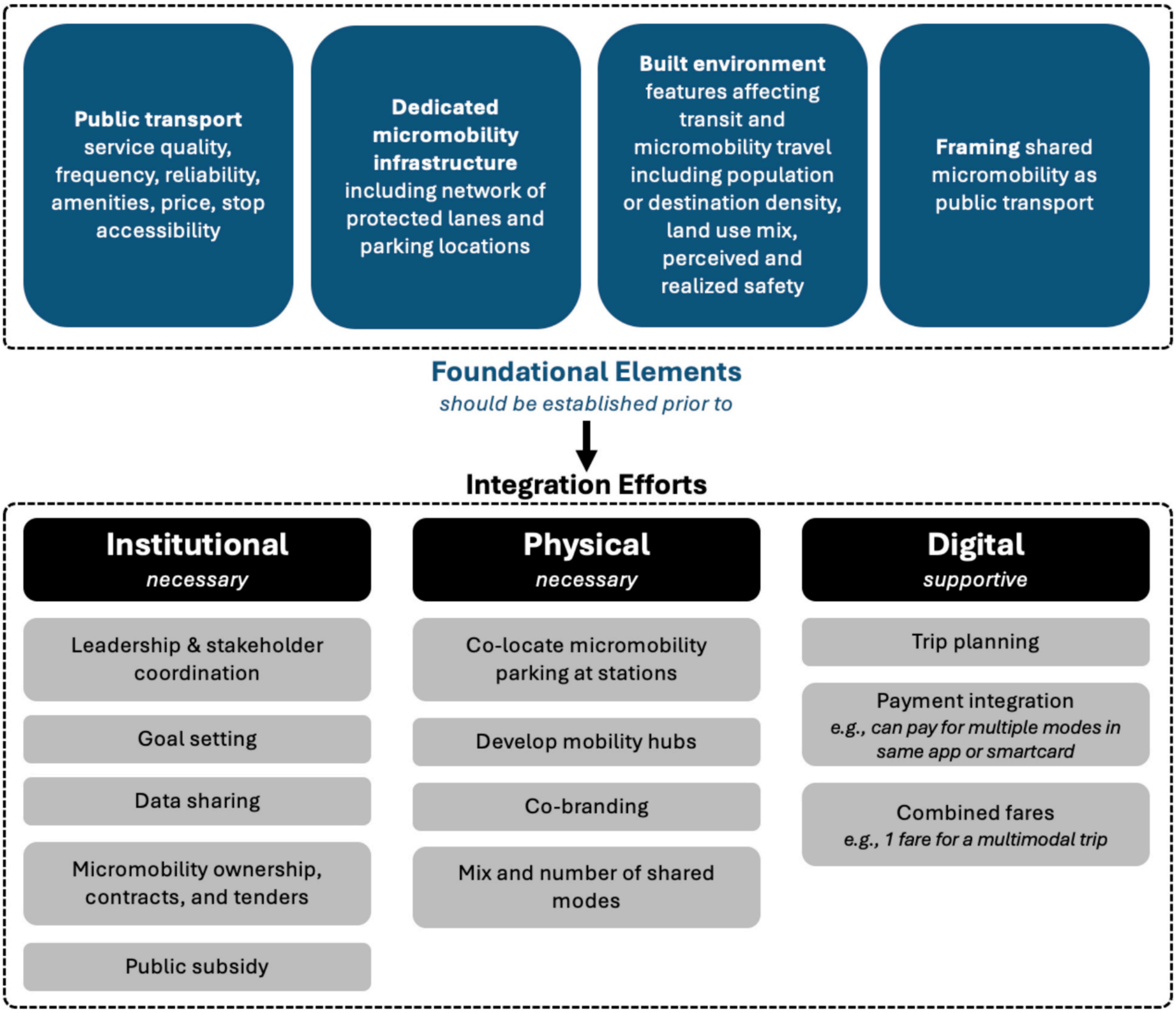

Fig. 2. Public Transport and Shared Micromobility Integration Framework.

cohesive mobility system. Digital integration efforts, while supportive of city goals, should be secondary to both physical and institutional integration.

