RAISE-IT

Guidelines for Improving the Urban Node Accessibility at Railway Stations on the Local and Regional Level

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The Guidelines represent the RAISE-IT Milestone 15 and are based on RAISE-IT Activity 1: Urban Nodes Accessibility and Activity 2: Seamless Connection from the Nodes

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1. Introduction

To promote a more sustainable way to travel, a modal shift from car or from short distance air travel to rail journeys is needed. Travel time savings are commonly seen as one of the key arguments for using a specific transport mode. Consequently, the whole travel chain from high-speed and/or long-distance rail to locally available modes needs to be considered[1]. Here, good interconnections with other modes such as walking, cycling or public transport are of great importance. They are also instrumental for increasing the overall quality and users' experience of train journeys. In addition to operational aspects of transportation, factors such as the quality of rail stations and their surrounding environment also play an important role in recasting and improving the attractiveness of rail journeys. From a users' perspective there is an urgent need to develop seamless and pleasant passenger transport solutions.

Modern stations are increasingly expected to accommodate a variety of services and facilities for different transport modes and urban amenities such as cafes, shops or hotels. In particular, additional mobility services such as car- and bike-sharing stations or dedicated charging columns for electric cars have called for extra space. However, many stations premises and immediate surroundings already face challenges due to limited availability of space. Stations need to be efficient in order to fulfil their actual purpose i.e. operations of transport services. Movement within the station and through the wider area are of similar importance for the users of these services. Here, stations need to be accessible for all types of users and they should provide good connections and route choices. A good usability is also related to aspects such as easy and effortless wayfinding, good service information and comfortable and secure waiting environments (TfL, 2009). In parallel with infrastructure and operational aspects, an efficient and inclusive public space should be created for improving the urban node accessibility and at the same time there is a need of comprehensive ways of integrating local, regional and long-distance passenger rail transport.

The present guidelines aim to provide recommendations towards an inclusive approach and a design for everyone in order to cater for the needs from diverse user groups such as commuters, tourists and other non-regular users or those with special needs such as visually impaired people. Each user's perspective can be influenced by various factors (e.g. the type of trip, external circumstances such as weather and congestion or individual's well-being and

[1] RAISE-IT Activity 3 Guidelines (Delpiano and Endemann, 2019)

condition). Van Hagen (2015) states, that the needs of the users are a pivotal point in enhancing the quality of a train journeys and the use of stations.

Moreover, a Swiss study showed that the user perspective differs substantially from the planners' assumptions, especially when it comes to bigger interchanges (Van de Wetering et al., 2007). In such complex situations, the overall quality of the interchange is judged by the ambience and organisation of the space and users don't distinguish sharply between different aspects such as ease of transfer, service of different modes, signage or cleanliness. Improving single aspects can surely add to a positive overall experience, but user's experience in rail journey should be improved in a holistic way. For example, direct paths are of high importance in transfer as well as travel related information. They should allow fast passages e.g. between platforms and only travel related retail and ticket purchase should be allowed nearby[2]. Also, the overall impression can be improved by balanced lighting a friendly atmosphere and cleanliness, both for main station concourse and hidden corners. In combination with a well-arranged configuration, it makes user's orientation and wayfinding easier while reducing stress and also improving the user experience, and thus increases the rating of other aspects and the overall contentment with the train journey.

1.1 RAISE-IT Project

The RAISE-IT project examined the better integration of long-distance rail, including high-speed rail, with regional and local transport networks along the Rhine-Alpine Corridor. It explored accessibility of passenger train services at key urban nodes by looking into manifold travel distances and destinations along the Corridor in a multi-spatial approach.

According to TEN-T Regulation, "urban node" is defined as the starting point or final destination for passenger and freight travelling on the trans-European network (EU, 2013[3]). For the RAISE-IT project the term "urban node" refers to an urban area where a railway station is located, while "node" means the railway station itself.

[2] Van de Wetering et al. (2007) and SVI (2013) refer to travel related retail as "run-shopping" in contrast to other retail and services that are referred to as "fun-shopping". These as well as advertisements should not be located where transfer between platform or between modes takes place and thus should not interfere with the orientation and wayfinding processes.

[3] "[…] those nodes are the starting point or the final destination ("last mile") for passengers and freight moving on the trans-European transport network and are points of transfer within or between different transport modes." (Regulation (EU) No 1315/2013: (30))

In line with the multi-spatial approach, three spatial scales have been investigated in three activities (Figure 1):

1. **Activity 1**: **urban node accessibility** (within railway stations and in the surrounding areas as well as the accessibility from/to stations at the local level);
2. **Activity 2**: **seamless connection from the nodes** (the regional level of accessibility); and
3. **Activity 3**: **corridor concept** (corridor-wide connections between the nodes at the inter-regional level).

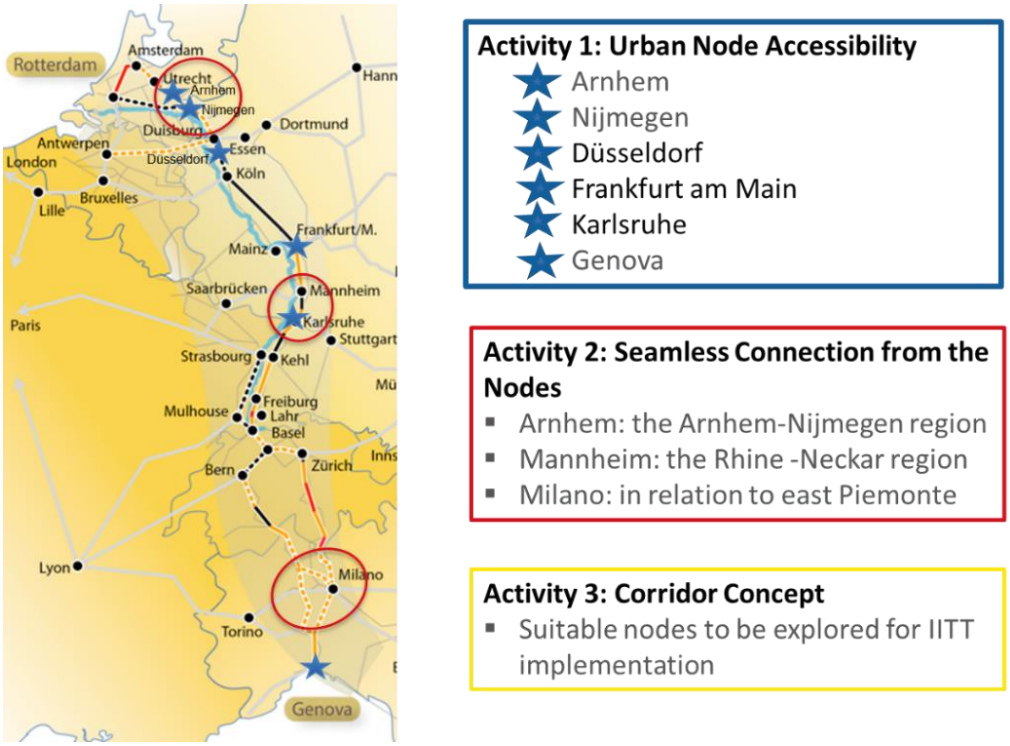


Figure 1. RAISE-IT partners and three activities
(Source: own illustration by Otsuka and Endemann, map adapted based on CODE24 initiative).[4]

The focus of the present guidelines is placed on the first and second scale of accessibility: the local and regional level. The guidelines aim to provide concrete examples for showing a comprehensive approach to improving (travel) experiences for all passengers and users of the services provided.

[4] https://egtc-rhine-alpine.eu/de/code24/

1.1.1 Study on Six Rail Stations at the Local Level

To examine urban node accessibility at the local scale (Activity 1), the performance of six rail stations along the Rhine-Alpine Corridor was studied (Arnhem, Nijmegen, Düsseldorf, Frankfurt am Main, Karlsruhe and Genova[5], see Figure 1). For each case study, the accessibility within and from/to the railway station was examined with reference to urban travel modes and services including walking, cycling, car- and bike-sharing and different types of public transport. The spatial levels ranged from station premises to the urban area within the municipality's boundary and different methods were used accordingly (Otsuka et al., 2019a).

- **Accessibility of a station and its adjacent area**, based on field observations and interviews with station managers using ten indicators (i.e. architectural and urban design, station facilities, intermodal and access facilities, ease of transfer, liveability and comfort, station square and adjacent area, information provision, station management, safety and security, and climate change adaptation; Figure 2);
- **Walkability of urban neighbourhood within a radius of 800 m from the station**, based on field observations with reference to four criteria for assessment (urban structure, design of the street, obstacle and traffic safety, and personal impression), walkability maps and a comparison of primary results with an adjusted version of Walkscore®[6] (Figure 2);
- **Accessibility to/from the station at the urban scale using different transport modes**, based on available sources, calculation of different indicators (e.g. average number of transfers, minimum travel time and average travel time with public transport as well as number and distribution of car- and bike-sharing) and creation of GIS maps for a city-wide overview (Figure 3).

