

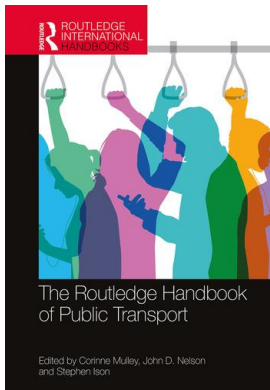
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6

PUBLIC TRANSPORT INTEGRATION

Lucy Budd and Stephen Ison

Introduction

In the lexicon of daily conversation, ‘integration’ means to bring disparate ideas or components together to form a co-ordinated, functional, and unified whole to enable systems or processes to work more efficiently and effectively to the benefit of their users. Within the context of urban transport policy and land use planning, ‘integrated transport’ has long been promoted as a means of achieving sustainable travel outcomes and reducing reliance on the private car. However, while the goals of delivering economically viable public transport that is of a reliable quality, meeting the needs of a diverse portfolio of users, and achieving widespread public acceptance are strategically important, the challenges to achieving them are considerable. Facilitating truly ‘integrated’ transport thus remains an aspiration rather than a reality for many places and cities around the world. This chapter begins by examining the concept of transport integration. The challenges of planning and delivering it are then discussed before specific vignettes of schemes which have delivered an integrated transport system are presented. Examples of where innovations in public transport technologies have facilitated greater integration are provided before the conclusions are presented.

The concept of transport integration

Transport integration involves co-locating different modes of public and private transport (including road, rail, air, maritime, and active transport infrastructure and vehicles) at dedicated or distributed interchanges to create accessible, affordable, reliable, sustainable, convenient, comfortable, safe, and seamless journeys for passengers (see Campaign for Better Transport, 2018; Nielsen et al., 2005) (see also Chapter 7). The provision of attractive, convenient, and safe interchanges not only influences human travel behaviour but can also have a positive effect on the public realm and built environment by making transport hubs attractive places in which to meet, eat, conduct business, and invest. Depending on their location, capacity, and design features, transport interchanges can facilitate multi-modal journeys and provide temporally efficient connections to a wide number of spatially dispersed destinations. This reduces the interchange penalty and the generalised cost of a journey by public transport, thereby making them more convenient and attractive propositions.

Integrated transport that is convenient, reliable, and attractive to users is essential for incentivising modal shift away from private cars, reducing carbon emissions, and improving local air quality. However, transport infrastructure has often been constructed in an ad hoc manner over time with little by way of co-ordinated planning or control and an emphasis on the needs of individual transport companies rather than the end users. There is now a recognition that the requirements for integrated public transport must be viewed from the perspective of the user. As a general rule, passengers require:

- The ability to travel to where they want to go at a convenient time and with a trip duration comparable (or ideally preferable) to that which could be achieved by private transport;
- Convenient and straightforward connections where a change of transport mode is required;
- Accurate, accessible, and reliable real-time information;
- Provision of an intuitive single (and preferably universal) end-user payment system involving contactless technology that is identical on every vehicle and mode, regardless of vehicle type or operator (in some jurisdictions, individual providers have separate end-user payment systems with little if any overlap);
- Safe and comfortable facilities and vehicles;
- High service frequency and regularity, including ‘turn up and go’ provision on high-demand routes;
- Assistance in the event of delay or disruption and the ability to take an alternative mode of transport to the intended destination without penalty, if required.

The components of an integrated transport system thus include not only spatial characteristics (the ability to access a wide range of destinations and enjoy convenient interchanges that involve minimal walking) and temporal attributes (convenient, reliable, and quick services) but also practical considerations concerning the provision of facilities at interchanges including seating areas, toilets, step-free access, travel information screens and help desks, and a single (and preferably universal) end-user payment system. Best practice suggests that this needs to be led and co-ordinated by a single agency which is responsible for developing public transport policy, planning system extensions and enhancements, devising pricing and fare structures, and operating and overseeing the system.

Achieving transport integration

There are arguably four prerequisites to achieving integrated transport systems (based on May et al., 2006): integrated policy, integrated planning, integrated infrastructure, and integrated operations.