This discussion section summarizes the imperative for investing in foundational elements prior to integration efforts, and synthesizes the primary opportunities and challenges for institutional, physical, and digital integration including examples of best practices to date. We use this section to highlight systems across North America and Europe to showcase exemplary efforts or illustrate varied approaches. We argue that no single regulatory or institutional setting is required for a successfully integrated multimodal setting; different approaches and structures can foster success so long as they adhere to central objectives of ensuring affordable travel that is reliable across both time and space.

5.1. Foundational service, land use, infrastructure, and framing are needed prior to integration

The Framework shows that integration efforts are effective after four foundational conditions are met including high-quality public transport, dedicated micromobility infrastructure, supportive land uses, and issue framing. Without such conditions, individual integration efforts may support travel behavior change at the margin, but are unlikely to realize the larger scale travel behavior shifts that cities seek.

First, high-quality public transport service is foundational to successful integration efforts (G1, G5, O3). Decades of research emphasizes the importance of public transport service frequency, reliability, speed, and safety in encouraging transit use (Diab et al., 2015; Iseki and Taylor, 2010; Kosmidis and Müller-Eie, 2024; Loukaitou-Sideris, 2014; van Mil et al., 2021; Van Oort, 2011). Previous research also finds that transit trip characteristics including trip distance, route types (direct, transfer), and station type can influence combined bike-transit travel (van Mil et al., 2021), and that transit routes with greater frequencies attract more cyclists (Brand et al., 2017). Customer satisfaction, including the satisfaction of access and egress trips, is also associated with travel behavior and use of public transport (Susilo and Cats, 2014). Finally, price is inversely related to public transport ridership, with research documenting ridership declines when fares rise (Litman, 2004), as well as affordability challenges faced by people earning lower incomes (Perrotta, 2017).

Second, integration efforts will only be successful if supported by dedicated micromobility infrastructure, particularly travel lanes, availability of direct routes, and reliable access to vehicles, which research repeatedly finds critical to facilitating bike or e-scooter travel (G6, G10, G11, MM5)(Attard and Balbontin, 2024; Kosmidis and Müller-Eie, 2024; NACTO, 2024; Oeschger et al., 2020; van Mil et al., 2021). A *lack* of these can impede integration, multimodal travel, or use of either mode (Pucher and Buehler, 2009; Spierenburg et al., 2024). Sufficient parking capacity also play a role in micromobility adoption (Ghaffar et al., 2023). Research finds that more shared micromobility hubs with fewer shared vehicles contributes to greater time savings compared to fewer hubs with greater capacity (Xanthopoulos et al., 2024); greater shared micromobility parking density (with designated parking spaced about every 200 m) can also contribute to shared micromobility parking compliance (Brown et al., 2025). Additional trip (e.g., trip purpose, distance, weather, time of day, baggage) and person-level (e.g., age, gender, income, education) characteristics likewise affect both travel behaviors and adoption of public transport and/or micromobility (Kosmidis and Müller-Eie, 2024).

Third, both public transport and shared micromobility travel are facilitated by land uses, particularly compact and mixed-use use development, alongside the relative attractiveness of alternatives modes (e.g., taxes and policies that make driving expensive and inconvenient; modal attitudes) (G10, MM5, MM7) (Kosmidis and Müller-Eie, 2024; Pucher and Buehler, 2008). Research extensively documents how higher population and activity densities are positively associated with transit ridership (for *meta*-analysis, see Ewing and Cervero (2010)). Perceived and realized safety likewise plays a role in travel behaviors (Branion-Calles et al., 2019; Spears et al., 2013), facilitated by built environment features including street crossings, sidewalk quality, and lighting (Annear et al., 2014; Parajuli et al., 2025).