Findings from the analysis were debated together with local stakeholders at roundtable discussions in each of the six urban nodes. In the roundtable discussions, complex issues were expressed by different stakeholders as well as conflicting priorities and goals in terms of improving rail stations. Key issues that were raised during the workshop were further

[5] The analysis for Genova was carried out on the two stations Piazza Principe and Brignole.

[6]. The original 'Walk Score®' provides scores based on the walking distance to the closest amenities (https://www.walkscore.com/). RAISE-IT developed a modified version and imposed some penalties with reference to traffic noise, road speed limits, traffic accidents (pedestrian) or air quality.

discussed at an expert workshop together with international academics, train operators, regional and local authority representatives.

Station and adjacent area

- Field observation with Likert scales
- Interviews with station managers

Walkability study: R. 800m

- Field observation (Walkability maps/ Rader Graphs)
- Walk Score®

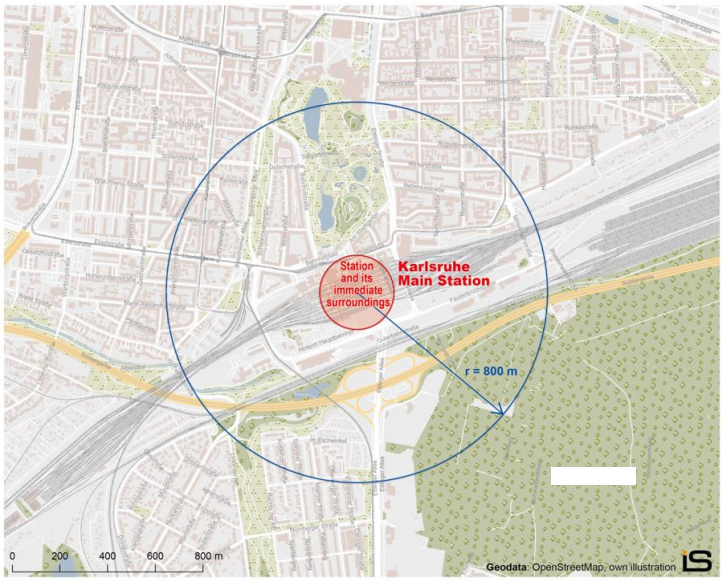


Figure 2. Study areas: station's accessibility and neighbourhood walkability at the local scale (Karlsruhe Hbf) (Source: own illustration by Otsuka, Gerten and Rönsch © ILS 2019, map adapted based on OSM).

Neighbourhood zones:

1 Grötzingen
2 Wolfartsweier
3 Oberreut
4 Grünwettersbach
5 Rüppurr
6 Palmbach
7 Hohenwettersbach
8 Waldstadt
9 Weststadt
10 Weiherfeld-
11 Dammerstock
12 Innenstadt-West
13 Nordstadt
14 Daxlanden
15 Nordweststadt
16 Südstadt
17 Stupferich
18 Mühlburg
19 Rintheim
20 Grünwinkel
21 Knielingen
22 Durlach
23 Südweststadt
24 Oststadt
25 Beiertheim-Bulach
26 Innenstadt-Ost
27 Neureut
Hagsfeld

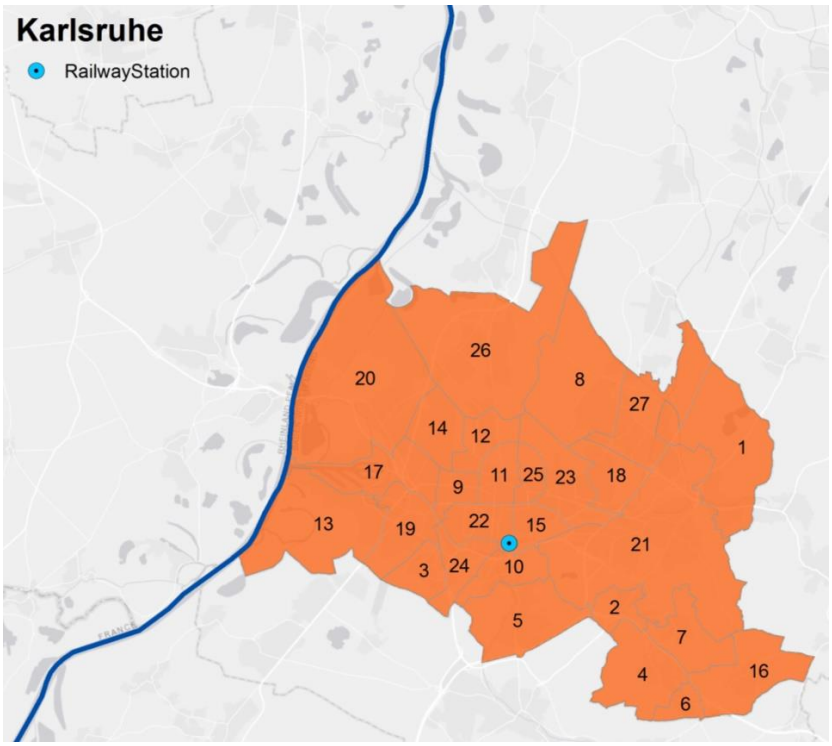


Figure 3. Study area for accessibility from/to station at urban scale (Karlsruhe Hbf) (Source: LINKS Foundation).

1.1.2 Seamless Connection from the Nodes at the Regional Level

Seamless connection from the nodes at the regional level (Activity 2) was analysed in terms of integration between long distance rail services and local/regional public transport services connecting the main railway nodes along the Corridor with their catchment area. Three case studies were considered: Arnhem node with Arnhem-Nijmegen region, Mannheim node with Rhine-Neckar region, and Milano node in relation to East Piemonte and West Lombardia. Major outcomes were developed through a participatory approach comprising a local meeting and two workshops for each case study. Stakeholders involved included: regional authorities, public transport operators, mobility agencies, Chambers of Commerce, trade associations. In detail, the methodology common steps included (Figure 4):

- The definition of the "regional area" (catchment area of each pilot node) in cooperation with the involved stakeholders. The regional areas selected for the three case studies are depicted in Figure 5 and were quite different in terms of spatial coverage, population density, user groups and level of public transport services provided. This produced different outcomes and allowed the representation of different contexts and aspects along the Corridor.
- The definition of a vision/strategy to improve regional accessibility to long distance trains co-designed with local authorities and relevant stakeholders.
- The assessment of current and perceived accessibility at the regional scale, carried out through desk analysis and surveys and discussed with relevant stakeholders.
- The identification of major gaps between vision and current accessibility. Gaps ranged from very specific issues at primary[7] nodes already enjoying a high level of service (e.g. long connecting times or need of two interchanges towards important destinations, mainly due to infrastructure capacity problems) to more general ones at secondary nodes (e.g. service frequency, information), to common issues (e.g. lack of integrated ticketing).

[7] Primary railway nodes refer to main railway stations along the Rhine Alpine Corridor already providing a high level of service and integration with more than 20 international trains per direction and per day calling at the node. Secondary nodes are international stops along the Corridor mainly located in low densely populated areas and providing less than ten international trains stops per direction per day (and a lower level of service than primary nodes).

- The development of Action Plans addressing the three priority gaps for each case study. Depending on the gaps, they included solutions already on Public Authorities' Agendas (examined in detail and compared in terms of feasibility, realisation times and costs), or new actions with indications on actors in charge of implementing them.

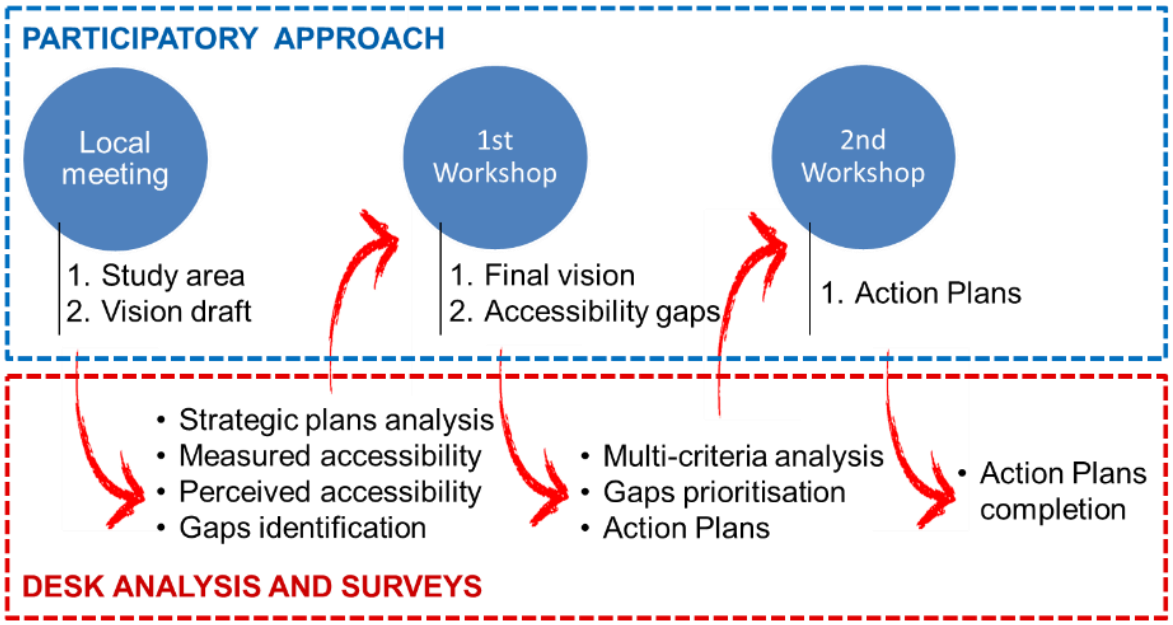


Figure 4. Methodological steps for seamless connection from the node analysis (Source: LINKS Foundation).

