



# Data ecosystem of tourism mobility: challenges and opportunities

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## Abstract

The development of smart tourism destinations increasingly relies on integrated tourism mobility services that combine digitalization and ecosystem collaboration. The article explores the concept and structure of the tourism mobility data ecosystem to enhance sustainable and personalized tourism experiences. We address the challenges of cross-sectoral collaboration between the tourism and transport sectors and the fragmentation of data and governance, and propose pathways for ecosystemic coordination and data standardization to realize advanced tourism mobility services.

The empirical material consists of ecosystem interviews conducted during the case project, as well as participatory observations carried out throughout its duration. Our research is grounded in the understanding of tourism mobility and its ecosystemic formation developed during the project. In the context of our study, tourism mobility is understood as the broad spectrum of movement that facilitates and constitutes tourism. This includes travel to and from the destination, as well as intra-destination mobility. The overall structure of tourism mobility emerges at the intersection of the tourism industry and mobility services. Despite appearing as an integrated whole, these sectors remain markedly siloed, both functionally and, more notably, administratively.

The insights derived from the data are reflected against our conceptual understanding of cross-sectoral ecosystems within the tourism mobility context. We concretize the results of our analysis through a case example, the Digital Travel Assistant, to construct a data categorisation needed in the development of digital tourism mobility services. Finally, we discuss how the tourism mobility ecosystem could be advanced through cross-sectoral and public-private collaboration.

*Keywords: Tourism mobility, data ecosystem, smart governance, digitalisation, data*

## Introduction

In the context of sustainable development and technological transformation, tourism research and policy have increasingly focused on the development of smart tourism destinations. Digital services, real-time data, and mobility management are seen as key tools for enhancing the tourism experience and strengthening regional competitiveness. At the same time, phenomena at the intersection of tourism and transport – such as digitalization, seasonal mobility, and resource sharing – call for new service design and ecosystem thinking.

Despite appearing as an integrated whole, the tourism and transport sectors remain markedly

siloed, both functionally and, more notably, administratively. This fragmentation is also reflected in the academic traditions of these domains, which often approach them from distinct disciplinary perspectives. For instance, research on digital development within both sectors has produced parallel discourses on smartness, each grounded in its own conceptual foundations and accompanied by a proliferation of related sub-concepts (Lusikka et al., 2025). Overarching thematic frameworks that attempt to bridge these discourses include smart tourism, smart mobility, smart destinations, and smart ecosystems (El Archi et al., 2023; Lusikka et al., 2025).

To knit together tourism and transport research, we comprehend tourism mobility as the broad spectrum of movement that facilitates and constitutes tourism. This includes travel to and from the destination, as well as intra-destination mobility. Tourism mobility is not merely a logistical necessity but can also be an integral part of the tourist experience, either as a means to access experiences or as an experience in itself. The realization of tourism mobility is contingent upon the availability and functionality of physical mobility services, supported by both physical and digital infrastructures. In contemporary society, digital accessibility, encompassing service discoverability, usability, and integration, has become a fundamental prerequisite for the effective delivery of mobility services, complementing their physical presence (Lusikka et al., 2025; Hakkarainen & Laamanen, n.d.)

Building on the theoretical foundation of user perspectives on tourism mobility makes visible the epistemological differences in the technical research of tourism and mobility services, that is, the starting points from which experiential knowledge related to mobility is interpreted. The technical design of existing mobility services is strongly based on research dealing with the psychological modelling of individual behaviour, where the individual is treated as a somewhat rational decision-maker when using services (Pihlajamaa et al., 2018). In addition, previous research has shown that the design of tourism digitalization is in many ways too production oriented. It focuses on technological efficiency and forgets the human orientation and the perspective of the tourism experience (Stankov & Gretzel, 2020). Customer understanding produced through tourism research, on the other hand, is based on the constructivist idea that reality is socially constructed and that individual experiences, lifestyles, and projects are flexible and always in relation to the surrounding society and culture (e.g. Koo, 2022; Mieli et al., 2024). The primary need in the technological development of tourism mobility services is to focus on a user-centred perspective combining the approaches of mobility services research and technologies with those of tourism research to produce next-generation traveller experiences (Haanpää & Hanni-Vaara, 2023).

In this research, we argue that integrating the knowledge and know-how of the two different sectors cannot be achieved without understanding their different approaches, actor roles, governance structures, and technological landscapes. Although research on smart tourism destinations has expanded in recent years, cross-sectoral and interdisciplinary ecosystem studies remain fragmented. The terminology used in different discourses varies widely, and the concept of a tourism mobility data ecosystem has not yet been systematically examined as a distinct entity. This lack of conceptual clarity hinders both academic inquiry and practical development efforts, which require clear models for actor roles, governance structures, and the integration of

technological solutions.

We address this gap by conceptualizing the cross-sectoral *tourism mobility ecosystem* and taking a deep dive into its sub-ecosystem *tourism mobility data ecosystem*. The research is grounded in empirical insights from the FIT ME! project (Foreign Individual Travelers' Hospitality and Mobility Ecosystem). The novelty of this research lies in its ecosystem-based approach that integrates the tourism and transport sectors and in its use of the *Digital Travel Assistant (DTA)* concept as a concrete case example. The article builds on the understanding of tourism mobility developed during the FIT ME! project and explores how service concepts such as the DTA could be realized through cross-sectoral collaboration. By examining the tourism mobility data ecosystem through the DTA example, it becomes possible to concretely identify what data is available, from which sources it can be accessed, and what kinds of actor relationships need to be formed to enable such service concepts.

The tourism mobility ecosystem is a multidimensional and dynamic entity where actors, technologies, data, and contexts are interwoven. Digital platforms and data utilization connect stakeholders across the tourism and transport sectors to co-create value. The ecosystem is built on information sharing, customer experience, and collaboration, while being shaped by location-specific factors, social trends, and regulatory environments. On the other hand, its sub-ecosystem, the tourism mobility data ecosystem, concentrates on creating value from data. It is a complex system of organisations, processes, tools, standards, and technologies aimed at providing smart capabilities for the ecosystem. In a sense, the tourism mobility data ecosystem represents the digital formation of the tourism mobility ecosystem.