Finally, how shared micromobility is framed within the broader mobility ecosystem is critical to integration scale and success (G5, G6, G10, G12, MM1, MM5, MM9). Specifically: is shared micromobility part of the public transport network? A clear *yes* from leadership and stakeholders is needed to marshal necessary public resources, coordinate stakeholder goals and actions, and motivate the supportive policies to support a successfully integrated multimodal transportation system. Oeschger et al. (2020) argued that treating "micromobility and public transport as two interconnected aspects of the same system [is necessary] to fully harness the potential and the synergies of the two modes" (p.2). Shared micromobility operators similarly view themselves as integral to public transport, while many public official view shared micromobility as a single tile within a mosaic of transportation options (Bruening et al., 2025). Framing micromobility as public transport is crucial to systemwide policy and management approaches (G5), micromobility service model decisions (MM5), station siting efforts (G12), level and source of financial support or public subsidy (MM5) (Buehler et al., 2019; Northern Virginia Transportation Commission, 2025), the inclusion of micromobility in long-term and strategic plans and policymaking (MM9) (APTA, 2024). Framing shared micromobility as public transport also acknowledges that, like fixed-route public transport, regional transport networks include suburban and rural areas that are more difficult and expensive to serve, yet are critical to creating a cohesive system (Buehler et al., 2019). Conflicts can arise when framings are mismatched across stakeholders, such as when shared micromobility is tasked with serving a wide geographic area like public transport, but without a subsidy to operate in a low-demand area (MM5).

Interviewees from cities, public transport authorities, and shared micromobility operators held that shared micromobility was a form of public transport but also acknowledged that this frame was not universally held: elected officials, other professionals, or the public may not share the view that shared micromobility was a form of public transport (G5, G6, G10, G12, MM3, MM4, MM5) (APTA, 2024; Ferguson and Sanguinetti, 2023). Framing shared micromobility prior to integration is not static. Some interviewees observed public and professional framing of shared micromobility evolved over time from competition to a complementary part of the broader network (G12); Bruening et al. (2025) document a similar shift towards more systemic thinking about a mobility ecosystem among German, Austrian, and Swiss professionals. Leaders can spur re-framing, or perceptions nudged by integration efforts themselves. Physically co-locating or digitally linking shared micromobility and public transport can help in reframing (G12, MM1). Policymakers can evaluate how framing evolves over time by examining leadership language, spending patterns or priorities, and policy documents.

Framing shared micromobility and public transport as a cohesive mobility system may also help in reorienting broader policy priorities within an motonormative system, in which cars are judged less harshly relative to other modes and social, physical, and government environments disproportionately favor cars in terms of funding, policy, and public space (Walker and te Brömmelstroet, 2025). Research finds that combined bicycle and public transport travel is positively associated with car congestion and negatively associated with cheaper and more available car parking and car ownership (van Mil et al., 2021). In other words, investing in shared micromobility and public transport alone is unlikely to shift travel behaviors at the scales needed to achieve city goals without complementary policies that increase the time or financial costs of driving.

5.2. Institutional and physical integration are necessary, digital secondary, to achieving goals

Institutional and physical integration are both necessary to facilitate multimodal travel and create cohesive regional travel networks, while digital integration plays a secondary supportive role. Table 2 synthesizes the opportunities, challenges, and considerations for the different dimensions of integration identified through literature review and professional interviews for this research. This research does not seek to prescribe specific integration practices that every city or public transport agency should adopt. Instead, we identify broad imperatives within different integration practices, alongside concrete examples, that may guide cities in prioritizing their limited resources to maximize integration impact and success.

Institutional integration is critical to achieve a stable and reliable multimodal network across time and space. Institutional integration includes setting clear goals, identifying a leader, engaging stakeholders, sharing data, aligning micromobility ownership or contracts with public goals, and considering public subsidies to facilitate regional access. Each of these elements within institutional integration should orient back towards the primary goals of spatial and temporal stability and reliability. An effective leader, for example (whether a public transport agency, or regional governing body), should engage stakeholders from across industry, departments, and local municipalities to reflect local needs and context, and create sustained buy-in among stakeholders. Leaders can also enshrine integration within policy documents or pursue complementary investments such as dedicated travel infrastructure to support integration objectives. Shared micromobility ownership or contract models should likewise support long-term stable and reliable multimodal networks. Private micromobility operators offer greater flexibility to adapt to changing technologies or market demands, but both longer contracts and targeted public subsidies are needed to ensure predictable access for travelers. Longer-term contracts incentivize greater private investment, while public subsidies can offset higher costs of operating in less-dense or trip-rich areas (necessary to serve in order to create a reliable system across space) or extend affordable access to select traveler groups, such as people earning low-incomes. Such goals can be met through either private companies via permit (e.g., Grand Rapids, USA) or concession (e.g., Antwerp, Belgium). In other cases, public ownership represents an investment towards broader objectives. Mbugua et al. (2025), for example, find that the benefits from the Dutch public bikeshare system, OV-fiets, outweighs its costs by a ratio of 1.5 because it generates substantial societal value including health, accessibility, reduced maintenance, and environmental benefits. They argue, however, that measuring integration from a purely financial perspective fail to capture these broad benefits, and that operators or cities must be willing to accept operational losses to achieve wider goals, as well as foster system stability through financial or operational disruptions (Mbugua et al., 2025).

