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# Reimagining the role of hub airports as multimodal transport hubs in a sustainable future

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Aniek Toet is a PhD candidate at Delft University of Technology, embedded within the Royal Schiphol Group. Her research focuses on transforming airport hubs like Schiphol into passenger-centric multimodal transport hubs. Specifically, she explores integrating air-to-rail and air-to-bus travel options, aiming to enhance seamless multimodal journeys beyond the traditional emphasis on air-to-air transfers. With a strong commitment to practical impact, Aniek adopts an action-oriented approach, emphasising system integration while prioritising the end-user: the passenger. Her work seeks to understand and meet passengers' needs and uses co-creation approaches with stakeholders to facilitate knowledge that not only advances academic theory but is also applicable in real-world contexts. Through this hands-on and collaborative process, Aniek aims to bridge the gap between research and practice, supporting Schiphol's evolution into a future-ready multimodal transport hub that serves passengers seamlessly and sustainably.

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### Abstract

*This paper explores the strategic importance of multimodality for airport hubs, especially considering sustainability goals that are pressuring airports to innovate. Although the European Commission (EC) has encouraged the transformation of airport hubs into multimodal transport hubs since 2011, most airport hubs prioritise aviation transfers over true multimodal connectivity. In response, Schiphol Airport has been taking active steps toward a multimodal future, supported by a collaborative PhD project with TU Delft, following an action research approach. Through iterative research cycles, this study reflects on Schiphol Airport's efforts to address passenger needs and enhance multimodal services. The research includes cases focused on improving passenger experience in multimodal trips, developing a support system for rail/bus transfers, enhancing information services and conducting strategic sessions with key stakeholders. The findings show that creating a seamless multimodal travel experience requires attention to passenger needs for clear navigation, efficient hub facilities and consistent, real-time information throughout the journey. Reliable updates and knowledgeable staff enhance travellers' confidence, while special transfer services and efficient coordination make the process smoother. Practical challenges persist, however, due to regulatory restrictions and the prioritisation of airline operations over multimodal initiatives. Achieving a robust multimodal system requires coordinated efforts across sectors and regulatory, infrastructural and service improvements. Overall, the findings highlight that long-term success in multimodal travel relies on deep collaboration and a shared vision among operators, hubs and mobility service providers, with the action research approach offering an effective way to facilitate this process by focusing on underlying needs and building trust among stakeholders. This article is also included in **The Business & Management Collection** which can be accessed at <https://hstalks.com/business/>.*

### Keywords

*airports, multimodal, transition, passenger experience, action research*

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## INTRODUCTION

Denounced and admired, the great hub airports around the globe are performing a constant balancing act. On the one hand they inspire economic activity, travelling adventures and connect us to our loved ones around the world. On the other hand, there are significant concerns about the impact on climate change and the environment. Local communities both benefit from and are burdened by airports. International hub airports serve international, national and local communities by facilitating connectivity on all scales. They develop travel facilities that range from welcoming wide-body intercontinental aircraft on the newest multiple aircraft ramp system (MARS) to co-developing cycle lanes and pedestrian zones. The role of the airport is evolving, and passengers' expectations and standards increase through what they experience on their journeys. Transport operators (airlines, rail operators, taxi companies, bus services, digital platforms, etc.) are creating an ever-growing range of travel options. Increasingly, these offerings combine different modes into a single, multimodal journey.

Airports need to amalgamate myriad transport services while navigating (inter)national political upheavals, climate change mitigation objectives and local agendas. As part of an ongoing effort to access, harness and absorb this new reality, Schiphol Group and Delft University of Technology (TU Delft) have teamed up to study multimodality in the context of airport hubs. The concept of multimodality raises important strategic positioning questions for hub airports.

Understanding multimodality, the drivers behind this trend, its relevance for airports and the approaches taken by major hubs is essential. This paper sheds

light on these subjects as the authors have encountered them in their collaborative research.

## SCHIPHOL AIRPORT AS A CASE FOR MULTIMODAL TRANSPORT HUB DEVELOPMENT

### Schiphol Airport

From a sustainability perspective, Schiphol, in collaboration with the Netherlands Aerospace Centre (NLR) and research institute CE Delft, has investigated the need to reduce CO<sub>2</sub> emissions by at least 30 per cent compared to 2019 to align with the Paris Agreement. This presents a significant challenge. Additionally, Schiphol has garnered significant media attention regarding potential airport downsizing, driven by the noise and environmental concerns of local residents and surrounding areas.