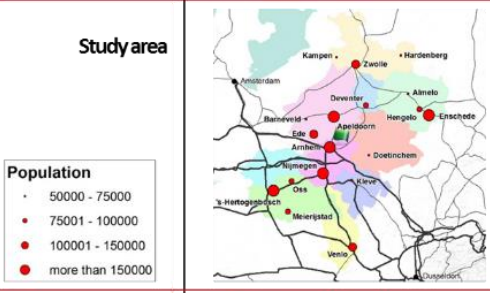
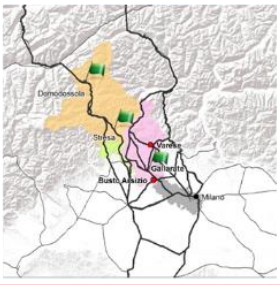
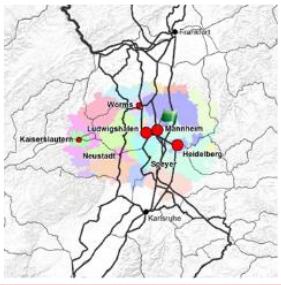
	Arnhem/Arnhem-Nijmegen	Milan/Piemonte-Lombardia	Mannheim/Rhein-Neckar
Study area			
Description	**Trans-national** area	Touristic **trans-regional** area	**Metropolitan** area
Area	**11.573 sqkm**	3.573 sqkm	6.254 sqkm
Municipalities	112	227	**343**
Pop. density	373 inhab./sqkm	283 inhab./sqkm	**428 inhab./sqkm**
Top 5 towns pop.	154.200 - 176.700	21.800 - 83.400	82.600 - [illegible]
International stations	1 (Arnhem)	**3 + 1 (Milan)**	1 (Mannheim)
International trains	24	5-7	**58**
International flows	Mainly **commuters**	Mainly **non-frequent users**	Mainly **commuters**

Figure 5. Regional level case studies portraits and study areas (Source: LINKS Foundation).

1.2 Guideline Development

The present guidelines are based on the main findings of RAISE-IT, including analyses at the regional and local levels and discussions with experts, stakeholders and local partners. They consist of five key themes that are presented in different chapters. The starting Chapter 2 provides an executive summary and highlights key recommendations for each theme.

The order of the subsequent chapters follows the users on their route. Once travellers get off a train and start walking towards their destinations, **Wayfinding to Station Facilities** and information provision within the station building is the primary factor to be considered (Chapter 3). Then, the **Layout of Stations and Quality of Facilities** such as waiting area, left luggage, shops and toilets which often have a strong influence on wayfinding and intermodal connections (Chapter 4) are discussed. Subsequently, **Integrated Approaches to Intermodal Connections** are explored in terms of both the local and the regional accessibility by looking into different transport modes (Chapter 5). When people need to exit the station building, they often enter the station square or need to use underground passages to walk towards different facilities or in order to reach a destination in the city. **Walkability around Stations** is therefore the subsequent topic to be discussed (Chapter 6). Finally, **Optimal Use of Space in the Station Area** is discussed with reference to various issues like fragmented landownerships or other restrictions such as heritage protection and design codes of station buildings (Chapter 7). Chapter 9 presents references to literature and good examples that were used in the guidelines.

Each theme starts with a presentation of lessons from RAISE-IT study results including improvement areas and good examples which were indicated as **(-)** or **(+)** when they are presented. (-) stands for necessary improvements and (+) stands for good examples. They are extracted from findings of the analyses at the local and the regional level. Furthermore, complementary and additional information are brought from any other stations than RAISE-IT case studies with reference to literature, other guidelines and good practices. They are based on a RAISE-IT literature and case study research and participants' input during the RAISE-IT workshops.

2. Summary

To improve users' experience in rail journeys, the guidelines are concerned with the urban node accessibility at and from/to railway stations with reference to the local and regional spatial levels. Five key themes are identified following users' routes from the platform to their destination: Wayfinding to Station Facilities; Layout of Stations and Quality of Facilities; Integrated Approaches to Intermodal Connection; Walkability around Stations; and Optimal Use of Space in the Station Area. To fulfil the travel needs from diverse user groups, the guidelines aim to provide recommendations towards an inclusive design, planning and management of rail stations and to optimise their integration with different public transport services and other transport modes.

Good wayfinding systems provide users with clear directions on their routes. Signs and pictograms are the key to wayfinding. They should be consistent, visible and recognisable, based on a systematic scheme using appropriate size, same colours and designs all along a route. In particular, clutter and overlap with commercial advertisements should be avoided. The direction to other transport modes and services and towards city centres should be well indicated within a station and its surroundings. Better systems of wayfinding help users to locate themselves quickly and guide their way easily, thus improving users' experience in the overall aspects of their train journeys. The clear configuration of a station building certainly makes users' orientation easier, and therefore wayfinding to station facilities should be planned in close alignment with the layout of station facilities.

In addition to functional aspects of transportation, the spatial layout of station facilities should be designed in response to users' various needs. To provide a good accessibility to several transport modes and services, transport related facilities such as bicycle parking spaces and metro/tram stations should be strategically placed to assist users in their fast movement towards their next dentations. In contrast, such areas where users tend to stay for a while (e.g. cafes, retail units, waiting areas) should have different design priorities in order to offer users a pleasant experience during their stay. Place making of public spaces and creating a user-friendly atmosphere have been increasingly recognised as one of the key factors to improve the quality of a station. A harmonised and bright ambient can be created through the use of natural light on platforms and station concourses as well as well-designed lighting that also should be applied for underground passages. At last but not least, well-maintained

street furniture, floors and ceiling and graffities free walls are the key ingredients for making people feel safe and comfortable.

To offer users a seamless and efficient travel chain, a better integration of transport services and of different modes can be achieved through several methods/tools. Integrated timetables are instrumental to optimise the connection of local and regional transport networks with long-distance and high-speed rails. This can be complemented by frequent public transport services in urban areas. It is also crucial to extend new mobility services (i.e. shared mobility) to peripheral areas beyond the city centre where such services are currently concentrated. To make users' experience in intermodal changes more pleasant, integrated ticketing systems for intermodal connections should be further improved. In case that a totally integrated ticketing system is not yet available, electronic tickets and smart cards that can be used for different transport services can be seen as an efficient solution. Also, real-time information for different modes and services should be available on the platforms and other important parts of the station building and its surroundings. Face-to-face communication between users and service providers is also an effective way for getting information. Thus, training for customer's relation should be provided to members of staff who are working for transport operators and are in direct contact with customers such as bus drivers.

In order to make urban transport more sustainable and well connected, the importance of walking and cycling in achieving low-emission and car-free urban mobility needs to be highlighted. Walkability around stations can be improved through a better design of pedestrian sidewalks (e.g. widen the width). In particular, tunnel walkways under rail tracks, that are connecting the two sides of a city, require innovative solutions for transforming an often narrow and long dark space into a bright and pleasant path. Walking is the active transport mode accessible to everyone, and special measures to improve the walkability for all types of users should be taken into account. Giving priority for pedestrians at traffic crossing and reducing traffic speed limits increase perceived safety of pedestrians. Also, well-lit and regularly maintained streets have a great contribution to this end. Bikeability around stations is another key agenda that can be improved by extending clear bicycle lanes up to the station's bicycle parking space.

Finally, the traditional configuration of a station's infrastructure should be reconsidered to meet the requirements for modern stations. Over the last two decades stations have been playing a strategic role in restructuring their immediate surroundings in alignment with the renewal or redevelopment of the station building. Given the limited space of the station area, an optimal use of this space should be the key agenda for future discussions. In many stations prime locations of station squares have been allocated to access facilities to private cars and public transport, while less priority was given to the space for walking and cycling. Additionally, there is an increasing demand on stations to accommodate new mobility related infrastructure (e.g. parking spaces for shared mobility or electronic car recharge stations) as well as commercial and business facilities. Stations are nowadays expected to function as a mini-city centre, that is a complex place for addressing the needs from different strata of people. It takes an extensive time to reshape stations for modern usages, and thus interim solutions during the redevelopment process should be always in place in order to reduce a long-term disturbance for users from a large-scale construction work.