While cities have implemented a host of institutional approaches to date, integration efforts are ongoing and evolving. A "muddling through" approach can play an important role to test best practices for how concessions, management, and permitting approaches can impact integration (O3). To support iterative governance, cities should ensure that they design clear goal-centered evaluation criteria to examine how well (or not) a particular structure or program is meeting regional goals. Cities or transport agencies should ensure that data sharing or collection efforts align with data needed to evaluate goals; for example, cities that permit shared micromobility operators should consider administering annual micromobility user surveys with pertinent questions about integration, or including questions about micromobility within public transport rider surveys.

Like institutional integration, physical integration of shared micromobility and public transport either at stations or mobility hubs is critical to facilitate multimodal travel. While logistical hurdles—such as land ownership, permitting, and cost—exist to physical integration, two key aspects of physical integration exist: 1) reliable access to multimodal travel across space, and 2) streamlining transfer processes to decrease total travel times, which is critical to travelers' willing to combine shared micromobility and public transport (Montes et al., 2023). Washington, D.C. (USA) and Toronto (Canada) consistently co-locate bikeshare stations at metro rail stations, creating a predictable network for travelers. In the Netherlands, public bikeshare parking is located within train stations, reducing both the time and space needed to transfer between modes. In station-based shared micromobility systems, parking should also be designated throughout the service region—not just at public transport stations—about every 200 m to maximize both parking compliance and traveler flexibility (Brown et al., 2025). Mobility hubs can also provide connections tailored to community needs, and serve a wide combination of modes and amenities beyond large rail stations. The provinces of Groningen and Drenthe (Netherlands), for example, illustrate effective hub development, with dozens of unique mobility hubs that successfully leveraged multi-jurisdictional coordination and community engagement to create amenity rich multimodal hubs (Kask et al., 2022). Jelbi, the integrated transport service app operated by Berlin's (Germany) transport authority BVG, is likewise a leader in multimodal hub development, with several hundred multimodal hubs across the Berlin region.

Finally, digital tools can support integration but often require substantial resources, and face data sharing and privacy, feasibility,

Table 2
Opportunities, challenges, and considerations of institutional, physical, and digital integration approaches.