We examine the ecosystemic development of tourism mobility and its sub-system tourism mobility data ecosystem through the case of the Digital Travel Assistant. The main research question guiding this article is: What are the practices and forms of ecosystemic collaboration that enable the realization of a DTA-type tourism mobility service? The sub-questions explore the following: (1) from what elements does a tourism mobility data ecosystem emerge and (2) what are the barriers and challenges hindering the realization of digital tourism mobility services and how can they be overcome?

The paper is structured as follows. First, we describe the methodological framework, our multidimensional data, and the stages of our theory-driven content analysis. In the theoretical framework, we synthesize ecosystem concepts in mobility and tourism research and present our own understanding of and contribution to the formation of the tourism mobility ecosystem. We present our empirical results using our case example, the DTA. We propose how the tourism mobility ecosystem could be approached through the tourism mobility data ecosystem and discuss the challenges and constraints involved. Finally, we summarize the results and present recommendations for further development and research.

## Data and Methodology

Our dataset comprised the full corpus of transcribed thematic ecosystem interviews, workshop reports produced during the project, and the researchers' own field notes collected throughout the project. The thematic ecosystem interviews included 14 interviewees, who represented the parties of the FIT ME! project consortium and key national-level stakeholders in tourism mobility. The interviewees held leading positions in their companies or were responsible for expert tasks in tourism mobility. The data included 249 pages of transcribed text, which was partially anonymized and partially pseudonymized. The collected interview material was rich and diverse.

During the FIT ME! project, the researchers used ethnographic participatory observation methods to gather information on the construction of the tourism mobility ecosystem and the pertinent co-development process in order to produce a comprehensive understanding of the operating environment (Haanpää et al., 2014, p. 288; Pritchard & Morgan, 2006, p. 771). The researchers participated in the project's events both as responsible organizers and as participants. The researchers mainly produced workshop and event materials, facilitated workshops, and produced event minutes and workshop reports for distribution to the event participants and for research use. This participation has generated valuable information about the operating cultures and practices related to the development of tourism mobility. The resulting understanding has enriched the research process and helped to anchor the discussion in the local context of the pilot areas and in the national framework. To ensure the objectivity of the data, the study involved continuous critical reflection on the researchers' own experiences and positions throughout the process. In addition, the study involved a continuous discussion on the perspectives of different disciplines and their impact on understanding the phenomenon.

The interview framework was built around five themes: the definition and actors of tourism mobility, the tourism mobility operating environment, the business ecosystem of the travel mobility platform, management and coordination of tourism mobility, and the FIT ME! project as a developer of tourism mobility. The data serves the research questions of the FIT ME! project and was particularly utilized in producing the project's main results: the comprehensive management model of tourism mobility and recommendations for tourism mobility data and development. The empirical research objective of this article was to advance the analysis by focusing on the tourism mobility data ecosystem through the lens of the Digital Travel Assistant case study.

We used theory-driven content analysis in the study. This method is well-suited for qualitative research when the aim is to deepen the understanding of a phenomenon and to condense and interpret large volumes of data (Erlingsson & Brysiewicz, 2017). In theory-driven content analysis, the researcher's interpretations and analytical process are guided by both an established theoretical framework and the empirical data itself (Tuomi & Sarajärvi, 2018, p. 113). The content analysis was conducted based on three main research themes: (1) the structural composition and key actors of the tourism mobility ecosystem, (2) the governance mechanisms and collaborative models enabling ecosystemic coordination, and (3) the implications of these dynamics for the development and management of the associated data ecosystem. The applied thematic delimitations enabled the reduction of the data and, in particular, significantly narrowed down the material collected through participatory observation. This reduction was especially necessary

in terms of the project's event and workshop materials and helped to focus the analysis on the most relevant parts of the field notes. The insights derived from the data were reflected against our conceptual understanding of orchestrating cross-sectoral ecosystems within the tourism mobility context, which integrates the tourism and transport sectors.

## The tourism mobility ecosystem framework

### Ecosystem approaches in the tourism and mobility sectors

In this chapter, we examine the way ecosystem terminology is applied within the tourism and mobility sectors. We then explore relevant academic discussions related to ecosystem research. Finally, we integrate these sectoral and disciplinary perspectives with general ecosystem research and present our own approach to understanding the tourism mobility data ecosystem.

The concept of “ecosystem” is widely used across the tourism and mobility sectors, yet its application remains fragmented and often inconsistent. In industry discourse, it can refer to anything from networks and projects to development programs. The concept is often introduced when attempting to explain cross-sectoral collaboration that transcends traditional industry boundaries, value chains, and clusters (Forsman-Hugg et al., 2022; Zuiderwijk et al., 2014). Despite this framing, research on cross-sectoral ecosystems has not yet emerged as a significant academic field.

In Finnish tourism policy, the term “tourism cluster” is commonly used, sometimes interchangeably with “ecosystem,” to describe the broader operating environment, including core industries, support services, and contextual factors (e.g., TEM, 2015; TEM, 2019; Lapin liitto, 2018). From a digital perspective, platform ecosystems have emerged to capture the interconnected nature of actors, technologies, and data (Alustatalous.fi, n.d.). In contrast to the tourism sector, the transport sector frames ecosystems through infrastructure and service provision, with concepts such as “smart transport system ecosystem” (LVM, 2017) and “digital mobility platform” gaining traction (Alustatalous.fi, n.d.).

The academic literature reflects similar conceptualizations and divergence between the sectors. The concept of a smart tourism ecosystem typically refers to a system leveraging smart technologies to create, manage, and deliver intelligent services and experiences. A defining characteristic of such ecosystems is the intensive sharing of information and the co-creation of value (Gretzel et al., 2015). Transport research, meanwhile, associates ecosystems more narrowly with digital services, such as the Mobility-as-a-Service (e.g., Guyader et al., 2021), smart mobility (Loos et al., 2020), shared mobility (e.g., Ma et al., 2018), urban transport (e.g., Mavlutova et al., 2023), and intelligent transport systems (e.g., Yuan & Wang, 2016).