3. Wayfinding to Station Facilities

Wherever people go, they need to find their way. The process of wayfinding at an interchange and its surrounding includes how people orient themselves and how they navigate from place to place. As briefly described by Lidwell et al. (2010, p.260), the process of wayfinding follows four stages:

- **Orientation**: customers need orientation about their location and the desired destination e.g. bus stop, another platform or a waiting area, ticket counter or shopping facilities;
- **Route decision**: a decision about the route is needed. Most transport users prefer direct routes to the selected destination;
- **Route monitoring**: While walking, people need to know where they are and monitor their path in order to make sure that they are still heading towards the desired destination;
- **Destination recognition**: when people arrive at their desired destination, they need to be able to recognise it.

Good wayfinding systems at interchanges thus need to tackle all of those four stages within a comprehensive approach. Interchanges often form a hybrid type between transport station and urban centres, in such complex situations wayfinding systems are of great importance. A wayfinding concept should be established including visible and recognisable signs or pictograms with consistent colours all along a route. Clutter and overlap with commercial advertisement should be avoided in order to improve visibility. In addition, good wayfinding helps to increase interchange passenger capacity and also reduces travellers stress level and helps to increases users' satisfaction[8].

[8] As Robin Woods points out, signs should be conceivable and easy to follow, pieces of arts can help orientation (see presentation that was recommended at the RAISE-IT expert workshop: recorded 2018 in Utrecht, the Netherlands https://www.youtube.com/watch?v=efdVRQwyfFM (last accessed 2 Nov. 2019).

3.1 Lessons from RAISE-IT Case Studies

Wayfinding is one of the main topics identified by the RAISE-IT local partners as a result of the six case study stations. Wayfinding to station facilities should be further improved since some station facilities and the connection to other public and private transport modes and services (e.g. Kiss & Ride, Taxi bay, bicycle parking, long-distance bus terminals, etc.) are not in line of sight and poorly signposted. Moreover, the complicated arrangement of intermodal connections in modern stations often confuses people, especially if they are non-regular users of the station.

The direction to bus stops, bicycle rentals, car- and bike-sharing stations at a station and its immediate surroundings should be well indicated. Visible and updated timetables and network maps should be provided in order to improve the travel experience of people to and from the station.

- **Kiss & Ride**: (-) in Arnhem Centraal Kiss & Ride is located at the roof top of the station building. There, it is located within the station building, but not in the line of sight of the potential users. In addition, it is difficult for drivers to find their way from the main road. Kiss & Ride is therefore currently underused (Figure 6). Unofficial drop-off and pick-up at the bus stop areas on the busy road on the north side of the station cause problems.
- **Long-distance bus terminal**: (-) Long-distance bus terminals are often located outside the rail station building but signage for wayfinding is missing (e.g. Frankfurt am Main, Düsseldorf, Nijmegen and Genova Brignole, Figure 6). Here, a conflict of interest was stated by train operators such as DB. When they perceive long-distance bus operators (e.g. Flix bus) as a competitor, they do not see the need for placing signposts to ease the access from / to rail station and the bus terminal.
- **Cater for different user groups**: (+) Genova's two stations (Piazza Principe and Brignole) offer high quality wayfinding for disabled communities together with dedicated information services to this user group. Several good practices are introduced through the recent renovation process (e.g. barrier free access, tactile and braille signs).

- **Signposting**: (-) In addition to the appropriate size and location of the signs, the consistency of the information needs to be considered. Frankfurt am Main Hbf presented an interesting example as Milano Centrale station was announced with the Italian name (Milano Centrale), while the German name (Mailand) was used on platform announcement board in Mannheim Hbf and Karlsruhe Hbf.

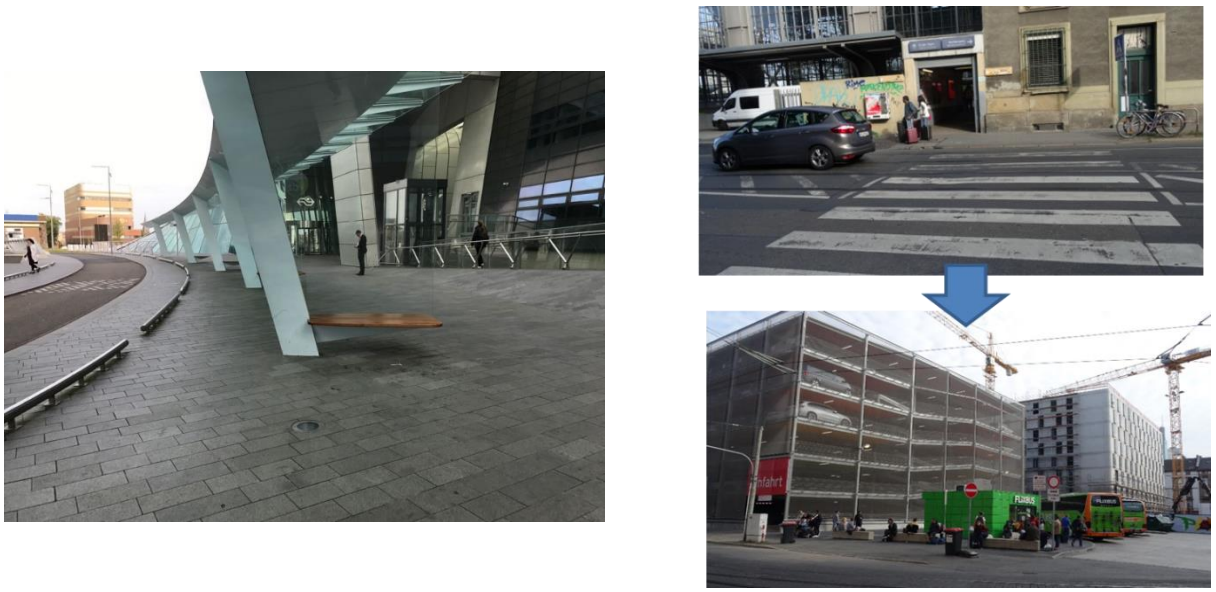


Figure 6. Underused Kiss & Ride in Arnhem Centraal (left © Otsuka).
Wayfinding to long-distance bus terminal in Frankfurt am Main Hbf (right © Otsuka).

3.2 Further Examples from Stations and Guidelines

In additional to the above presented RAISE-IT examples, an excerpt of further examples and guidelines on wayfinding are shortly described below.

Porta Susa station, one of Torino's train stations, was mentioned as a good example at the expert workshop for Activity 1 (Otsuka et al., 2019b). The transparent glass roof of the extended underground station is a new Torino landmark. Trains and metro both depart underground and the clear design and the spatial layout of facilities, pathways and connections to different services supports easy wayfinding (Figure 7).

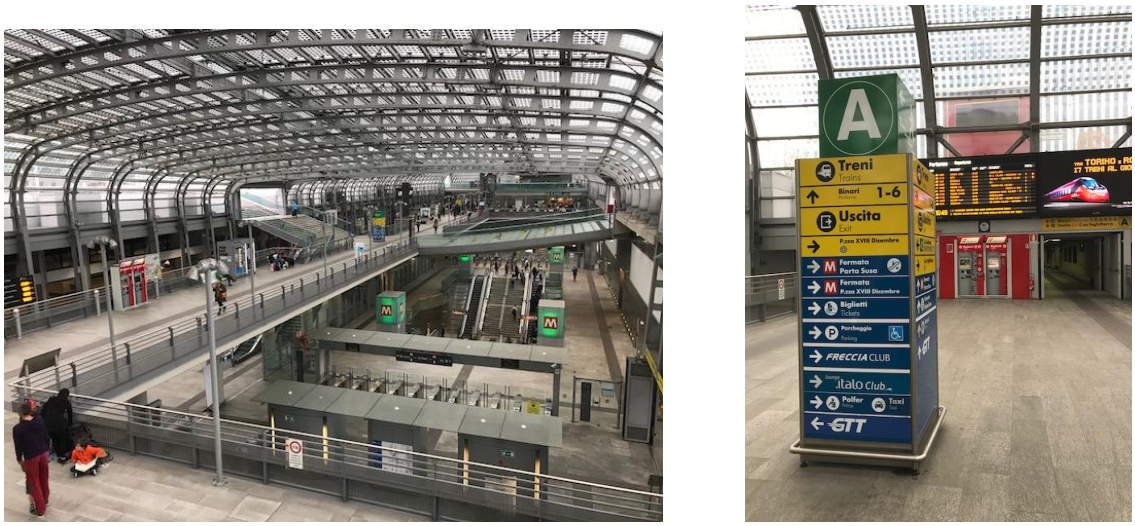


Figure 7. Porta Susa in Torino (© Otsuka & Welsch).