Highly controversially, the Dutch Government has aimed to shrink airport activities, specifically the amount of air traffic movements at Schiphol. An experimental measure was launched ahead of the balanced approach procedure, with the aim of reducing maximum capacity at Schiphol from 500,000 air transport movements (ATM) to 440,000 ATM. Court cases back and forth have ruled out any shrinkage at this point in time, awaiting the balanced approach procedure with the European Commission (EC). Schiphol Group sided with the Dutch Government in the court case, which was mounted by the airline industry, claiming any reduction is unlawful and in direct violation of regulations.

This political turmoil has further ignited the push for more sustainable network connectivity to and from Schiphol Airport. Public outcry to

reduce flights towards airports close to Schiphol, such as Brussels and Dusseldorf, has even led the legacy carrier KLM to enhance its air–rail services from Brussels and aim to start trials towards Germany (if a direct connection to the airport could be made). Various reports indicate that the potential substitution of flights by rail could reduce as much as 60,000 ATM or reallocate them to serve other parts of the aviation network. An important aspect of discussions on the significance and relevance of air–to–rail substitution is the so–called substitution paradox. This concept suggests that reducing flights on a short–haul route could harm sustainability if the freed slot is subsequently used for a long–haul flight.

### Schiphol's opportunity

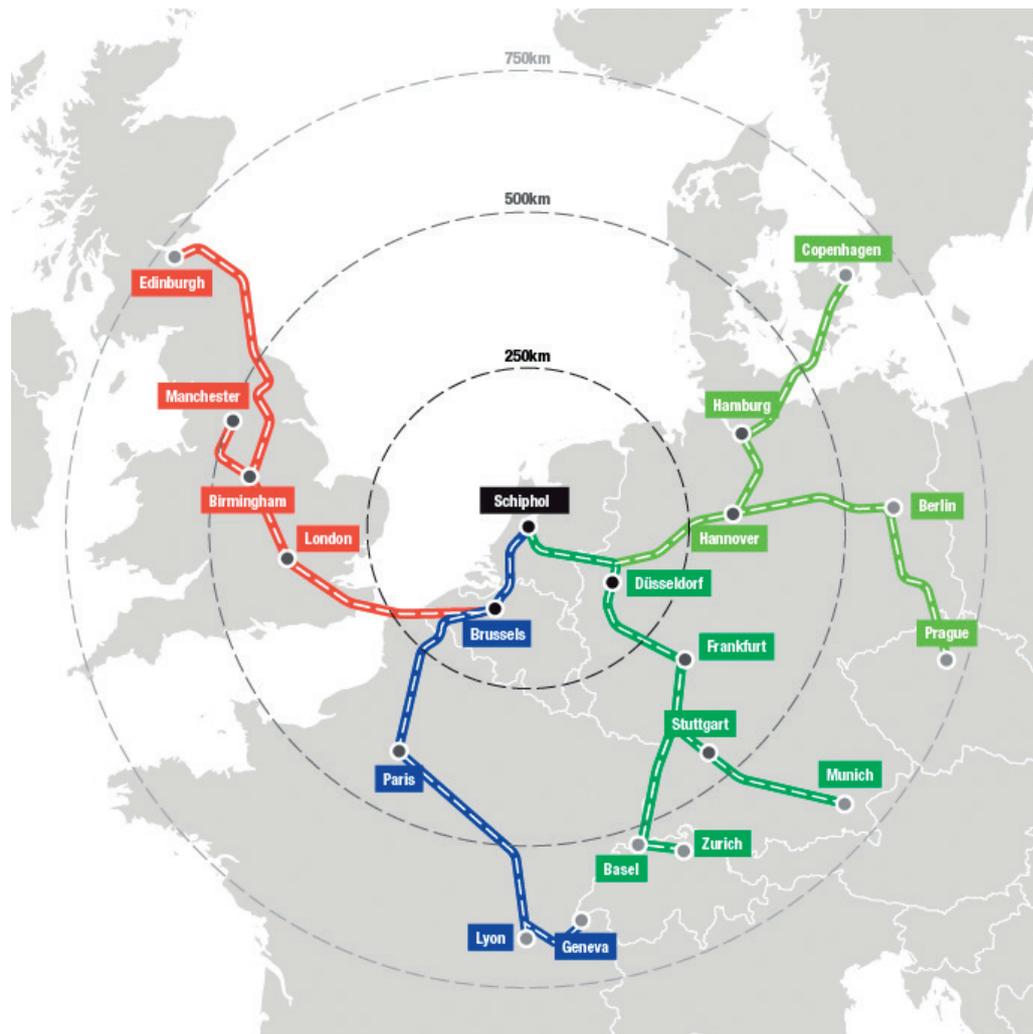
Fortunately, Schiphol is strategically located atop the main Dutch north–south trunkline of the Trans–European Transport (TEN–T) network (see Figure 1), the primary rail network within the Netherlands and Europe. Plans to connect to the TEN–T line to the east are already financed and being realised, although completion seems at least another decade away. With the expansion of railway station Amsterdam Zuid (South), international trains bound for Germany could quite easily also stop at Schiphol Airport. The physical proximity between air and rail transport at the airport — an important factor in the quality of seamless air and rail integration<sup>1</sup> — poses no obstacle, as the railway station is located directly under Schiphol's central hall. Nearly 50 per cent of (origin and destination) passengers already utilise trains as the main mode of transport to travel to and from the airport.