However, like tourism research, transport research also employs the ecosystem concept to describe broader systemic structures. For instance, Ma et al. (2018) use ecosystem terminology to analyse the development of meso-level operational environments in the context of shared mobility. Loos et al. (2020), in turn, highlight the influence of megatrends, policy and regulation, and the academic context as key factors shaping ecosystems.

According to Gretzel et al. (2015), a smart tourism ecosystem comprises a diverse set of actors, including tourist and resident customers, travel providers and intermediaries, support services (e.g., payment systems, telecom operators), platforms and media (including social media), regulatory bodies, NGOs, transport services, tourism technology and data companies, consulting services, tourism and residential infrastructure, and businesses from other sectors (e.g., retail, healthcare). Similarly in transport and mobility, an ecosystem is a network of actors connected to a specific service, application, or platform, all of whom are necessary for delivering a complete service offering to the end user (Arias Molinares & García-Palomares, 2020). However, the term may also refer to the networked system formed by the underlying technology itself (e.g., Yuan & Wang, 2016), not just the group of actors providing its components.

### The tourism mobility ecosystem framework

Beyond sectoral definitions, broader ecosystem frameworks – such as business ecosystems, digital ecosystems, and data ecosystems – highlight the fluidity of boundaries and the integration of actors across domains (Zuiderwijk et al., 2014; Oliveira et al., 2019). In this research, the tourism mobility ecosystem is understood as a multidimensional and dynamic entity where actors, technologies, data, and contexts are interwoven. The concepts of platform economy and data ecosystems provide tools for understanding how digital platforms and data utilization connect actors across the tourism and transport sectors to co-create value (see Oliveira et al., 2019).

The framework of tourism mobility ecosystems combines perspectives from different ecosystem discussions by examining how different actors (tourists, service providers, technology companies, public sector actors) participate in the formation and preservation of the ecosystem rather than examining industry-specific technology platforms, service networks, and regional development environments. The value creation of the ecosystem is based on sharing data and information, focusing on the customer experience, and co-creation. Different technologies, digital platforms, data spaces, and smart systems enable value co-creation in the ecosystem. Furthermore, the framework accounts for the location- and context-specific nature of tourism mobility, with various social trends, regional differences, and the regulatory environment, among other factors, influencing the ecosystem's development.

Figure 1. Framework of tourism mobility (Lusikka et al., 2025).

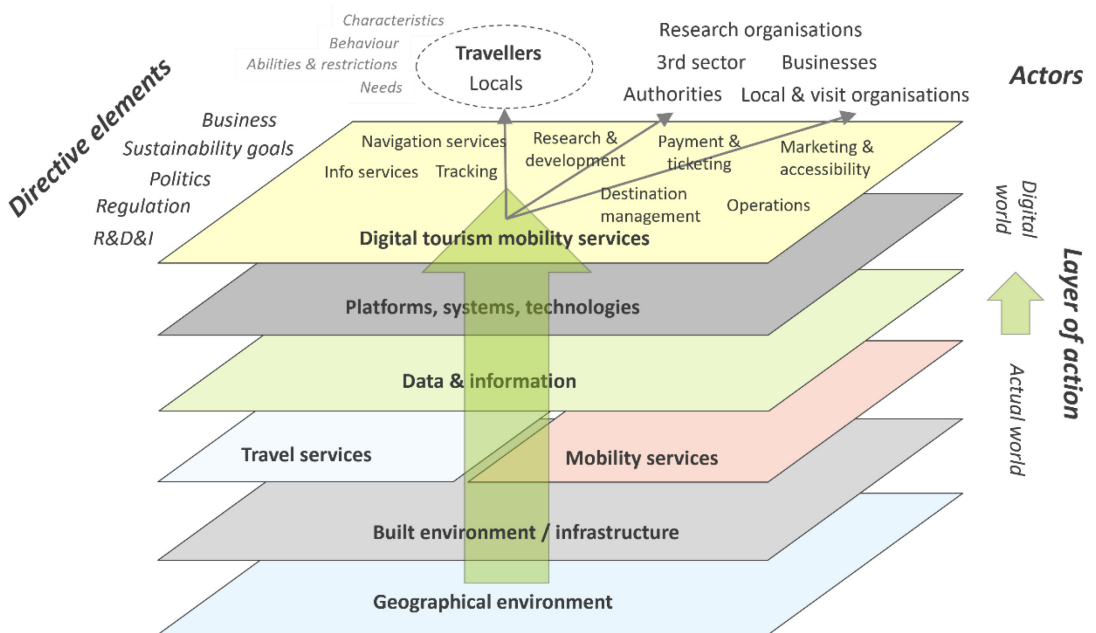


Figure 1 (as depicted in Lusikka et al., 2025) shows the tourism mobility ecosystem as a layered structure that combines guiding elements, actors, and levels of action. At the highest level, the development of the ecosystem is guided by elements such as business objectives, sustainability goals, policy, regulation, research and development, and innovation actors. Key actors include tourists, service providers, local residents, destination management actors, authorities, research organizations, and third-sector operators.

The ecosystem is organized into interconnected layers: (1) Digital tourism mobility services (e.g., navigation, information, tracking, payment, ticketing, destination management), (2) platforms, systems, and technologies, (3) data and information, (4) travel and mobility services, (5) the built environment and infrastructure, and (6) the geographical environment. These layers span from the digital world to the actual world, emphasizing how technologies, data spaces, and smart systems enable value co-creation through data and information sharing, with a focus on the customer experience and multi-actor collaboration. The figure highlights the dynamic interplay between actors and technologies within location-specific contexts shaped by social trends and regulatory frameworks.