Milano Metro was mentioned at the expert workshop as another good example for a holistic approach and a good design as well as a good wayfinding system. Here, signage and wayfinding were designed by a graphic designer, Bob Noorda[9], who worked in close cooperation with the architect. To make wayfinding and orientation as effortless as possible for users, a colour-code was used, e.g. red for the line 1. Handrails and furniture such as seats use this colour consistently. At the stations, a continuous stripe of the red colour was put on the wall in such fashion that it was in line of sight for the train passengers and easy to read signage was placed there (Figure 8). Having the user's perspective in mind, the station

[9] Description of the design: https://www.citylab.com/design/2016/05/the-undervalued-simplicity-of-bob-noordas-vision-for-milans-metro/483782/.

names were placed repeatedly and additional signs were added, e.g. to mark exits or transfers to other places or lines, thus making it easy to orientate and find the way.[10]

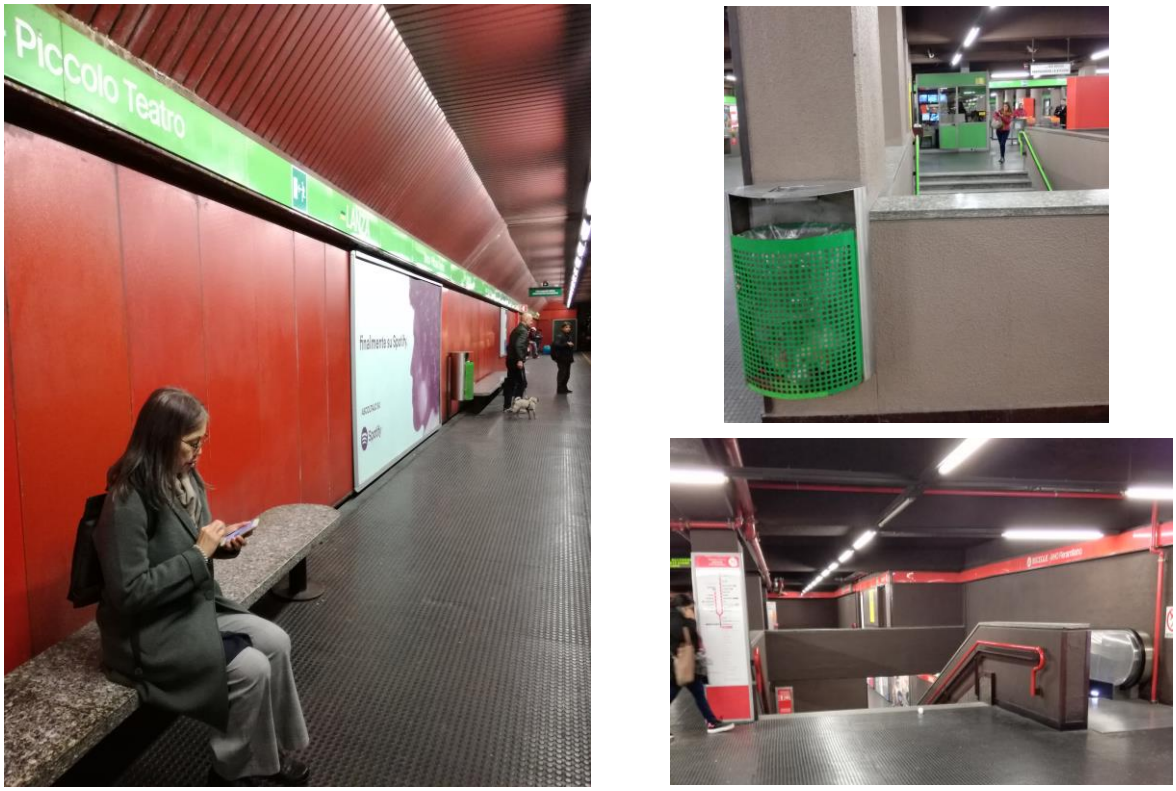


Figure 8. Milano Metro green and red line (© Otsuka & Welsch).

An example of general guidelines, '*Legible London*' is a good example for planning and designing a systematic scheme for wayfinding. It was created to guide people, in particular pedestrians, in order to understand London complex urban structure and the transport system (Figure 9). It aims to enhance walking choices and experience, provide a better orientation, point people to different destinations, add information about walking time and distances and thus it makes it possible to offer better route choices and increase access and walking experience, in close coordination with other local activities (TfL, 2007; TfL, 2018; TfL, 2019). A good example for a signpost for visual impaired people is provided at the station of Piazza Principe in Genova (Figure 9).

[10] Similar, Massimo Vignelli and Bob Noorda produced a Graphics Standard Manual for the subway system of the New York City Transit Authority (https://standardsmanual.com/pages/original-nycta). Short video why reprint occurred (https://www.kickstarter.com/projects/thestandardsmanual/full-size-reissue-of-the-nycta-graphics-standards).

Figure 9. Signpost at Genova Piazza Principe station (left © Otsuka).
'Legible London' (right © Stevekeiretsu 2015[11]).

Several guidelines aim for improving interchanges and refer to layout and wayfinding within stations in general and to different facilities as one of the main aspects. In order to facilitate better wayfinding, the interchange area should be divided into different spaces dedicated to different purposes. Transport for London refers in its guidelines on interchanges (TfL, 2009) to:

- **Decision spaces** where passengers need to decide where to go e.g. entrances or corridor junctions. Here, a clear signing or transport information and good sight lines are important and no other information should distract or confuse passengers;
- **Movement spaces** connect those decision points and include connections between transport modes and services or the stations surroundings. Direct paths and unobstructed routes are important, no retail units should be allowed here but can be placed in adjacent areas.
- **Opportunity spaces** include those areas that are not involved in passengers' decisions or transfer and could accommodate travel related facilities like vending machines or ticket counters and other facilities such as cafes, waiting zones or shops.

[11] Retrieved from Wikimedia Commons: https://commons.wikimedia.org/wiki/File:Legible_London.jpg#filelinks

4. Layout of Stations and Quality of Facilities

The planning and development of most stations are traditionally based on a functional design. For the design of railway stations, priorities tend to be placed on how to operate trains and how to transport passengers from A to B as well as the circulation planning of passengers within a station building. Thus, place making of a public space as well as creating a user-friendly atmosphere and a good travel experience have been dealt with as a secondary matter. Structural engineers, traffic engineers and architects are the key actors to lead the physical and infrastructural design of stations.

In recent years, users' travel and waiting experiences has increasingly come to the fore and the importance of monitoring user's satisfaction in rail journeys is also emphasised for example by van de Wetering et al. (2007) and the previous EU funded project, called NODES (van der Hoeven et al., 2013).

For example, the Station Experience Monitor (SEM) has been developed as a measurement instrument by Nederlandse Spoorwegen (NS, Netherlands Railways)[12] and ProRail. Four spatial domains[13] within a station have been considered in order to address the needs from different user groups according to time and place (van Hagen, 2015; Peek and van Hagen, 2002):

- **Arrival** or **reception domain**: where people buy tickets and get information;
- **Stay domain**: shopping, dining and waiting area where people stay;
- **Travel domain**: where people can quickly move round (e.g. platforms, station concourses);
- **Surrounding domain**: the interface between city and station;

The SEM was developed to guide interchange designers and operation managers to create a user-oriented station for the purpose of delivering a more pleasant and attractive interchange for users. In addition to the physical layout and design, the place is also determined by environmental and atmospheric conditions such as colour, brightness, sound, scent and infotainment. Hernández and Monzón (2016) identified key factors for an efficient urban transport interchange from users' perspectives, and they have pointed out how people's

[12] See the formal policy for station design introduced by NS in https://www.spoorbeeld.nl/
[13] They differ from the above-mentioned spaces, but also support the idea of describing purposes for spaces in/at stations that need to be considered, designed, maintained and managed accordingly.

perceived safety, security and comfort can be influenced positively by good design, operation and management of urban transport interchanges.

4.1 Lessons from RAISE-IT Case Studies

The previous chapter highlighted the importance of wayfinding and the fact that a good spatial layout of a station contributes to easing user's orientation. Users' satisfaction can be enhanced not only by the location and layout of station facilities, but also by their design and quality. Station facilities should be useful, usable, and pleasant for all user groups. A previous EU funded project, Trendy Travel (2010) has clarified two distinctive types of user experience at a railway station: fast and slow. The fast area corresponds with the transfer area where users need to move around efficiently, fast and easily. Station facilities such as retail units, food stalls and cafes but also seasonal events (e.g. Christmas markets, concerts) should be carefully located in order not to obstruct fast areas and people's movements within these areas. In contrast, the slow area should offer a comfortable, pleasant, and useful experience for people to spend their time. When they are waiting for their departing, connecting or delayed trains, well-designed and pleasant waiting area help in shortening their perceived waiting time.