### Schiphol's challenge

A major challenge lies in integrating international train services with long–haul flights, requiring a deep understanding of the unique characteristics and challenges of both transport modes. Finding optimal connections and ensuring consistent service delivery presents a new challenge for all stakeholders at national, northwestern European and global levels. While there is a collective desire to participate, the regulatory framework remains underdeveloped due to divergent interests.

Airlines would aim to use trains as means to feed their intercontinental network, much as 'city hopper' flights do today. The majority of the major European airport hubs serve legacy carrier airlines that are part of airline alliances, enabling code sharing to further expand the number of direct (or single–transfer) connections. To these larger, internationally operating networked airlines, feeder flights are essential to remain competitive in the ever–expanding global market.

A simple transfer from train to plane (or vice versa) seems straightforward on paper, but the reality is a marshland of local regulations, non–compatible IT systems, diverging interests and, perhaps most of all, a showdown over who 'owns' the passenger. Offering multimodal travel involves a struggle for power.<sup>2</sup> Bear in mind that the train leg in a plane–train journey to an airline is a feeder connection, while to international rail operators it is their main profit line. This immediately sparks a yield–optimisation issue: airlines want cheap fares to 'feed' the main intercontinental lines, while train operators aim to get the biggest profit from direct origin and destination (O&D) traffic. Picking up a few extra passengers to the airports is



**Figure 1** Schiphol in relation to TEN-T network

fine, but it is definitely not their *raison d'être*.

Consider the following example: in 2024, Eurostar-Thalys operates 11 trains per day from Amsterdam Central Station to Brussels Midi. This translates to approximately 6,650 seats. KLM operates four flights totalling approximately 360–400 seats per day from Amsterdam Schiphol (AMS) to Brussels Airport (BRU). The first and last connections KLM offers do not (yet) match up with the Eurostar-Thalys scheme. Therefore,

of the 6,650 seats the train operator offers, only 200 per day (3 per cent) would be eligible for integrated air–rail transfers in the current schemes.

Operating a high-speed train with a capacity somewhere between 450–800 passengers equates to 4–8 city hoppers. City hopper connections are typically distributed across the day, from early morning to late in the evening, to best connect with international long-haul flights or to provide O&D passengers with the benefit of arriving at (or departing)

their destination at a convenient time. To align the timing of bulkier rail transport with the city hopper schedule requires a significant number of additional non-transferring passengers. In essence, using the train instead of a city hopper is equivalent to using the capacity of two (or three) wide-body aircraft to replace a small city hopper.

The EC advocated as early as 2011 for the transition of airports, ports and stations into multimodal transport hubs (MTHs); however, this transition is still in its infancy. Currently, most airport hubs focus on facilitating transfers within aviation rather than between different modes of transport.

Nevertheless, airport hubs across Europe are not remaining passive; rather, they are undertaking various initiatives to advance multimodality. Fraport recently reopened their air–rail express facility at Frankfurt Main Airport (FRA), Charles de Gaulle Airport (CDG) works closely with key stakeholders in France, and the design of a mega air–rail hub to be built in Poland (Centralny Port Komunikacyjny [CPK]) was recently announced. Additionally, many airlines are boasting on their websites and tickets that extended air–rail services are being developed, piloted or tested, and are becoming the norm. As demonstrated by recent shifts in France towards more sustainable alternatives replacing short-haul flights with rail transport, it is conceivable that airports may evolve into air–rail hubs. Delayed or inadequate investment in such developments, however, risks compromising both airport and airline networks and the strategic accessibility of regions and nations. Airports that are lagging behind neighbouring airports in multimodal infrastructure investments could over time face a weakened position in the mobility landscape, which would affect

both the airport and the country it is situated in.