- 1 *Integrated policy* – Transport policy is often developed at a variety of levels: national, regional, and local (see also Chapter 2). The three often have competing needs and priorities and thus do not always fully align. The involvement of politicians and governments, who often have short tenures, means that the creation of long-term transport policy can be problematic, and cost pressures mean that pragmatism rather than long-term progress is often prioritised.
- 2 *Integrated planning* – The second challenge is ensuring that the multifarious public and private actors who are involved in planning and delivering transport networks and services co-ordinate their endeavours and engage in joint working to ensure new infrastructure and services are developed in an integrated manner for the benefit of end users. Co-ordinating

planning in this way should help to ensure that all the different transport modes readily connect (both spatially, temporally, and practically) at interchanges to minimise transfer times and provide a safe and positive customer experience. Although planning is often considered a long-term exercise, planning is also required for short-term or one-off events that will lead to a surge in demand (or a significant change in the normal pattern of demand) for public transport. Major sporting events, cultural and religious festivals, national celebrations, and political marches would fall into this category, and all may result in a sudden upturn in demand (Currie & Shalaby, 2012). Co-ordinated planning between transport providers and network controllers is thus required to ensure adequate capacity (which may involve the use of additional or larger vehicles as well as the introduction of extra services) is provided.

- 3 *Integrated infrastructure* – Individual transport modes require dedicated infrastructure, such as tracks, signalling, roadways, and ramps, and, for reasons of public safety, security, and operational expediency, often need to be physically segregated from one another. At the same time, however, there is a need to ensure that passengers can change from one mode of transport to another in a safe, convenient, and seamless way that minimises delays to their journey. Public transport interchanges need to ensure safe and secure seamless physical connections between pavements, cycleways, trams and railway platforms, bus stops, car parks, jetties, and airports. The infrastructure also needs to extend to public facilities, principally toilets and waiting areas, as well as retail concessions.

It is important to note the different types of transport infrastructure integration and how it varies by transport mode and geographic location. National railways, for example, often exhibit a type of vertical integration in which the track, signals, station, and rolling stock are all owned and operated by one provider. This system emerged because, historically, railways developed as integrated firms which owned both the track and the trains and which had regional or national monopolies. Since the 1990s, some countries have privatised the provision of train services and created a complex system of franchising and track access agreements. In the case of the United Kingdom, maintenance of the track and lineside infrastructure is provided by one agency – Network Rail (which in turn outsources many maintenance functions to third-party contractors) – while the operation of stations and rolling stock is provided by a range of private train operating companies (TOCs) that have been awarded the franchise to operate passenger services on a particular part of the network. This separation of track from trains was designed to improve the productivity of the railway network and reverse the decline in patronage. It does, however, make the provision of integrated operations (see subsequently) arguably more challenging and complex, as more stakeholders are involved in the production of public services.

- 4 *Integrated operations* – As well as integrating the built infrastructure of transportation, transport services need to be co-ordinated to ensure seamless connections between services and between modes. The challenge is that waiting times are often perceived to be two to three times longer than they actually are, and so ‘turn up and go’ services, which reduce reliance on a timetable, are a good option on high-demand routes such as urban metro networks. The Moscow Metro, for example, can provide a service once every 95 seconds, while the Victoria Line on the London Underground offers a peak-time service frequency of a train every 100 seconds. These routine high-frequency services help to further reduce the interchange penalty. Crucially, all the different modes (and different lines within a single network) must be co-ordinated and complement each other in terms of service frequency, capacity, and customer service in order to prevent congestion and avoid potentially damaging and disruptive competition.

Service and timetable co-ordination, particularly where multiple operators are using the same infrastructure (for example, multiple train operating companies operating from the same railway stations and platforms), is essential. Integrated ticketing and fares are also key to delivering a seamless connection between services and modes. It is important that no additional cost be levied for transferring between modes. Integrated operations must also extend to the provision of travel information and customer support. Real-time service information and the provision of customer service agents to support passengers who are unfamiliar with the network or who are experiencing disruption are also needed to help users navigate the network and make informed decisions about their travel options,

Integrated operations also extend to the oversight and supervision of the network. Here, close control and co-ordination between drivers, customer service assistants, signalling centres, area traffic control, the police, and the security services is key to keeping the transport system safe and secure.