- **Waiting area**: (-) The RAISE-IT team is pointing out the shortage of seating areas for German stations, while closed waiting areas are exclusive to the railway card holders with frequent traveller status[14]. This point is especially evident in Frankfurt am Main Hbf and Karlsruhe Hbf cases as there is a lack of seating opportunities in and around the station. More seating area is instrumental for improving users' waiting time.
- **Shelter**: (+) the terminus model of stations offer users a good shelter on platforms, protecting from cold weather, heat and intense sunshine as it seen in Frankfurt am Main Hbf (Figure 10).
- **Street furniture**: (-) There are some dated and not well-maintained station facilities (e.g. benches on platforms), and run-down walls with graffiti inside the station building (Frankfurt am Main). This kind of situation is known to make users feel unwelcome, unpleasant or uneasy.

[14] Holders of a German BahnCard with a frequent traveller status and those with Bahncard 100 (annual rail pass for the whole network) can use especially built waiting areas (DB Lounges) in some stations like Frankfurt am Main Hbf.

- **Bicycle parking**: (+) In Frankfurt am Main Hbf the new development plan of the City of Frankfurt foresees a bicycle parking garage on the north side of the station. It is an important milestone and will provide additional space beside the existing bicycle parking space on the south side.

  (-) The shortage of bicycle parking was pointed out also in the Düsseldorf and Karlsruhe cases. Informal bicycle parking seems to be common practice in the Düsseldorf station squares (Figure 10). For the latter due to a big development project on the southern station square, some of the bicycle parking and car-sharing spaces will be lost, and thus solutions to increase the number of parking spaces are needed.

  (+) Dutch stations have a wealth of experience in accommodating a large number of bicycle parking spaces within the station premises and Arnhem has got over 5,000 bicycle parking spaces.

- **Layout** and **design of station building**: (+) ProRail and NS have a general concept for all the Dutch stations in terms of spatial characteristics and functionality. The layout of the station has been clearly divided into four spatial domains as explained in the introduction of this Chapter.

  (-) The terminus model of stations often faces difficulties in serving a large number of passengers transferring between platforms. For Frankfurt am Main Hbf there is a plan to widen the underground walkway that connects the platforms in order to reduce congestion of the main station concourse and to increase passenger capacity in the future. At the moment shops and food stalls are located densely within the main concourse of Frankfurt am Main Hbf. This layout clearly blockades the circulation of the crowd of people who are getting on/off trains and are struggling to go through narrow walkways between retail units (Figure 10).

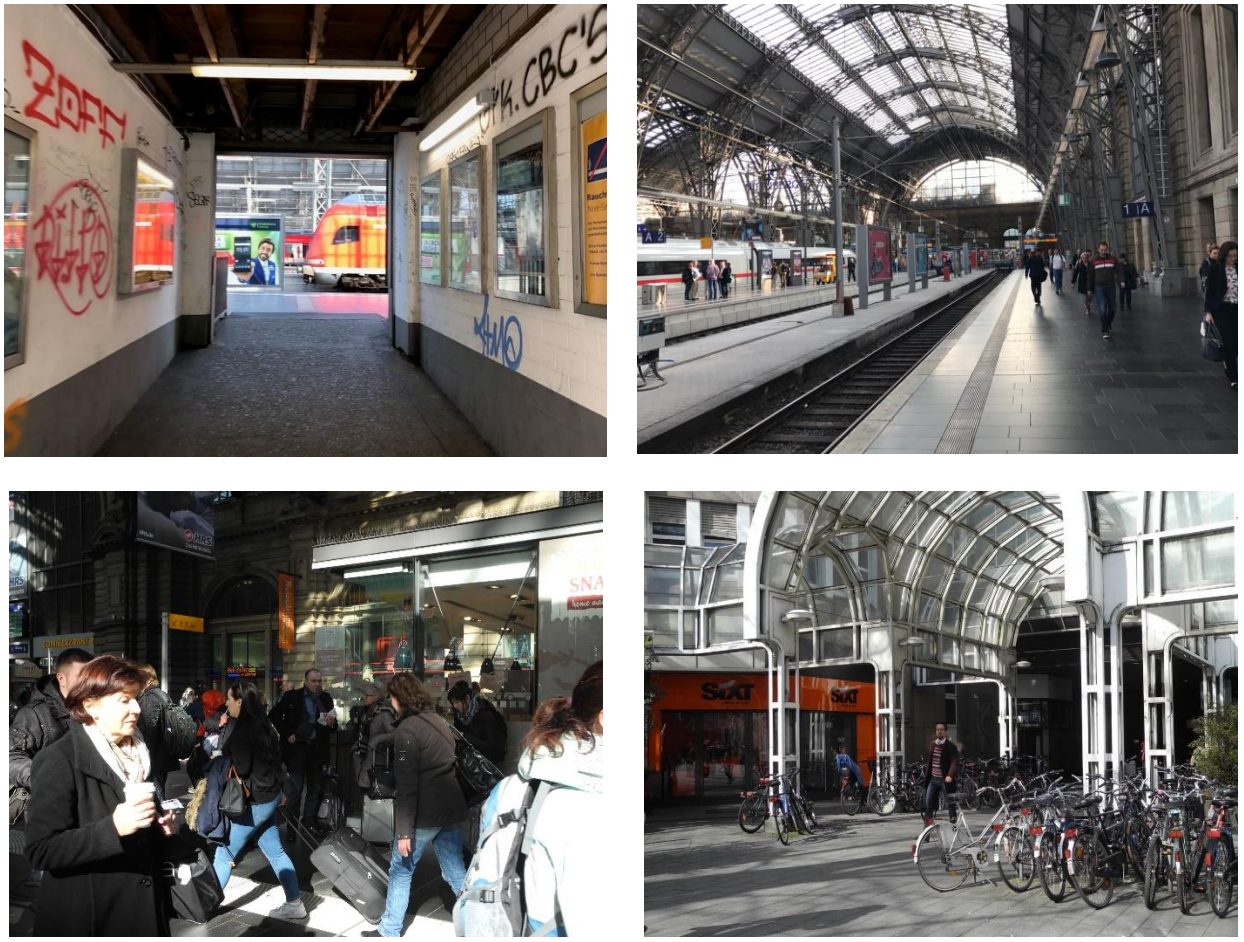


Figure 10. Frankfurt am Main Hbf: Graffiti (left top), shelter in the terminus model (right top), congested station concourse (left bottom).
Informal bicycle parking in one of the Düsseldorf station squares (right bottom) (all: © Otsuka).

4.2 Further Examples from Stations and Guidelines

In addition to the previously mentioned guidelines that refer to different spaces or domains and to different user needs with regard to station wayfinding, layout and facilities, in the following good examples that were discussed during RAISE-IT meetings and workshops are presented (Otsuka et al., 2019b). For example, the Italian station Roma Termini represents a good balance between architectural quality, accessibility with regards to core transport functions (platform access/egress, ticket purchase and travel information) and accessibility with regards to commercial areas (Figure 11).

In Rotterdam, Netherlands, the newly rebuild station entrance building was officially opened in 2014. The modern station Rotterdam Centraal provides good accessibility by several modes, especially through large bicycle parking areas, nearby bus, tram and metro stations and an underground parking garage for cars. The very legible station also presents the travellers with a good layout and orientation and clear lines of sight. The meeting point is highlighted with a cloud of lights, and the stations ambience is intensified by the use of natural red stone, a wooden roof, and natural light both, on the platforms (Figure 11) and in the hall. Shops and stores (food and non-food) are located near the escalators to the platforms and the large video screen with slow moving pictures of Rotterdam Harbour gives local colour.

Figure 11. Roma Termini (left © Endemann).
Platforms of Rotterdam Centraal (right © Endemann).

The local rail station Taunusanlage in Frankfurt am Main, Germany, can be seen as a good example for renewal of the underground walkway. Here, a new design and lighting was installed in order to create a harmonious ambience for passengers, whose main destination is the surrounding financial district (Figure 12).

The Yokohama station (横浜駅) in Japan is a good example for designing a station for daily commuters. It allows good interchange between different public transport services and other modes and is fully integrated with other uses such as shops and offices. Within the densely build environment, the user's needs for a seamless and pleasant interchange are taken into consideration. Therefore, stations like this are built to be efficient for transport and other activities and there is no strict separation between transport and other functions (Figure 12).

Figure 12. Taunusanlage in Frankfurt am Main (left © Gross).
Yokohama-Eki (横浜駅) (right © Chen).

5. Integrated Approaches to Intermodal Connection

EU transport policy, from the transport White Papers of 1992 and 2001 via the Communication “Keep Europe Moving – Mid-Term Review of the Transport White Paper” of 2006 to the latest European Commission’s White Paper “Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system” of 2011 include the objectives to offer a high level of mobility to people and businesses throughout the European Union and to better connect internationally. In order to achieve these objectives, the EU supports the development of several measures. They aim to optimise each mode to meet the objectives of a clean and efficient transport system and to integrate modes for seamless transport and supporting co-modality, that is the efficient use of different modes on their own and in combination[15].