## UNDERSTANDING MULTIMODALITY: A BRIEF LITERATURE REVIEW

This section discusses the state of the art on the drivers of the shift toward multimodal travel, essential characteristics of MTHs, and how airport hubs (can) function as MTHs and the opportunities this can bring.

### Drivers of the shift toward multimodal travel

Transport and mobility systems are evolving, driven by the shift towards sustainable mobility and increasing digitisation.<sup>3-4</sup> The growing concern for sustainable solutions significantly affects the mobility industry, with 194 nations and the European Union (EU) committing to climate goals under the Paris Agreement, leading to an influx of national regulations.<sup>5</sup> These regulations exert pressure on high CO<sub>2</sub>-emitting organisations such as airlines and airports. For instance, France has banned direct domestic flights that could be replaced by train rides under 2.5 hours,<sup>6</sup> and the Austrian Government required Austrian Airlines to cease flights that could be covered by rail journeys under three hours as a condition of a COVID-19 rescue package in 2020.<sup>7</sup> Other countries are following suit, prompting many employers to do the same.<sup>8</sup>

One way of mitigating the climate impact of travel is through the development of new technologies such as biofuels and electric, hydrogen and solar technologies.<sup>9</sup> In addition, new information and communication technologies (ICT) enable new mobility systems with more efficient resource use, lower energy

consumption and reduced environmental impact.<sup>10-11</sup> This shows how ICT is revolutionising mobility with intelligent transport systems and shared mobility apps. For example, cities now offer shared mobility services, such as bike sharing (eg StadtRAD in Hamburg, Velo in Antwerp) and integrated solutions like the OV-fiets service in the Netherlands, which combines train and bike rides with a single swipe of the OV-chip card.

Taking such integrated solutions one step — or several steps — further, we arrive at the concept of Mobility-as-a-Service (MaaS), which allows travellers to plan routes and access various mobility services through a single interface, shifting the focus from the mode of transport to the overall journey experience.<sup>12</sup> But even without MaaS, many travellers use mobile phones and platforms like Google Maps to plan trips, empowered by increasing data availability from transport operators. This holistic approach enhances the travel experience and paves the way for future mobility innovations.

### Multimodal journeys

The shift towards a more holistic approach towards mobility, focused on enhancing the whole journey and overall travel experience, even though travellers use different modalities during their journey, carries significant implications for the design and infrastructure of transport systems. Known as multimodal transport, this concept involves a unified contract that encompasses the entire trip, with a single operator or mobility service provider assuming full responsibility for the journey. Multimodal transport ensures door-to-door service even when multiple operators participate in the transport process.<sup>13</sup> This multimodal

system that emerged in freight transport integrates various modes of transport in a particular sequence.<sup>14-15</sup> Facilitating multimodal transport necessitates collaboration among various transport providers and the adjustment of transport schedules to meet travellers' needs.

The rise of multimodal travel underscores the importance of an approach that seamlessly integrates different modes of transport. This not only improves convenience for passengers but also enhances the overall travel experience. MTHs play a special and significant role in integrating different travel modalities into a truly seamless journey, serving as the intersections of these various modes.<sup>16</sup>

### Airports as MTHs

This also raises the question of what the role of airport hubs would be in the emerging multimodal travel landscape. Airport hubs fall under the typology of transit hubs, which serve as gathering points for various travel modalities and facilitate passenger transfers between different transport systems.<sup>17</sup> According to previous research, airport hubs have the potential to transform into passenger-oriented MTHs.<sup>18</sup> Yet, another study<sup>19</sup> demonstrates that while airport hubs excel in managing passenger transfers within the air transport system, they fall short in providing services for transfers between alternative modes of transport. This study specifically focuses on alternative modes that can cover longer distances and serve as substitutes for short-haul flights. The authors argue, in line with previous findings,<sup>20</sup> that travelling over greater distances requires more thoughtful planning, including booking tickets and managing the typically higher costs associated with these modes. When transfers between

connecting modalities become unfeasible for any reason, it is crucial that airport hubs offer robust support for affected travellers. Thus, passenger treatment in multimodal journeys should mirror that of transfer passengers within the air transport system: they receive essential information, are automatically rebooked, and, when needed, hotel accommodation is arranged.