The challenges of, and opportunities for, public transport integration

So far, this chapter has explored the concept of public transport integration and identified its key components. The reality, however, is that achieving true integration is fraught with practical and political difficulties, some of which are a legacy of past planning decisions and modes of operation. Examples from the United Kingdom are presented later in this chapter by way of illustration. May et al. (2006) detail the principles of integration, albeit in terms of urban transport strategy, identifying the barriers to integration as legal and institutional, financial, political and cultural, practical, and technological.

Historically, private individuals and enterprises were responsible for building much of the early public transport infrastructure. Over the last 150 years or so, the network in the United Kingdom has variously been in private and public hands. As these owners have different priorities and financial resources, the pattern of service provision that has emerged is highly complex, and this has important implications for public transport integration. This point is illustrated with reference to the development of the UK railway and London underground network.

UK mainline rail/bus integration

The Victorian-era mainline railway network was financed and constructed by private companies. These firms surveyed the routes; purchased the land; constructed the track, station, and communications infrastructure; and operated the trains. Frequently these companies faced opposition from wealthy landowners who did not want new railway tracks constructed on or near their land. As a result, the railway companies often had to compromise not only on the route their tracks took but also on the location of their stations and termini. For example, London's major railway stations – Kings Cross, St Pancras, Euston, Marylebone, Paddington, Waterloo, Victoria, and Liverpool Street – each of which initially served a different company and route network, had to be constructed on the periphery of the old city, as the railways were not permitted to penetrate its core. Beyond London, too, the independent railway companies built their own station facilities with the result that passenger rail services were fragmented between different sites.

Over time, the railway companies bought up competitors to increase their market share and to take advantage of regional or national monopolies. Although this process of consolidation naturally led to the closure of some lines and stations, the legacy of multiple stations remained, and examples include, in the United Kingdom's second-largest city of Birmingham, the three

mainline stations of Birmingham New Street, Moor Street, and Snow Hill. Outside the railway stations, private companies, who do not necessarily share the same payment systems or ticket types as the TOCs, provide local and regional bus services. Although customers booking rail tickets online have been offered a 'PlusBus' option since 2002, this is not available at every railway station, and coverage of the scheme is patchy. PlusBus is a discount price travelcard for unlimited bus and tram travel around town at the start or end of a journey on the UK national rail network. From an initial offering of 35 cities, over 290 are now in the scheme. The most notable exception is London (see later in this chapter), a city which has its own distinctive transport geography and forms of transport integration and governance.

Between 1923, when the railway companies were rationalised, and nationalisation in 1947, the 'Big Four' (as they were known) private railway companies – the Great Western Railway (GWR); the London, Midland and Scottish Railway (LMS); the London and North Eastern Railway (LNER); and the Southern Railway (SR) – dominated British railway operations. The creation of the new national British Railways in 1948 brought all track, stations, and rolling stock under state control. This model existed until 1994, when British Rail (as it was then known) was privatised over a period of 3 years. Responsibility for the track and lineside infrastructure initially passed to the private company Railtrack (before subsequently being bought back under public control as Network Rail in 2002 following a series of high-profile accidents), while responsibility for operating the trains passed to private companies (see also Chapter 14). The process of UK railway privatisation was completed in 1997 (Harris & Godward, 1997; Shaw, 2000; Preston, 2017). As of early 2020, 16 separate franchises and 5 open access operators provided passenger train services in the country. Each operator pays access charges (which are regulated by the UK government's centralised Office for Road and Rail) to Network Rail for using the infrastructure. The track access charge is levied per vehicle mile travelled and varies according to the type of locomotive or multiple unit that is being used. The passenger train operating companies, in turn, lease much of their rolling stock from third-party leasing companies, including Porterbrook and Angel Trains. As the TOCs are not generally able to make any interior or structural changes to the vehicles they lease, they cannot adapt the vehicles to local needs (for example, by removing kitchen areas from catering cars to increase the seating capacity of their services). For the average passenger, however, such administrative and managerial complexities are irrelevant. Passengers simply want a safe, reliable, and cost-effective service that meets their travel needs. The idiosyncrasies of service provision and rail franchising are not important and only manifest themselves in the event of service disruption, when passengers need to know which TOC they were travelling within in order to claim compensation for any service delays they experienced.