Shift towards more environmentally friendly modes is especially required on long distances, in urban areas and on congested corridors such as the Rhine-Alpine Corridor. The integration between the different transport modes and services is one of the main challenges faced by multimodal passenger transportation systems and refers to five **key aspects** (Booz Allen, 2012):

- **Physical integration**: the interchange stops should be designed and sited with ease of access in mind;
- **Network integration**: the routes and schedules of each mode of transport should be designed such that they complement and are linked to the other modes;
- **Rate integration**: the fare system or payment method (electronic cards) should be unified or alternatively, users who use different services or modes during their trips should have special fares;
- **Information integration**: the information of the entire system should be standardised by means of signage which is complete, useful and easy to look-up and understand;
- **Institutional integration**: the different operators and agencies involved in the system should cooperate and coordinate their actions.

[15] Multi-modality refers to the use of different transport modes in general, while inter-modality is used more specific and refers to a mode change within one specific travel or trip e.g. from bicycle to train or between different types of public transport.

Integration is the key to improve users' trip perception since it fosters the efficiency of the entire transport system and ensures easy and accessible connections. It is the first step for providing a real user-centric service, and for creating a market ready for Mobility as a Service (MaaS). In its vision paper, the MaaS Alliance urges that the development of the whole transport sector, including multimodal and cross-border travel chains, should be closely followed before new legislative measures are taken (MaaS Alliance, 2018).

5.1 Lessons from RAISE-IT Case Studies

In order to provide seamless travel chains for people travelling along the corridor not only efficient connections between high speed, international and long-distance services should be provided, but also good interchanges with reasonable transfer times between urban, regional and local public transport and international trains needs to be guaranteed at international railway nodes. Also, frequent services can compensate ineffective connections and address the long transfer time issue shortening the waiting times (also see RAISE-IT Activity 3 guidelines). In addition, integrating alternative services such as car and bike-sharing, that are mainly provided by private companies, with the public transport supply can improve the connections to and from railway nodes.

- **Integrated timetables**: (-) Regional and local public transport services are mostly integrated at the national level in order to provide good connections for commuters and systematic passengers. The scheduling of international and long-distance trains follows different criteria and their integration with regional/local transport is not a priority. This often translates into ineffective transfer times between international and regional/local services (e.g. more than 25 minutes wait to transfer from RE 19 trains and national services to Zwolle in Arnhem; too long or too short transfer times in Domodossola between Eurocity trains from Switzerland and local public transport to the mountain Valleys[16]).

[16] Passengers arriving at 9.17 have a connecting solution after 2 or 3 minutes or need to wait more than 3 hours (or 2 hours if they arrive at 10.17 to reach Formazza and Macugnaga respectively).

(+) In few cases, local public transport services have been integrated, already during their planning phase, with long-distance international trains; a good example is represented by the Gallarate – Porto Ceresio line, a renewed local railway line recently opened by Lombardia Region (Italy), providing regular hourly services that are also integrated with 3/5 minutes transfer times with EC trains to/from Switzerland calling in Gallarate (only 2 stops/day per direction).

- **Frequency of public transport services**: (+) Public transport in urban areas often guarantees a high frequency service to all the zones of the Municipality thus supplying efficient **multimodal** connections. For instance, in Frankfurt am Main Hbf connections between the railway station and the different zones of the Municipality range between 5 and more than 30 per hour during the peak period (7.30-8.30).
  (-) High frequency services connecting primary railway nodes (that are often close to capacity limits) with their hinterland can affect the reliability of the service in terms of punctuality and thus the effectiveness of the changeover itself (e.g. between Mannheim and Heidelberg passenger trains run every ten minutes, but the trains are often delayed due to high congestion on the line and crossing with other lines). Improving the level of service in these nodes often implies infrastructure work or other hard measures that often depend on national policies and financing of main infrastructural improvements. (-) In secondary and minor nodes the public transport often do not provide adequate frequency of services (e.g. only few road public transport services are provided in Domodossola, Stresa and Gallarate towards tourist attraction points on the mountains or next to the lakes. This leads to service gaps within the daily schedules and missed connections in the Domodossola area during holidays and off-peak hours due to the fact that most of the local road services are provided during peak hours and winter time for workers and students). However, in such areas soft measures and regional policies supporting multimodal transport supply can still enhance the level of service.

- **Alternative and new mobility services**: (-) Sharing mobility services are predominantly serving the city centre and central areas of main cities, while the peripheral areas (that are often provided with less frequent public transport services) are not included (e.g. Frankfurt am Main as shown in Figure 13); (-) These services are often less accessible than public transport, in particular for non-regular users, due to specific procedures to access the service itself (e.g. subscription or pass needed).

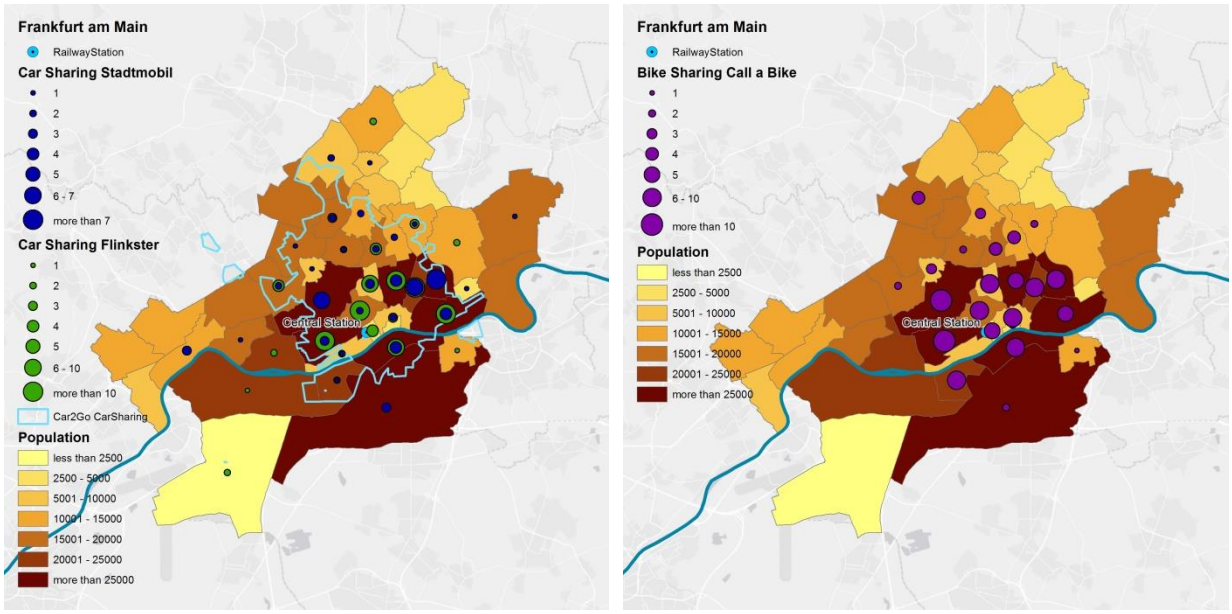


Figure 13. Frankfurt am Main city area: distribution of car- and bike-sharing (Source: LINKS Foundation)

A high number of transfers can hinder a seamless travel chain and decrease travellers' perception on the trip quality. People travelling along the Corridor should be provided, as far as possible, with direct connections from the Corridor nodes to their regional, metropolitan or urban area. Here, integrated ticketing would also improve the ease of intermodal journeys. Integrated ticketing allows a traveller to transfer between different transport modes or to use services provided by different operators with a single ticket that is valid for the complete journey.

- **Direct connections** from and to the node: (-) Non direct services towards tourist attraction points or new points of interest out of the nodes are still quite diffused. For example, the Wageningen University site, next to Arnhem is growing and attracting increasing numbers of students and workers even from Germany, but is not yet directly connected with the Arnhem node, and thus Regional Authorities are carrying out feasibility studies for direct services. Domodossola and Stresa are interesting for many foreign tourists, but most of the connections between their respective railway stations and main attracting points require the use of more than one service and often also of different transport modes and operators.

- **Integrated ticketing system**: (+) In Mannheim and within the administration area of VRN (Verkehrsverbund Rhein-Neckar), a fully integrated ticketing system (including all types of public transport and operators) is available and allows users to travel in all the zones with one ticket. Similar systems are available in many other German cities like Düsseldorf and Karlsruhe.