To achieve these high-quality transfer services, cooperation between airport hubs and transport operators of various scales is important to support multimodal transfers.<sup>21</sup> Such collaborations can ensure smooth passenger transitions where new travel schedules are automatically created and booked in case of disruptions, such as a train delay leading to an automatic flight rebooking. As a seamless switch to another type of modality within a single journey can significantly affect the travel experience,<sup>22-23</sup> the growing popularity of multimodal travel places an emphasis on the quality of passenger services at transit hubs like airport hubs. This is supported by the EU Commission, which states that ‘airports, ports, railway, metro, and bus stations should increasingly be linked and transformed into multimodal connection platforms for passengers’.<sup>24</sup>

The typology of passenger transit hubs introduced in previous research<sup>25</sup> is designed around various transport modalities and their characteristics, such as the distinction between landside and airside modalities at airports.<sup>26</sup> The typology shows that at airports the emergence of new modalities such as high-speed rail (HSR), electric aircraft, hydrogen planes and urban air mobility may face different regulatory challenges, potentially rendering the current design and efficiency of airport hubs less effective.

Previous research highlights that successful MTHs integrate both

infrastructure and service elements.<sup>27-28</sup> Infrastructure integration refers to the facilities needed to support various transport modalities, such as railways, roads and runways, along with connecting elements such as buildings and moving walkways.<sup>29-30</sup> From the passenger perspective, however, the service quality of MTHs also includes services that facilitate seamless transfers between different transport modes, encompassing the transfer environment, accessibility, signage, safety, public utilities, comfort and convenience.<sup>31</sup> Achieving high-quality service involves integrating transaction, reservation, information and planning (TRIP) services across different transport modes, thereby enhancing the journey quality and addressing unplanned interruptions in multimodal travel.<sup>32</sup> Figure 2 visualises the difference between a transit hub and an integrated MTH.

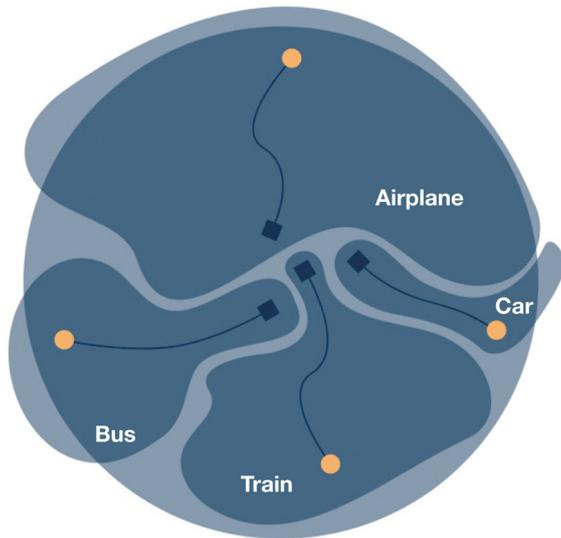
The traveller experience of both unimodal and multimodal journeys through airport hubs are significantly enhanced by the digitisation of airport services, such as automated check-in processes and personalised travel recommendations.<sup>33</sup> Advances in data processing have implications for how airports and travel services can cater to the individual needs and preferences of travellers. Leveraging digital technology allows airports to streamline operations, provide real-time information and offer personalised services, ultimately enhancing the overall travel experience.

### Opportunities for airports

The pursuit of sustainability goals presents both challenges and opportunities for airport hubs. With an increasing demand for sustainable transport options, airports face added pressure to innovate and adapt.

### Example of a transit hub: Airport Hub

At Airport Hubs, various transport subsystems come together, having adjacent infrastructure, but each subsystem operates independently and provides its own services.



### Multimodal Transport Hub

At MTHs, the services of each travel modality are fully integrated and overlapped, enabling passengers to experience a seamless multimodal journey.