However, we see that the ecosystem framework is currently only a theoretical and generic – albeit comprehensive – depiction of the operating environment. The ecosystem and the interconnected network of actors is mostly visible in digital services where the diversity of actors is observed by accessing different booking and reservation websites while making the travel itineraries. Thus, we think that the core of the future tourism mobility ecosystem builds on digital technologies and a tourism mobility data ecosystem enabling service interoperability and the utilization of data to produce next-generation services for future travellers seeking new,

personalised, and immersive experiences.

## Mapping the tourism mobility data ecosystem

### Digital Travel Assistant case study

To examine the tourism mobility data ecosystem, we use the Digital Travel Assistant (DTA) application prototype (Lusikka et al., 2025) as a case example. Understanding the diversity of traveller profiles and consumption habits is essential in designing inclusive and responsive tourism mobility services that enhance the discoverability and accessibility of destinations. Thus, the described DTA use case is founded on gathered research data on stakeholder needs and desires based on their customer understanding.

The DTA represents a novel approach to personalized and sustainable tourism, particularly in sparsely populated areas where access to public transport and local services is limited. From the traveller's perspective, the DTA offers a seamless and intuitive way to explore destinations based on personal interests and values. Whether seeking cultural experiences, nature adventures, or local cuisine, the DTA curates recommendations and guides the traveller through each step of the journey. It provides real-time updates, helps navigate transport hubs and attractions, and allows for flexible itinerary adjustments (Lusikka et al., 2025).

For the traveller, the DTA is not just a digital tool, it is a smart companion that simplifies travel planning, enhances the experience, and supports environmentally conscious choices, especially in areas where services are otherwise difficult to access. The DTA integrates diverse data sources containing mobility patterns, consumer behaviour, personal preferences, and social media activity and offers tailored recommendations and real-time guidance, enabling travellers to adjust their plans dynamically in response to changing conditions. While technological solutions for integrated tourism mobility services exist and have been successfully implemented in urban contexts, their adaptation to rural and remote destinations remains underdeveloped (Lusikka et al., 2025).

### Enabling data-driven tourism mobility

Even though the described DTA use case fulfils most of stakeholder needs, it is clear that there is no such service available yet. Our research shows that multiple actors in the tourism and mobility sectors want to have such a service or a similar one but are powerless or unable to create it for several reasons. There are commercial services that capture part of the elements of this type of service, but they tend to focus on one sector only or, if they cover both mobility and tourism, they are more likely to provide information and not sell the whole package (e.g. so called Super Apps that combine different apps but do not actually provide a full single-app experience). Commercial services providing also in-app purchasing tend to focus on creating closed platforms and ecosystems, which leads to an unfavorable situation from the travellers' point of view.

In Europe, authorities and governmental organisations have made efforts towards enabling such services by creating regulations, guidelines, and/or databases and providing funding to empower actors to make their data available and shareable (DSSC, n.d.). However, there is a gap between actions taken in the tourism and mobility sectors. For example, in the mobility sector,

the Finnish Government created in 2017 the Transport Services Act that forces every transport operator to open their service data and sales API for single tickets to everyone who wants to resell them. In addition, it is mandatory for operators to provide the metadata of their services to the Finnish national open transport service catalogue, which is provided and governed by the state-owned company Traffic Management Company Fintraffic Ltd. The purpose of the legislation is to open the mobility market and create new digital services for end users.

In the tourism sector, there is no such regulation to open sales APIs or any service data to others. However, Visit Finland has created a database service called Visit Finland Datahub that enables businesses to provide similar metadata about their services in order to form a comprehensive view of the offering of the Finnish tourism sector. Based on our research, the Datahub has been used mainly for marketing purposes. Furthermore, the European Union has established multiple data-related regulations in the past years and established programs and strategies to enable sustainable data economy in the Member States. A closely related example of the European actions concerning Finnish endeavours is the Common European Data Spaces. These data spaces aim to “collectively create a data sovereign, interoperable and trustworthy data sharing environment, to enable data reuse within and across sectors, fully respecting EU values, and supporting the European economy and society” (DSSC, n.d.).

Although there have been several actions to enable data-intensive services, it seems that in most cases the cross-sectoral view is often lacking, and data availability, standards, and stakeholder needs are considered from a limited perspective only (Lusikka et al., 2025). Looking into these issues on a sectoral basis creates obstacles when trying to utilize, combine, and fuse data from different sources. Furthermore, established ecosystems and their key actors benefit from the situation, as it is difficult for new competitors to enter the market when large ecosystem actors have already laid down the rules in their favour. However, our research suggests that at least in Finland there is a common interest between market players and governmental organisations to develop tourism mobility, but for one reason or another, they all lack the ability to improve the situation. Thus, we argue that enabling DTA-like services requires a more comprehensive and boundary-spanning view, joint cross-sectoral activities, and methods focusing more on end-user understanding in phygital interfaces of different sectors.