The fragmentation of service provision and service delivery is not simply a UK phenomenon. In the San Francisco Bay Area in California, US, 27 different transit agencies were providing public transportation services in early 2020. One consequence of separate companies providing public transport services is that there is often little or no commonality between fares, ticket types, concessionary arrangements, end-user payment systems, cartographic styles or timetable co-ordination. Indeed, at one provincial railway station in the United Kingdom, an entirely empty bus leaving the railway station two minutes before the morning peak intercity rail service arrives from London is a regular occurrence. At the next railway station, 8 minutes further north, the £25.5 million East Midlands Parkway station featured inconveniently timed services with 2 trains an hour in each direction timed 7 minutes apart (northbound services) and 10 minutes apart (southbound services). Furthermore, despite being located less than 5 miles away from an international airport, rail-air connections are only provided by an on-demand (and relatively expensive) minibus shuttle service to the terminal which passengers are obliged

to pre-book. The railway station that was built in 1971 adjacent to Durham Tees Valley airport in northeast England is even less well served, with only one train in each direction calling per week. Unsurprisingly, it is one of the United Kingdom's least-used stations, with only 74 passengers using the site in 2017–2018 (BBC, 2020).

More positively, owing to its location near the north–south M1 motorway and the fact that the station was relatively underutilised, from 30th March 2009, East Midlands Parkway was used as an interchange station for combined multi-modal journeys using Megabus-branded services run by Stagecoach (which at the time also operated the East Midlands Trains franchise). The MegabusPlus services were designed to transport passengers from/to cities in the north of England to the East Midlands Parkway station, where they could then transfer to the Megatrain rail service for the journey to/from London. Routes operated under the MegabusPlus brand included London St Pancras International to/from Hull and Bradford. Although Abellio replaced Stagecoach as the franchise holder for East Midlands Trains (renamed East Midlands Railway from August 2019), Megatrain services continue to operate from the station.

Vignettes of public transport integration

This section provides two vignettes relating to public transport integration, namely urban public transport integration and airport ground (or surface) access. Park and Ride is another example (see also Chapter 7).

Urban public transport integration – London Underground and Transport for London

As was the case with mainline railway development in the United Kingdom, the construction of the London Underground in the mid-nineteenth century was also influenced by commercial and political concerns. Tracks and stations were often constructed opportunistically wherever land was available, and private companies vigorously competed for custom. Pragmatism and politics were thus significant factors in the development of London's early urban railway. As with the national railway network, private companies developed the early underground lines from the 1860s onwards. It was not until 1902 that most lines came under the unified control of the Underground Electric Railway Company of London. In 1933, following the creation of the London Passenger Transport Board, the Underground came under state control and was managed alongside the city's other urban railways, buses, trams, trolleybuses, and coaches. This arguably made timetable co-ordination, service provision, and the creation of a centralised ticketing system (based on a series of zones which radiated out from central London) more straightforward.

The subsequent integration of London Overground lines, Transport for London (TfL) rail, the Docklands Light Railway, trams, river buses, the Air Line cable car, and bus services (which are provided by 20 different private bus operators) within a single centralised jurisdiction has further improved the provision of integrated transport in the capital. The authority responsible for overseeing London's public transport and managing its major roads is TfL, an integrated transport authority created in 2000.

In 2003, TfL introduced the Oyster card, a contactless smart card payment system in which users tap in and tap out of the network to ensure the correct fee for the journey is charged (see also Chapter 33). The Oyster card can be used to pay for individual trips (on a pay-as-you-go basis) or be programmed to carry various different travel cards. A daily maximum charge ensures travellers never pay more than the nearest equivalent Day Travelcard. In addition to using an

Oyster card, passengers can now pay for travel using contactless debit and credit cards. The contactless payment system was first introduced on London's buses in December 2012 and later extended to Underground and TfL rail services from September 2014. The system automatically calculates the best fare for a customer's specific journey history and then charges them that amount at the end of the day. By mid-2017, more than one billion pay-as-you-go journeys had been made by contactless payment cards, and 2 million journeys a day (accounting for 40% of pay-as-you-go travel) were being undertaken using it. The contactless payment system was further expanded to accept payment using Apple Pay, Google Pay, and Samsung Pay. By 2017, almost 1 in 10 contactless transactions was made using a mobile device, and over 31 million journeys were conducted using mobile phones (Transport for London, 2017). The addition of a free Oyster and contactless app further allow travellers to top up pay-as-you-go (PAYG) credit, receive notifications when PAYG credit runs low, check journey history, buy certain types of Travelcards and travel passes, receive notifications before a Travelcard or travel pass expires, and manage multiple season tickets and cards.