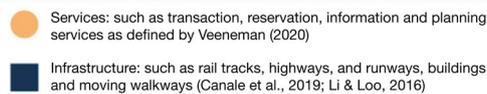
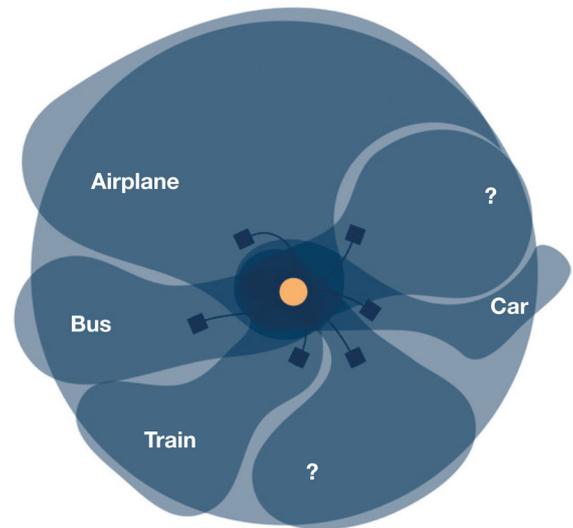


Figure 2 Airports as MTHs<sup>34</sup>

Fortunately, airports have extensive coverage across various transport modes, which uniquely positions them to facilitate seamless connections between long-haul flights and shorter-distance modalities. Currently, these connections are predominantly managed through the hub-and-spoke model, which efficiently organises flight operations; however, there remains untapped potential to expand these connections to include high-speed trains and other low-emission alternatives. By strategically integrating these modes, airports can effectively replace high-emission transport with more sustainable options such as trains and buses.

Moreover, substituting short-haul flights with international rail integration within the hub-and-spoke framework

not only aligns with climate objectives but also holds promise for reducing environmental impact without compromising the integrity of the airport's or home carrier's network. On the contrary, it has the potential to strengthen both networks and enlarge catchment areas.<sup>35</sup>

## MULTIMODALITY PRACTICES AT AND AROUND SCHIPHOL

This section explores the practices of multimodality at and around Schiphol Airport, describing current collaborations, research cases and their findings.

### Air–Rail Action Agenda

Schiphol has been exploring its role in multimodal travel over the past few

years. In 2020, Schiphol, together with partners Prorail, IenW, NS and KLM, published the Air–Rail Action Agenda, based on a research and collaboration effort that began in 2018. The five collaborating parties, the main actors in the Netherlands regarding air–rail integration, signed off on an agenda aimed at connecting six priority city pairs to the airport by rail. The political green party GroenLinks published a manifesto titled ‘Flying on the Rails’, which ignited this response.<sup>36</sup>

### **Rail sector collaborations**

A second example of multimodal initiatives around Schiphol is its active collaboration with rail sector parties through Railforum and the taskforce International Rail Transport. These efforts contribute to promoting a unified European rail system. The taskforce developed a set of recommendations for the European Committee and the Dutch national government on improving international rail connections. These recommendations include sharing data, raising awareness of cultural differences, enhancing the competitiveness of international rail transport, considering the cross-border network as a foundation, supporting pilot projects and ensuring slack capacity.

### **Multimodal action research cases**

In 2020 Schiphol and TU Delft also started to collaborate on the subject of MTHs in the form of a PhD project following a qualitative research approach employing action research (AR) as its central methodology. AR involves stakeholders directly in the research process, making it an ideal method for understanding and improving specific

organisational contexts.<sup>37</sup> By developing improvements within an organisation or ecosystem, and then actually implementing these improvements in those environments and observing the effects, AR allows researchers and practitioners to enrich scientific theories with knowledge for future improvements. According to previous research ‘AR rests on the premise that reality is interconnected, dynamic, and multivariate and always more complex than the theories and methods that we have at our disposal’, and AR follows the mantra.<sup>38</sup>

The aim of the study is to help Schiphol, through several AR cycles, to explore and improve its role in the future of multimodal travel. AR emphasises not only implementing improvements but also reflecting and learning from the experiences that accompany them. So, the experiences of developing multimodal practices were reflected upon and led to new actions being taken.

Next, we will focus on the initiatives that have been carried out through this collaboration and the lessons learned from them.

### *Case 1: Literature about passenger experience factors*

To make informed decisions regarding the transition to a passenger-oriented MTH, airports must first understand passenger needs in multimodal travel. Therefore, we conducted a literature scoping analysis on the passenger experience factors at airport hubs, mobility hubs and multimodal travel by searching for relevant keywords in the Google Scholar database.

We followed the train of thought of the passenger’s experience as ‘activities and interactions that passengers undergo in an airport (terminal building)’.<sup>39</sup> In the

context of travel, passengers are regarded as users of the travel service.