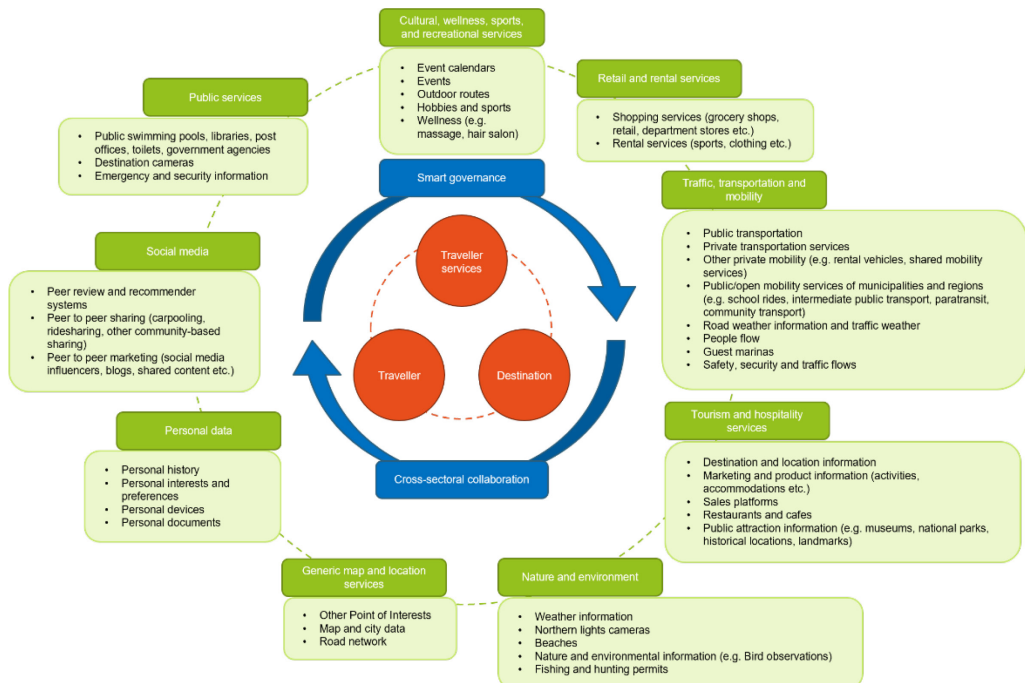
As a first step towards DTA-type services, we mapped the tourism mobility data ecosystem in Finland and categorized the research data. In following chapters, we investigate the data needed to provide the services, map the data ecosystem, and analyse the ecosystem to provide detailed information on the challenges and barriers, opportunities, and requirements related to developing tourism mobility and digital services.

## Tourism mobility data ecosystem

To advance tourism mobility in its entirety, we utilize the DTA as a case study to describe and analyse the tourism mobility data ecosystem. As described in the case study chapter, DTA-type services offer multiple functions to its users. Providing these functions requires a great deal of information. To generate this information, many datasets, data sources, and digital access points must be obtained from individual ecosystem actors. In addition, to provide full-experience DTA-type services, it is necessary to integrate different platforms, systems (sales and booking), and payment services. However, in this article, we only focus on the data and information needed to provide the DTA service. We exclude the other identified technological layers (see Figure 1), as information on accessing and utilizing different sales, booking, and payment APIs should be part of the datasets provided by the ecosystem actors. Hence, we consider the Data & Information layer (see Figure 1) the most important element in creating and providing any digital service.

The central factors in designing the DTA are obviously the traveller, the services they need, and the destination providing basic hospitality functions. Using the travellers' needs as a starting point, we identified nine data categories and 38 possible data sources, which we further divided into data products needed to create the DTA. In addition, we identified ecosystem actors involved in the respective data sources. The table compiling all these findings is provided in Appendix 1. Figure 2 below provides summary of the table, focusing on the central factors (red circles), data categories (dark green boxes), and data sources (bullet points in light-green boxes).

**Figure 2.** Data categories and data sources of the tourism mobility data ecosystem (summary of Appendix 1).



As seen in Figure 2 and Appendix 1, numerous data sources are needed to provide a comprehensive DTA service for travellers. Some data might be considered a must-have in providing basic functions and fluent traveller experiences, while other data is needed to provide nice-to-have functions. For example, it is necessary to provide information about public transport or other transport services and accommodation for travellers to be able to complete their journey. On the other hand, for example, queue data from airport security checkpoints is not a necessity but it would make the travel experience more comfortable if travellers knew that they can board their plane in time.

In addition to necessary data, a DTA service could also produce data for the ecosystem. When travellers use the service, they could give consent to producing and using data about their mobility, consumer behaviour, preferences, interests, and social media activity. This would enable the creation of better traveller experiences while utilizing the data to develop the ecosystem offering to better match traveller needs and interests. Furthermore, the data could be used to create personalised itineraries and to suggest suitable services for the traveller, while automatically customising services based on user preferences.

As already stated, the data needed depends on the value proposition of the DTA service. For example, if the service targeted mountain bikers, it would not necessarily need to include bird observation and sightings in its service. On the other hand, outdoor routes and trails used by mountain bikers would be very useful information for bird watchers seeking suitable paths to potential bird locations. Thus, as the needed data varies depending on the actor's preferences, it is challenging to map all the relevant data, its owners and producers, and the relationships between the actors connected to the tourism mobility ecosystem. While our research data suggests that many actors would appreciate a digital one-stop-shop service providing everything and fulfilling all customer needs, it has also been argued that such a service would become so massive that all the data and information would ruin the user experience. The purpose and value proposition of the service should therefore be very well defined.

As DTA-type services are aimed at fulfilling most customer needs, the user experience of the services should be carefully considered and technical solutions should be employed to utilize the personal data of travellers for outlining the data and information offered to the individual traveller. Offering such a service targeting multiple customer segments and groups would require incorporating as many data sources and data products as possible. However, our research shows that all the required data is not yet available or accessible. There are gaps between the ecosystem actors and there are data quality issues hindering the usability of data. Furthermore, combining data from multiple industries and sectors can cause technical compatibility issues as well as governance and business-related challenges. Thus, creating such a service requires a functioning data ecosystem of tourism mobility. In the following chapters, we discuss these challenges, barriers, opportunities, and requirements as well as the way the challenges and barriers can be overcome.

## Challenges and barriers in the tourism mobility data ecosystem

The phase of ecosystem formation can be vague or obscure if all actors are still seeking their role, developing offerings, and forming relationships. In addition, regulation may be under development or even absent, as in a recent case concerning the electric scooter business. Our research also shows that when it comes to tourism and mobility, there are challenges or even barriers related to regulation, as the two sectors have different sets of rules, governing organisations, interpretations, technological systems and capabilities, and ways of working, which sometimes lead to overwhelming bureaucracy and contractual difficulties.

For example, if we take the DTA as a practical example of creating a tourism mobility service, the regulation related to travel service combinations (Act on Travel Service Combinations) imposes heavy requirements on an actor creating and offering a combination of services. It makes the actor responsible for other businesses participating in producing the combination, and liability cannot be transferred to the businesses providing the actual services. Obviously, this means that the actor offering the combination should make sufficient contracts with the other businesses and hold contractual power if there are issues in performing the travel service. However, based on our research data, these obligations mean that not everyone is capable of creating such services. The requirements hinder the new service development and make it hard for newcomers to establish their services in a market already dominated by customary travel agencies. Nevertheless, the regulation is made for protecting travellers, which is a positive thing from the customer's point of view. Thus, it would be beneficial for newcomers (e.g. start-ups, SMEs) and non-profit organisations (e.g. some DMOs) if liability could be transferred to another actor (e.g. to insurance company).