	Key Actors	Opportunities	Challenges	Additional considerations	Examples *(cities / programs)*
Institutional integration (Necessary)					
Identify clear goals	–Public sector (e.g., city, transport operator, regional government)	–Align efforts across different stakeholders to create buy-in and common purpose	–Stakeholders often have divergent or competing interests or priorities	–Goals should draw from and be integrated into broader regional planning or policy agendas to create sustained efforts	–Seattle (USA)
Leadership & stakeholder coordination	–Transport agency –City –Regional government	–Clear leader lends stability and facilitates disparate stakeholders	–Fractured jurisdictions across region creates complexities including different transport agencies and/or shared micromobility policies	–Leader is context-dependent (e.g., regional government, city, or transport agency): advantages and challenges exist with each –All stakeholders must be at table	–Chicago Department of Transportation (USA) –LA Metro (Los Angeles, USA)
Data sharing	–Public regulator –Micromobility operators –Transport operator	–Help to manage, grow, and improve services –Aid service planning or deployment to create comprehensive system	–Data privacy may limit sharing –Self-reported or irregular data may be insufficient to answer integration-related questions	–Data sharing must be bi-directional between transport operator and shared micromobility –Data should be standardized	–Examples of shared micromobility data sharing requirements catalogued by Staben et al. (2024)
Micromobility ownership					
Private	–Public sector (regulator) –Micromobility operators	–No upfront public investment required –Innovative	–Financial uncertainty can create risks for cities –Private goals may not align with public	–Following pilot period of experimentation, longer tender or contract period supports stability	–Baltimore (USA) –Denver (USA)
Public	–Public sector (owner + operator)	–Can foster stability through public leader and investment –Encourages integration of shared micromobility within city policy and infrastructure planning	–Budget constraints –Lack of institutional or political support	–Can be paired with private mobility to create different offerings	–BIXI (Montreal, Canada) –Capital Bikeshare (Washington, DC, USA) –Divvy (Chicago, USA) –Metro Bikeshare (Los Angeles, USA) –OV-fiets (Netherlands) –Toronto Bikeshare (Toronto, Canada)
Concession	–Public sector (regulator) –Micromobility operators	–Integrated service by design –Fosters data sharing	–Limited, recent applications in practice mean little is known about efficacy	–Iterative governance may support long-term goals	–Amstelland-Meerlanden (Netherlands) –Louvre (France) –Orlean (France)
Public subsidy	–Public sector	–Reduce costs to increase affordability and ridership	–Budget constraints –Public acceptability if subsidizing private operators	–Targeted subsidies to areas costly to serve or travelers with low-income may maximize impact	–See “Public ownership” systems above –Grand Rapids (USA) –Transportation Wallet (Portland, USA) –Rome (Italy)
Physical integration (Necessary)					
Co-locate parking at transit stations	–City –Transport agency –Private landowners –Micromobility operators	–Reduce transfer friction between modes to encourage ridership and first/last mile connections –Communicates that shared micromobility part of greater transport network	–Limited available parking locations at or near stations can require coordination with multiple landowners –Physical constraints at or around stations may also limit opportunities	–Who owns the station (and adjacent) land matters for co-location and coordination. Not all may have incentives to permit parking –Placement and signage matters	–OV-fiets (Netherlands) –Washington, DC (USA)

(*continued on next page*)

Table 2 (*continued*)

Mobility hubs	–City –Transport agency –Private landowners –Micromobility operators	–Attract new users and catalyze development, activities, and/or shift travel choices	–Need for clear leadership and political support to implement –Context-specific nature makes difficult to standardize	–Hub at locations already integrated into daily travel patterns attract more people –Need to engage community	–Berlin (Germany) –Groningen-Drenthe (Netherlands) –Vienna (Austria)
Mix and number of shared modes	–Public regulator	–Ensure choice for travelers with different needs and preferences	–No mix will meet all needs –Too many options can create confusion or uncertainty	–Mix may include power (electric vs acoustic), mode, or design (e.g., seated, cargo)	–Washington, DC (USA)
Co-branding	–Public regulator –Transport agency –Micromobility operators	–Visual connection between modes	–Confusing if physical branding disconnected from digital	–Service stability is more important than co-branding	–OV-fiets (Netherlands)
Digital integration (Supportive)					
Trip planning	–Micromobility operators –Transport operator –MaaS platforms	–Raise awareness of multimodal options and shift travel behaviors –Responsive to dynamic events (e.g., disruptions)	–Data sharing needed –Deep link integrations to pay for trips through different apps creates additional friction	–May be more important for occasional travelers rather than commuters	See "Combined fare" below –Citymapper –Transit
Payment integration	–Micromobility operators –Transport operator –MaaS platforms	–Reduce friction for users and need for multiple apps –Create more cohesive transport ecosystem	–Added data requirements and steps (e.g., account registration) create friction –Existing fare vendors may complicate integration	–Some agencies adopting open-loop technologies and seek to connect passes or subsidies to traveler credit/debit cards	–Metro Bikeshare (Los Angeles, USA) –OV-fiets (Netherlands)
Combined fare (e.g., one fare per multimodal trip)	–Micromobility operators –Transport operator –MaaS platforms	–Creates seamless multi-modal travel and payment options within single app –Can discount multimodal trips (e.g., don't have to pay bike unlock fee twice)	–Data privacy / sharing concerns –Desire to control customer relationship may limit buy-in –Substantial time and resource investment required to support initial and ongoing engineering	–Outstanding questions around feasibility, return on investment, and scalability	–GAIYO (Netherlands) –Rejseplanen (Denmark) –Ruter (Oslo, Norway) –WienMobil (Vienna, Austria)