The literature scoping identified several factors, mainly focused on passenger satisfaction: (1) wayfinding; (2) hub facilities; (3) waiting environments; (4) hub design; (5) journey process information; (6) personal communication; (7) special transfer services; (8) ticketing services; and (9) transfer coordination.

### *Case 2: Passenger experience in multimodal journeys in Europe and US*

The second case, which is also the first AR case, focused on enhancing passenger experiences in multimodal travel. It built upon Case 1, which explored factors influencing passenger experience through a literature review. While Case 1 provided valuable insights into the multimodal passenger experience at airports, the literature it drew from primarily focused on passenger satisfaction — an important but narrow aspect of the broader travel experience. Moreover, much of the existing literature relied on quantitative studies or qualitative research based on expert opinions, rather than capturing actual passenger experiences. This highlighted the need for in-depth qualitative research from the passenger's perspective to understand how and why these factors affected their overall experience.<sup>40-41</sup>

This study used an autoethnographic case approach to explore integrated air-rail and air-bus journeys, identifying key factors influencing multimodal travel at airports. Autoethnography allows researchers to create meaningful narratives based on personal experiences within a specific cultural context, making it accessible to a wide academic audience.<sup>42</sup>

The research process began with desk studies, leading to the selection

of various cases in Europe and the US for exploratory analysis. The insights from these cases were then discussed with both the strategy and operations departments at Schiphol Airport to identify factors specific to multimodal transfers.

The findings highlighted the importance of creating specialised multimodal wayfinding for travellers, providing real-time updates about transfers before and during the journey to ensure a sense of predictability and reliability, and ensuring that staff are well informed about multimodal travel options to offer personal assistance. Furthermore, it appeared to be essential to clearly communicate transfer information through media channels prior to the journey and to offer special multimodal transfer services, such as fast lanes at security checkpoints.

### *Case 3: Support system for rail-bus transfers at Schiphol*

The following AR case consisted of Schiphol's effort to enhance its product by focusing not only on air travel but also on rail-bus connections. Although this may seem unusual for an airport, it makes sense given that Schiphol is the fourth-largest railway station in the Netherlands in terms of connectivity. Through a master graduation project at TU Delft, a support system was designed, tested and redefined for Schiphol's strategy department to provide valuable insights into traveller needs during rail-bus transfers.<sup>43</sup> The traveller needs were classified into six categories that contribute to a great passenger experience: placement and distance, information and signage, comfort and environment, accessibility and efficiency, atmosphere and safety, and facilities.

#### *Case 4: Improving multimodal information services at Schiphol*

Next, a series of AR cycles focused on improving the information services at Schiphol, such as creating an instructional video for multimodal transfer passengers, installing multimodal information screens and exploring more multimodal touch-points. These initiatives were carried out in collaboration with key actors in multimodal transport in and outside the Schiphol organisation. Through the iterative approach of the AR method, lessons were learned about progressing towards multimodal service offerings.

One crucial lesson was that establishing multimodal journeys requires collaboration from all participating operators. Unlike single-operator journeys, where one entity leads and coordinates with stakeholders, multimodal journeys necessitate that all operators involved share responsibility equally for the passenger experience. And while the transfer occurs at the airport, the quality of the transfer is significantly influenced by the operators involved.

Next, existing multimodal travel represented a small portion of the airport's overall operations, leading to a prioritisation of airline operations. It was found that due to stringent regulatory requirements, there is limited room for experimental approaches, even for minor information service experiments. This makes it challenging to quickly improve multimodal services.

Furthermore, misalignment between the interests of operational and strategic departments was observed, highlighting the need to bridge the gap between long-term planning and current operations.

From these cases, we concluded that innovations in train–plane and bus–plane travel are still in the experimental phase.

#### *Case 5: Learning about AirRail travel in action with Schiphol's key actors*

Based on insights gained from these three cases, an AR case was launched with stakeholders from air–rail travel at Schiphol. Employees from key organisations involved in air–rail travel at Schiphol were asked to perform several air–rail journeys. They documented their observations and experiences in a journal and later reflected on them through interviews. This was followed by a brainstorming exercise where they discussed operational improvements and long-term enhancements for air–rail travel.