Furthermore, our research suggests that there are governance issues (ownership, responsibility, funding) related to the development of tourism mobility. As tourism mobility by definition already combines two different sectors and two administrative sectors, there actually is no ownership regarding traveller accessibility, because in Finland, *tourism* falls under the administrative sector of the Ministry of Economic Affairs and Employment and *mobility* under the administrative sector of the Ministry of Transport and Communications. One of the study's informants also suggested that if the problem involves a lack of ownership, there is no problem to be solved.

We, however, argue that travellers and end customers are the owners of the problem, but they cannot solve the issue, as they are a scattered group of prosumers, while businesses and administrative organisations are responsible for creating propitious conditions for them. The situation is actually very similar to what Angel & Benjamin (1976) refer to as "the principle of somebody else's problem" in their article on low-income housing issues in the public sector. They argue that there is an entrenched structure that militates against accepting responsibility for solving the problem, as all administrative branches of government have strict, defined responsibilities and cannot overstep their authorities. Furthermore, they argue that the problem is multisectoral (land, housing, economic, legal, and social) and thus the issue falls outside every organisation's jurisdiction. And as governmental organisations have well-defined responsibilities, even those who would want to overcome issues are not able to do it. Different levels of the public

sector (city, region, national) disagree about responsibilities, resources, and courses of action.

In the context of tourism mobility, public organisations have their own political steering, strategies, and goals based on agreements with higher levels of government. However, in many cases public organisations also lack funding to fulfil their strategies. Two of our interviewees also mentioned that the public sector could have a natural role to “own the problem”, but as they lack funding for it, it is not possible to take the responsibility. Furthermore, it seems that politics and regional policy also play major roles in the development of tourism mobility, which can cause uncertainty in both industries. It was also noted that although the public sector produces many reports on the development of mobility, the actual progress has been minimal or non-existent.

In both sectors, the role of public actors is significant, but national governance differs a great deal between the sectors. The structure of the tourism sector differs from other sectors because of strong regional actors (destination management and marketing organizations, DMOs). The role of regional DMOs is central, and they have various ownership bases (commercial, public organizations, associations, and PPP models), but they are often perceived as public actors regardless of their background. DMOs are also often grouped together without considering that their backgrounds in different regions are distinct and that different regions have divergent needs. DMOs also operate on various purposes: some are marketing/sales channels, while others engage in many other operations, such as coordination of regional mobility (Lusikka et al., 2025). Furthermore, the tourism sector encompasses vast amounts of SMEs that operate individually and might not act as part of or in collaboration with the local DMOs.

In transport and mobility, there is strong national governance and major regional and local organisations are in charge of organizing public transport. Only a relatively small part of public transport is organized by private transport operators, and they operate on behalf of the public organisations who organise the majority of the public transport in Finland. However, there is a substantial amount of private transport operating on shuttles, taxis, rental vehicles, and shared mobility. So, the presence of private actors is strong even though many of the large actors are publicly owned organisations.

In addition to the obstacles in the public sector, our research also showed that commercial and half-commercial organisations see many challenges hindering the development of tourism mobility. One of them is seasonality, which affects the availability of public transport in sparsely populated areas. Seasonality is a supply-demand problem. In Lapland, for instance, there is a slowly growing demand for summer tourism, but only a few destinations offer tourism services. And as summer is also a holiday period for locals, there is no public transport travellers could make use of. Due to limited funding and the well-defined purpose of public transport (it is mainly organized to serve the locals), public transport is seldom organized to serve travellers, which leads to a situation where a demand for such tourism service might exist but there are no means to meet it. One could argue that the tourism sector should therefore provide or organize the transport service. In some cases, they do provide it, for example, as a private shuttle not serving locals or other businesses but only their own customers. There are also rare cases where tourism companies organize transport services that are available for all similar to traditional public transport (e.g. Apukka Shuttle Bus).

The public sector also has a significant role in both tourism and transport, which leads to high expectations, according to which the public sector should always take care of or take responsibility for certain issues. This hinders the possibilities of commercial organisations to advance issues, as they do not possess a mandate to coordinate transport and everyone expects the public sector to step in. Commercial organisations also have competitive business interests that can hinder development. Furthermore, legislation on competition can also create obstacles for close collaboration between different companies aspiring to advance the market and services provided for travellers.

Other challenges and barriers reported by commercial organisations relate to digitalization. The participants in the study reported deficiencies in the following: digital expertise and capabilities in both companies and public organisations, financial capabilities and the pricing of digitalization, customer acquisition to new digital services, business models of digital services, and cross-regional and cross-modal data. One major challenge or barrier mentioned was compatibility standards for digital services, which are needed but impossible for small businesses or regions to create. On the national level there could be enough attraction, but as we are looking into digital services intended especially for international travellers, it was mentioned that the national level is not applicable, and the development of standards should instead be based on international collaboration. Moreover, it was reported that such development should be based on open consortiums, because if they are developed and established by commercial organisations, there are likely to be multiple closed and/or limited options competing for the market.

Our research data suggests that there should be a keystone organization that would take responsibility for coordinating tourism mobility on a national level to overcome the issues described. Notably, the respondents stated that there should be “someone who would drive the issue forwards”, “someone who would coordinate and lead”, “someone should gather actors together”, and that “there is no one who coordinates”. However, as our research addressed real-time ecosystem formation, we have noticed that there is no keystone actor that would single-handedly drive the ecosystem formation. There are several organizations that could be the keystone, but they all lack the ability, willingness, or power to confront the aforementioned challenges and barriers. Thus, it seems unlikely that there would be (at least in near future) “someone” that would take on the responsibility for coordinating tourism mobility development.