and scaling challenges. Trip planning apps (e.g., Citymapper, Transit) can raise awareness of multimodal options and be useful for occasional travelers, but are less useful for habitual travel. Integrating fare payments can reduce the number of apps travelers need for a multimodal journey, but most integrated systems today (e.g., OV-fiets bikeshare (Netherlands); LA Metro Bikeshare (Los Angeles, USA)) still require users to complete additional steps including account and payment registration to use shared micromobility. Combining (and potentially discounting) fares so that travelers pay a single fare on a multimodal trip could solve fragmentation and increase competitiveness of public transport and shared micromobility compared to the car. While successful examples of MaaS exist (e.g., Gaiyo (Netherlands), Rejseplanen (Denmark), Ruter (Oslo, Norway)), many stakeholders question the investment required to bring end-to-end digital integration efforts to scale. Each type of digital integration, while supportive of overall mode shift and access goals, require strong physical and institutional integration to build upon (G1, G8, MM1, MM4, MM6, O3). Ralph (2025) theorizes that preconditions for cycling include safety, comfort, relative convenience, tools, and social approval; if one need is not met, people will not bike. If people will not bike (or scoot), they will also not make multi-modal trips combing shared micromobility and public transport. Under this "deal breaker theory of cycling", echoed by interviewee experiences, critical physical and institutional underpinnings must be met prior to travel behavior change. Sophisticated apps will not be used, for example, if shared micromobility vehicles are not reliably positioned nearby public transport stations, shared services have sporadic rather than stable availability, or fares are unaffordable.

6. Conclusion

Public transport and shared micromobility may be integrated across three pillars: institutional, physical, and digital. A synthesis of existing literature alongside interviews with 25 transportation and city professionals across Europe and North America demonstrate that foundational elements—high quality public transport, dedicated micromobility travel lanes, supportive land uses, and framing—are the cornerstone to successful integration. Beyond investments in these foundational elements, cities seeking to integrate public transport and shared micromobility should focus on institutional integration (leadership, data sharing, ownership/contracts, and public subsidy) and physically co-locating shared micromobility and public transport through dedicated shared micromobility parking at public transport stations or mobility hubs. Digital strategies (trip planning, payment integration, combined fares) can likewise support multimodal travel, but should follow, not proceed or be implemented in lieu of, physical and institutional integration efforts. Digital strategies also face questions of scalability, feasibility, and data privacy. Data integration should be pursued independently, but alongside institutional and physical integration.

This research fills the gap in existing research by synthesizing existing research with critical perspectives from stakeholders engaged in public transport and shared micromobility integration across continents. Research limitations likewise offer opportunities for future research. While this research proposes a framework of priorities for integrating shared micromobility and public transport, it does not attempt to quantify or measure the marginal effects of different integration efforts. Future research may model strategic choice behaviors, conduct social cost benefit analyses (see for example Mbugua et al. (2025)), or quantify the effects of integration efforts outlined in this research. In particular, more needs to be known about how evolving (and often experimental) institutional approaches affect integration efforts. Future research could, for example, seek to evaluate iterative approaches to public transport and shared micromobility integration within a single context—such as examining effects of integrating shared micromobility into public transport tendering processes—to digest and document how approaches and structural differences yield varying results in terms of integration costs, experiences, and goal-related outcomes like trip-making. This research also represents a snapshot in time against a backdrop of quickly evolving technologies and ongoing integration efforts. Additional research will be needed to evaluate integration efforts and priorities over time as the shared micromobility industry matures over medium and longer-term time horizons. Finally, this research cast a wide geographic net to synthesize literature and perspectives across North America and Europe. However, perspectives and findings here may not be generalizable to geographies beyond, or even within, these diverse continents. Future research could examine integration across additional contexts, such as suburban settings or car low developments to understand how integration efforts or outcomes may vary across space.

CRediT authorship contribution statement

Anne Brown: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Niels van Oort:** Conceptualization, Investigation, Methodology, Writing - review and editing.

Declaration of competing interest

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

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Appendix A. Supplementary data

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Data availability

The data that has been used is confidential.

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