From this case, several key focus areas emerged that need further development for multimodal travel. First, multimodal travellers should be treated as transfer passengers, providing them with the same level of information, benefits and speed as traditional transfer passengers. Secondly, it was confirmed through this initiative that multimodal travellers should be informed about what to expect before their journey and kept updated throughout the trip, regardless of any disruptions. Thirdly, Schiphol has excellent conditions for air–rail travel, mainly due to the short walking distances. This means that a streamlined operational process at the airport can achieve a reasonable level of seamless AirRail travel without complex and expensive infrastructural investments.

#### *Case 6: AirRail strategy sessions*

The final AR case united air–rail actors through the air–rail strategy sessions. To address long-term air–rail ambitions, Schiphol participates in multi-stakeholder strategy sessions that explore various scenarios. Five key stakeholder organisations (the same as the Air–Rail

Action Agenda) sought to understand each other's needs in different future societal scenarios, facilitated by Delft University of Technology. These multi-sector, public and private scenario sessions were designed to explore different options for how to implement air–rail services, and how the various implementations would hold in future societal scenarios. The resulting package of alternative air–rail service propositions provides an overview of policy requirements, infrastructural investment needs and service design challenges. It therefore offers a narrative for the cross-sectoral collaboration we aim to further develop.

Through the collaborations and the AR cases, Schiphol Group is actively building a network of organisations that are relevant to pursue further integration of modalities, becoming multimodal in the process. The goal is to facilitate connectivity to and from the Netherlands in the most sustainable manner. Adding and integrating more sustainable modalities to the modality mix offered by airport hubs makes sense. Because seamless multimodal travel is a new development that involves long-term investments and depends on many stakeholders, it is also essential to develop the roadmap together, step by step.

## CONCLUSION

This paper has described initiatives to facilitate seamless multimodal travel at airport hubs, highlighted crucial success factors in these initiatives and advocated for further development of air and rail services and systems.

One of the most important observations that surfaced during the cases is that one individual organisation, having its own goals and interests in mind, does

not stand much chance of successfully improving multimodal travel. To facilitate seamless multimodal travel, many parties need to contribute, and thus alignment of goals, interests and ways of working is key. Trying to venture out and explore together does work. The chosen AR approach emerged as a highly effective strategy, as it enables individuals with outsider perspectives but insider knowledge to play a facilitative role, grounded in research, thereby bridging gaps between different stakeholders. The approach provides an effective way to focus stakeholders on understanding the reality of the situation or the underlying need, rather than emphasising differences between them, and helps in building trust and fostering relationships over time. Once that trust is in place and the bonds are strong, formulating a goal together starts making sense. The next step is then to establish a collective notion and ambition among all relevant stakeholders to collaborate, learn from each other and prioritise broader objectives over individual interests.

Beyond airports, the presence or absence of multimodal services and infrastructure at the airport hub can significantly affect both air and international rail connectivity. A well-established air and rail connection attracts international rail operators, catering to both point-to-point rail passengers and air–rail transfer passengers. For current hub airports to maintain relevance in a future where short-haul flights are largely replaced by sustainable alternatives such as buses and trains, it is imperative to accommodate sufficient international bus and rail operators and develop integrated air and rail services.

Our discussion highlights critical insights for improving multimodal travel experiences at airport hubs, emphasising

the need for specialised services, clear communication and effective operational integration. Nevertheless, navigating regulatory challenges that prioritise airline operations and bridging gaps between strategic planning and operational realities pose significant hurdles.

Achieving such a transition requires coordinated efforts and governmental support, as individual airlines, rail operators or airports are unlikely to effectuate this change independently. The potential impacts of a multimodal transition — whether in terms of sustainability gains, network expansion or environmental considerations — depend on the evolution of international mobility needs, societal factors and policy actions at both national and EU level. Addressing these factors will be crucial in shaping the future landscape of multimodal transport.

In the end, we believe the coming decade is essential for airports like Schiphol to make their intentions clear and determine their strategic positions in relation to a future where air and rail are more integrated modalities. We believe a more multimodal future can have enormous consequences for the airline industry and airport hubs, both for organisations that align with it and those that do not. Coordinated investments from different parties need to be aligned, and a collective strategy put in place. Each stakeholder — governmental bodies, infrastructure owners and service operators — will be looking to the others to make the first move. Some hub airports have already set things in motion (Frankfurt, Charles de Gaulle, CPK), but to really develop MTHs of significance in the long run, extra effort is needed from the stakeholders involved and additional improvements in regulations, infrastructure and services are

required. But above all, successful multimodal travel depends on coordination and collaboration.

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