### The tourism mobility data ecosystem: opportunities and requirements

Despite the challenges and barriers, there seems to be a need and willingness in Finland to develop tourism mobility towards a more sustainable and user-centric future. The most frequent comment on the creation of the tourism mobility ecosystem was that it would be very beneficial to have a lasting ecosystem where the most important actors could discuss with each other outside various research, development and innovation projects. The ecosystem should have enough actors involved (critical mass to hold the ecosystem together) so that they can define the purpose and goals of the system based on common challenges and create solutions to overcome the challenges. The ecosystem members should also have shared goals and rules, and only those members who share the goals and accept the rules would be included in it. However, the ecosystem should cut

through both sectors and include both private and public organisations on the local, regional, and national levels. The shared goals should also be prioritized in each member organization to ensure that the organisations are committed to solving the common challenges and overcoming the barriers.

From a product development point of view, DTA-type services are considered very welcome. It is difficult for users to find routes, public transport, and other services. It makes sense that many travellers use travel agencies and ready-made travel service combinations, as the combinations are easy to purchase and there is a responsible party taking care of customer service during the whole trip and providing assistance if needed. DTA-type services would, however, provide more possibilities to tailor services cost-efficiently to specific customer needs. They would also allow customers to select public transport and route guidance options often lacking in ready-made travel service combinations that usually lean on shuttle buses and/or rental car services. It was also noted that if such a service reached the market, it would have a significant demand-driving effect.

Furthermore, building DTA-type services requires solving some technical challenges. However, our research suggests that the technology and needed solutions are already on the market or can be developed. What is actually needed and what hinders deployment of the technology relates to governance, as there are no requirements for data availability and quality. Furthermore, the processes and practices needed to create, share, and maintain data are as various and fragmented as the industries themselves. The life-cycle maintenance of data is in many cases filled with holes, and organisations are not putting enough resources into data management and governance. By investing in data and solving data availability, quality, and compatibility issues through close collaboration between public, private and third sector actors, it is possible to gain a whole new generation of travel technology and services providing modern user experiences for travellers.

## Discussion and conclusion

This study explored the Finnish tourism mobility data ecosystem as a foundation for developing DTA-type services. By mapping the ecosystem, we identified data categories, potential data sources, and key actors (Figure 2), and the critical role of the Data & Information layer (Figure 1) in enabling digital tourism services. While the technological solutions largely exist, the ability to create integrated, user-centric services depends on overcoming governance, regulatory, and structural challenges.

Our findings reveal that the formation of the ecosystem is complex and fragmented. Regulatory frameworks differ between the tourism and mobility sectors, creating contractual and liability barriers that limit new entrants and favor established actors. The responsibilities are divided across administrative domains, resulting in ownership and coordination gaps. This fragmentation is compounded by seasonality, limited public transport in sparsely populated areas, and competitive interests that hinder collaboration. Both public and private actors face resource constraints, a lack of digitalization expertise, and high costs, while interoperability standards remain underdeveloped. Furthermore, expectations that the public sector will assume

responsibility discourage private initiatives, yet public organizations often lack funding and a clear mandate to lead the development of tourism mobility data ecosystem.

Despite these challenges, the opportunities for development are significant. Stakeholders express a strong willingness to advance tourism mobility towards a sustainable and user-centric ecosystem. A lasting, cross-sectoral structure with shared goals, rules, and commitment between public and private actors is essential at the local, regional, and national levels. DTA-type services are considered very valuable for improving accessibility, personalization, and cost-efficiency, with potential to drive demand and enhance competitiveness. However, governance issues, such as fragmented data practices, a lack of standards, and insufficient investment in data quality and lifecycle management, remain key obstacles. Addressing these through coordinated action, international standardization, and open consortium-based development could unlock a new generation of travel technologies and services, delivering modern user experiences and strengthening Finland's position in sustainable tourism mobility.

### Insights into the management and practical development of the ecosystem

Based on our research, we argue that overcoming the obstacles requires a functioning tourism mobility data ecosystem. No single organisation can tackle all the obstacles alone, and therefore several stakeholders need to take action. Our research shows that there is a need for government intervention, as ownership of tourism mobility must be assigned to an organisation with sufficient funding and a mandate to coordinate tourism mobility development as a whole. The creation of a functioning tourism mobility data ecosystem would enable public, private, and non-profit organisations to develop new services, advance their interests, and provide better service to travellers. It would also allow commercial organisations to advance their interests through a coordinating entity. However, this would require all actors to participate in coordinated efforts, for example, by investing in the formation and activities of the ecosystem.

Our research also suggests that regulation related to tourism mobility may favour large, established organisations and create obstacles for smaller, non-profit organisations looking to generate new, innovative services. It would therefore be beneficial to revisit regulation such as the Act on Travel Service Combinations so that liability could be transferred to an actor with the financial capability to support the creation of innovative digital services. Further research into data-sharing initiatives may reveal other regulatory implications, as governance, rules, and standards are needed to ensure the compatibility of data when creating functioning digital services. Close collaboration between public, private, and third sector actors to solve data availability, quality, and compatibility issues would enable the development of a whole new generation of travel technology and services that provide modern user experiences for travellers.

This research also provides a comprehensive data table presenting a categorisation of data sources and actors needed to form the data ecosystem. To our knowledge, this is the first table of its kind, and it has potential for use in both academic and practical endeavours. All ecosystem members can use this data table to create their services and to form the partnerships needed to advance digital tourism mobility services, while academics can use the table as a basis for further data ecosystem research.

## Further research directions

Future research should focus on two critical areas. First, there is a need for the development of smart governance frameworks, regulation, and coordination mechanisms that enable cross-sectoral collaboration, clarify responsibilities, and establish shared rules for data management and interoperability. Second, the culture of digital development in the tourism industry, including readiness, skills, and resource allocation, requires deeper investigation. Understanding how to foster digital capabilities and collaborative practices across diverse actors will be essential for building a resilient and innovative tourism mobility ecosystem. In addition, particularly when developing practical applications, it should be noted that the data classification and data sources described in this article are not necessarily all-encompassing and may not fulfil all existing needs, but they describe the extent and characteristics of the tourism mobility ecosystem based on our research data.