Future features will enable it to be used by customers who receive free or discounted travel. The new contactless payment mechanisms have substantially changed the way customers pay for their travel around the city. One key advantage is that it is open and accessible to multiple currencies and does not require customers to buy specific tickets or travel passes. This makes public transport a much more convenient and attractive option for overseas tourists and visitors to the capital.

Additional convenience and incentives to use public transport in the capital have been generated through the comprehensive redevelopment of many of the original London railway termini into major destinations (or 'Destin-Stations' as some commentators have termed them) in their own right. In 2007, the neo-Gothic station at St Pancras, which had been designed by the Midland Railway and opened in 1863, was unveiled after an £800-million redevelopment project. The project involved remodelling the station's layout, creating new platforms for domestic national rail services, and creating space for Eurostar train services from Europe. St Pancras International is also directly connected to six London Underground lines. The station's interior was reimagined into a major retail space featuring four zones – Rendezvous, Market, Circle, and Arcade – supporting a range of luxury shops, dining options, lifestyle brands, and, in the case of Market, a daily farmer's market. The station is used by over 45 million passengers a year.

Kings Cross station on the former LNER line to northeast England and Scotland has undergone a similar transformation. The £550-million redevelopment was opened in 2012 and included placing a geodesic steel and glass dome over the top of a London Underground ticket hall, redesigning existing platforms, enlarging the existing concourse, and incorporating a range of shops and restaurants. Onward transport is provided through the combined Kings Cross/St Pancras London Underground station, local buses, taxis, and bike hire facilities, and the station is used by over 47 million passengers a year.

Airport ground access

Airports are major generators of surface/ground access traffic. Passengers, staff, and visitors need to access and egress airports 24 hours a day, and a lot of surface access is undertaken by private car. This impacts congestion and local air quality. Major airports offer the traffic density that is required to make significance investment in public transport provision and provide an integrated multi-model hub. London Heathrow airport is a major generator of traffic, but as well as servicing over 475,000 air traffic movements in 2018, it is also the site of a major public transport interchange (CAA, 2019). The central terminal area features the busiest bus and coach station

in the United Kingdom, with over 1,600 services each day to over 1,000 destinations (Europa.eu, 2019). The site is also connected to the London Underground, TfL rail, and the Heathrow Express rail services.

Public transport access focusing on integrated air-rail links and connection to local and regional bus networks has been encouraged as a way of dealing with the issue of surface transport congestion and environmental degradation (Budd et al., 2011). Air-rail integration, such as that found at Heathrow, Birmingham, and Stansted airports in the United Kingdom, is impacted by the:

- numbers of passengers allowing for costs to be covered and for a frequency of service to be delivered;
- the level of regional service so as to facilitate the ease of connection, in essence, a hub-and-spoke network in the delivery of rail provision; and
- the level of difficulty in accessing an airport by private car (Budd et al., 2011).

Airports attract a number of users, most notably passengers, employees, and visitors (such as meeters and greeters), all with different ground access requirements including the need for frequency of service, reliability, convenience, and price. As such, various rail services are more suited for some of these users than others. For example, the Heathrow Express, a direct but more expensive service from Paddington Station in central London to Heathrow airport, is costly and is primarily used by air passengers. The local rail service, on the other hand, tends to be less expensive and provide a more dispersed trip origin and as such is clearly a focus for Heathrow employees.

Bus-airport integration has been a significant component of ground access, there being a range of provision, be it local scheduled services or long-distance coach services, such as National Express in the United Kingdom. In this situation, airport bus stations are acting as hub points providing heated and/or air-conditioned waiting areas including food and drink provision, information points, signage, and real-time passenger information (RTPI). The provision of public transport networks within an airport location provides a facility in which passengers can readily transfer between modes or indeed the same mode, in which passengers simply use the public transport provision with the intention of taking a journey via air. As with rail provision, local scheduled services appeal more to airport employees than airline passengers given their frequency of stops and poor provision of luggage facilities. Long-distance coach provision can be slower than journeys undertaken by rail and can also be subject to road congestion (Kazda & Caves, 2015). This can be addressed to some extent by the provision of bus lanes aimed at increasing speed and reliability and thus impacting ridership. Ridership is also a function of familiarity with detailed information about public transport provision. However, the environmental imperative to increase public transport use conflicts with the commercial incentive to generate non-aeronautical revenue through the provision of extensive car parking facilities (see Ison et al., 2009, 2014).