Furthermore, the international standardization model for tourism service information must be investigated further. One potential pathway towards such a model could be based on the common European data spaces (for European tourism data spaces, see, e.g., European Commission, 2023). Especially business models are mostly missing in the data spaces, while our research shows that it is difficult to create sustainable travel services that combine services provided by private and public organisations with very different business models and operational logics. The fact that different organisations and industries prioritise different needs and do not discuss them together will most likely lead to technological and business-related compatibility problems.

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## Appendix 1

Table 1. Data categories, data sources, data products, and respective ecosystem actors.

Category	No. of data source	Data source	Data product	Examples of ecosystem actors
Traffic, transportation and mobility	1	Public transportation	Timetables, routes and stops, service availability, capacity, prices, accessibility, real time transport information (disruptions, trip updates, vehicle locations)	Public Transport Authorities, Public Transport Operators, Traffic Management authorities
	2	Private transportation services	Timetables, routes and stops, service availability, capacity, prices, accessibility, real time transport information (disruptions, trip updates, vehicle locations)	Waterborne, airlines, taxi, ski bus, shuttle bus etc. Operators
	3	Other private mobility (e.g. rental vehicles, shared mobility services)	Service availability, pricing, capacity, accessibility, real time transport information (disruptions, trip updates, vehicle locations)	Other private mobility operators: rental vehicles, shared mobility operators, micromobility operators
	4	Public/open mobility services of municipalities and regions (e.g. school rides, intermediate public transport, paratransit, community transport)	Timetables, routes and stops, service availability, capacity, prices, accessibility, real time transport information (disruptions, trip updates, vehicle locations)	Municipalities, regional authorities, Public Transport Authorities and Operators
	5	Road weather information and traffic weather	Weather information, roadside unit information, road cameras, sea forecast	Traffic Management authorities, Weather information service providers, Road maintenance operators
	6	People flow	Airport security check flows, rush hours on stations and bus stops	Airport operators, public transport operators and infrastructure managers
	7	Guest marinas	Service availability, equipment and facilities, pricing, accessibility	Municipalities, Private marina operators
	8	Safety, security and traffic flows	Road and traffic management cameras, traffic flow/ vehicle calculation data, real-time traffic monitoring data	Traffic Management authorities, Public Transport Authorities and Operators, Airlines, Airports, Emergency services
Tourism and hospitality services	9	Destination and location information	Place and destination description, accessibility, research data on areas	DMOs, municipalities, tourism service providers, aggregators
	10	Marketing and product information (activities, accommodations etc.)	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Tourism service providers, Visit Finland Datahub, DMOs, Aggregators
	11	Sales platforms	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Online Travel Agencies, DMOs, Peer-to-Peer platforms, Distribution channels
	12	Restaurants and cafes	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Restaurants, Map and location data providers, Table booking providers, aggregators
	13	Public attraction information (e.g. museums, national	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Museum agency, municipalities and cities, forest administration, DMOs, aggregators

		parks, historical locations, landmarks)		
Social media	14	Peer review and recommender systems	Peer reviews, recommendations	Peer review and recommender system operators
	15	Peer to peer sharing (carpooling, ridesharing, other community-based sharing)	Product description, service availability, capacity	Social media platforms, peer to peer platforms
	16	Peer to peer marketing (social media influencers, blogs, shared content etc.)	Recommendations, stories of destinations	Social media platforms
Cultural, wellness, sports, and recreational services	17	Event calendars	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Aggregators, event organisers, ticket retailers, DMOs, municipalities
	18	Events	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Event organisers, ticket retailers
	19	Outdoor routes	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Forest administration, municipalities and cities, tourist areas, museum agency, Commercial and open route and hobby platforms
	20	Hobbies and sports	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Commercial and open route and hobby platforms
	21	Wellness services (e.g. massage, hair salon)	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Service providers, booking providers
Retail and rental services	22	Rental services (sports, clothing etc.)	Product description, service availability, pricing, accessibility, opening hours, location information	Rental service providers, map and location data providers, aggregators
	23	Shopping services (grocery shops, retail, department stores etc.)	Product description, service availability, pricing, accessibility, opening hours, location information	Shops, shopping malls, map and location data providers, aggregators
Public services	24	Public swimming pools, libraries, post offices, toilets, government agencies	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Municipalities, local, regional and national authorities
	25	Destination cameras	Camera feed	Destinations, cities, private feed providers
	26	Emergency and security information	Emergency aid and crisis communication, adverse weather information	Local, regional, national and global authorities, Weather information providers
Nature and environment	27	Weather information	Weather information, weather warnings and announcements	Weather information providers
	28	Northern lights cameras	Weather information	Weather information providers, Space agencies, private service providers
	29	Beaches	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Infrastructure operator and authorities, community-based map and location providers, private map and location service providers
	30	Nature and environmental information (e.g. Bird observations)	Location information, species information, nesting areas, habitat range, environmental information	Environmental centre, Luke, universities, bird watching communities

	31	Fishing and hunting permits	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Retailers, Forest administration
Generic map and location services	32	Other Point of Interests	Product description, service availability, pricing, accessibility, capacity, opening hours, location information	Infrastructure operator and authorities, community-based map and location providers, private map and location service providers, aggregators
	33	Map and city data	Accessibility, opening hours, location information, disruptions	Infrastructure operator and authorities, community-based map and location providers, private map and location service providers, aggregators
	34	Road network	Accessibility, location information, disruptions	Infrastructure operator and authorities, community-based map and location providers, private map and location service providers
	35	Personal history	Browsing history, purchase history, calendar, emails, tickets and bookings	Traveller
Personal data	36	Personal interests and preferences	Notes, files, playlists, social media	Traveller
	37	Personal devices	Location and mobility data	Traveller
	38	Personal documents	Identity, certificates, special needs, age	Traveller