Innovations in public transport

As cities become more crowded and polluted, the need for innovative public transport solutions grows as the link between economic performance and seamless mobility becomes ever more apparent. Transport has always been innovative. Changing patterns of passenger demand have, over time, led to the introduction of new public transport and communications technologies from the stagecoach to the train to bus and automated rail. Recent decades have seen the

widespread uptake of real-time travel information and service updates as well as contactless payment systems, on-demand mobility, and increased electrification and automation. Some of these changes have been transformative, such as the introduction of contactless payment for TfL services in London, while others have been more subtle but nonetheless have sought to make public transport more convenient and attractive to potential users. Co-ordinating time-tables; synchronising payment systems; and co-locating different transport modes within a single, clean, and safe transport hub are all important. Mainline train services in Switzerland and the Netherlands, for example, routinely feature digital displays which, when the train is on approach to a station, provide details of connecting rail services (time of departure, destination, and platform number) and local bus and tram networks to make the mode transfer as seamless and straightforward as possible.

Other transit operators have sought to broaden their appeal to potential users by turning stations into centres for artistic exhibitions and employing leading urban designers and architects to develop new stations and transform the urban realm. The Hungerbergbahn funicular railway in Innsbruck, Austria, for example, features stations by Zaha Hadid, while the architect Sir Norman Foster designed stations on the Bilbao metro. In this way, form and function can be combined to create a space that not only meets the needs of users from the perspective of transport and mobility but which also creates pleasant transfer spaces which have often become tourist attractions in their own right. Elsewhere, major interchanges in cities including Madrid, Paris, and London act not only as transport hubs but also provide many of the shops and services that support daily urban living. Likewise, the landside shopping plaza at Schiphol airport is used not only by airline passengers and airport staff but also by local residents who arrive by train to do their regular shopping. Even smaller interchanges have the potential to offer a limited number of additional services, such as shelters, newspaper stalls, vending machines, and lavatories. In this way, mobility and retail services can be spatially integrated and co-located to provide time-saving convenience to users.

Conclusion

Public transport integration is far from a new concept, but it is an idea that has not always been done well owing to the competing (if not commercially conflicting) priorities, interests, and involvement of multiple different public, private, and individual stakeholders. Stakeholder management, when the stakeholders are as varied in their needs and working practices as local authorities/planning committees, national government, private operators, business groups, environmental organisations, and users, is all important. Indeed, public transport integration works most effectively when there is good communication between all parties and all stakeholders are incentivised to work towards a common goal that benefits everyone.

There is a compelling need to make public transport work by making it easier, cheaper, and more convenient to access. The goal of reducing private vehicles will not only lead to reductions in congestion and improve local air quality, it will also help countries meet increasingly urgent goals on climate change by helping to decarbonise their transport systems.

The COVID-19 pandemic is likely to have a major impact on the passenger use of public transport interchanges. Future research will be required in relation to the use of such hubs as attractive places to meet and to facilitate multi-modal journeys by air, rail, tram, bus, coach, and so on, journeys that from a public perspective are unlikely to be risk free. There will be a reluctance to undertake journeys involving hubs in the short term post-COVID-19, and research focusing on the role of planning and service providers will be all important so as to address legitimate user fears, not least since the spread of the pandemic in the first instance was

facilitated by air passenger movements (see Budd & Ison, 2020). In addition, at the time of writing, the advice of many governments is to avoid the use of public transport if at all possible. Transport infrastructure has been constructed in an ad-hoc manner, and clearly uncoordinated planning is unlikely to be sufficient in the post-COVID environment. Research will be required as to the correct response of planning, in terms of the both the aftermath of the pandemic and preparing for future reoccurrences, involving all stakeholders but the user in particular. While a high-quality, frequent, convenient integrated transport service is required, a safe environment will be paramount.

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