- **Electronic tickets and smart cards**: (+) Where an integrated ticketing system is not available, electronic tickets can still provide an efficient solution allowing people to use a unique smart card where different subscriptions (of different services, modes and operators) or a pay per use credit (that will be deducted at each single trip depending on the travelled distance) are charged. A system of this kind is available in the Netherlands and in Piemonte region (including Domodossola and Verbano Cusio Ossola Province) and is planned also for the entire Liguria region. In 2017, an open call for tenders was launched for the implementation of the electronic ticketing system for the public transport service of Liguria region, which has been extended to bus and train services in the whole regional territory and is currently being developed.

  (-) E-tickets and pay per use credit are often charged on a smart card requiring quite long procedures to be bought (e.g. in Domdossola and Province of Verbano Cusio Ossola the public transport smart card can only be bought at the transport company offices, providing ID cards). They should be made easily available and accessible also for foreign people and non-frequent travellers.

  (-) Train operators and the station managers have presented a problem in station gates and platforms where the e-ticketing system is not fully integrated since passengers need to use different validating machines for different operators. When transferring between trains operated by different companies, passengers are required to check-in and check-out at specific machines (often one for each operator) placed on platforms. This system is not customer friendly and causes congestion in the platform area and the entrance gate and waste of time for travellers (e.g. Nijmegen and Arnhem stations, Figure 14).

Figure 14. Arnhem Centraal: entrance gates for different train operators (left © Otsuka) and check-in and out system on platforms (right © Otsuka).

In order to ease intermodal transfers and to improve the quality of the journey, availability of clear and complete information is key. It is also needed to ensure adequate accessibility to different transport services by users.

- **Accessible and complete information**: (+) Urban level: Grandi Stazioni Rail[17] is developing new projects such as a car parking reservation system for the stations with a dedicated mobile application that allows users to find a parking space and gives them real-time information;

  (-) The dynamic displays of real-time information provided in the main railway nodes have already improved (Figure 15), but should be placed even more on the platforms and in a larger and better visible format (e.g. Nijmegen and Arnhem stations). Advertisements are still too dominating and sometimes more visible than information panels (Frankfurt am Main Hbf, Figure 15);

[17] Grandi Stazione Rail is responsible for upgrading, visioning and managing Italy's 14 largest railway stations.

- (-) Travellers who need to travel from/to railway stations outside of the main cities are often not provided with complete and clear information on the available mobility services and solutions. Passengers should be provided with more efficient information on timetables and ticketing including trip planning services, real time data, sharing and parking services. In secondary nodes information is often provided in a confused way due to lack of cooperation between different operators (e.g. Stresa, Figure 15) and therefore users tend to ask questions to public transport drivers who are often not prepared to answer the questions especially not those from foreign people.

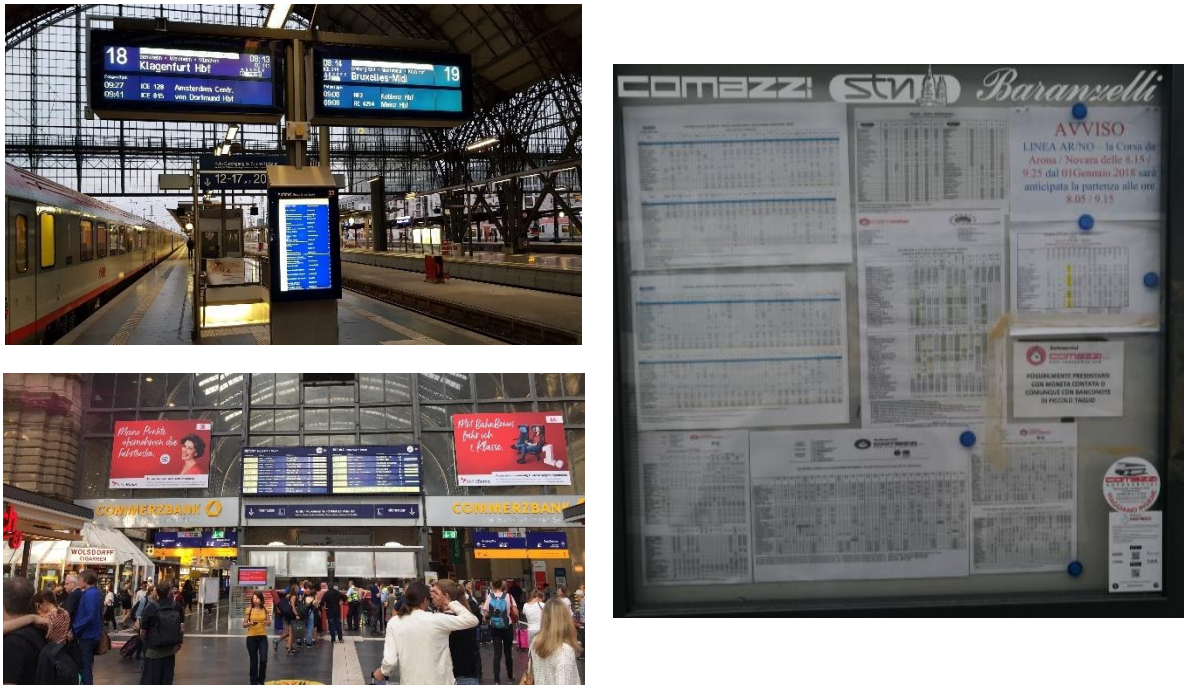


Figure 15. Frankfurt am Main Hbf: Real-time information on platforms (left top © Endemann) and large advertisements next to real-time information board (left bottom © Endemann).
Stresa station: Public transport timetables information provided outside (right © LINKS Foundation).

- **Incentives for using public transport**: policies for stimulating the use of public transport and sustainable multimodal mobility solutions. (+) Discount tickets for Park&Ride in stations were introduced by the application of a monthly card for car parking in Genova, that can be worked as incentives for stimulating the use of public transport and sustainable multimodal mobility solutions.

5.2 Further Examples from Stations and Guidelines

Good examples of integration between international and local PT not only at the main stations but also at secondary nodes can be found in Switzerland. Here a national integrated timetable exists and the Swiss Rail seasonal ticket enables rail passengers also to use other public transport modes and services. An integrated timetable was established in 1982, where trains depart and arrive at one station at the same time each hour (when service exists). That way public transport can be coordinated and harmonised throughout whole regions. In Switzerland, a public transport card (SwissPass) can be purchased. The most integrated ticket is the Generalabonnement, it allows travellers to use practically all trains and public transport including busses, tram and ferries and some cable cars, other offer discounts.[18] Furthermore, there are several offers for tourists, e.g. the Swiss Travel Pass which allows tourists the use of the railway network and local transport in more than 90 towns and cities. Good regional examples can be found as well e.g. in the region Lake Geneva-Alps where the Regional Pass «Lake Geneva-Alps» was developed for tourists and visitors who want to discover the region by public transport (Figure 16 and Figure 17).

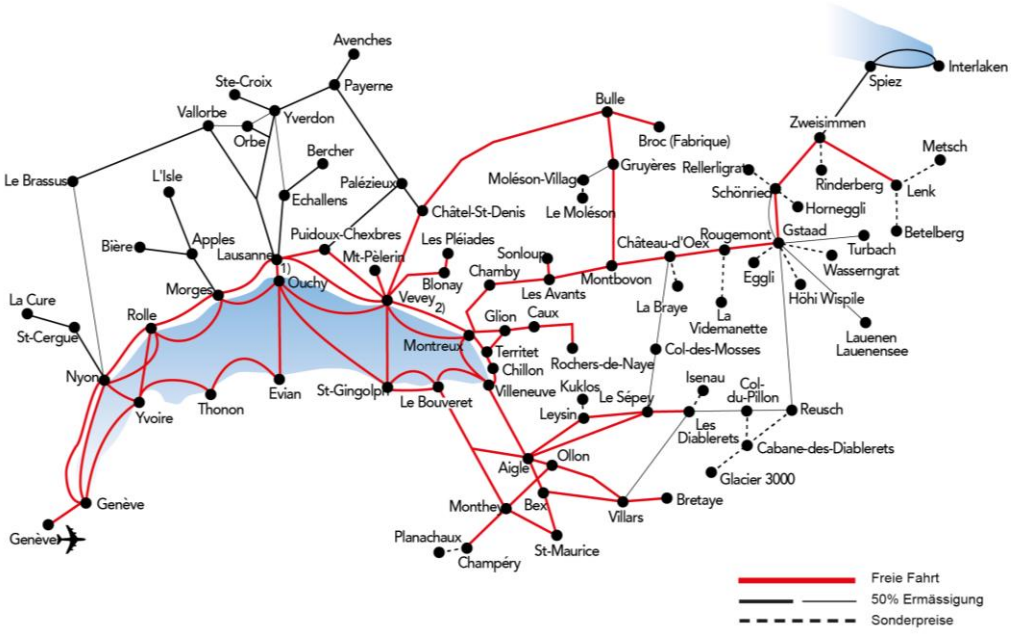


Figure 16. Regional Pass Lake Geneva-Alps: area of validity and panorama view
(© Compagnie du Chemin de Fer MOB (GoldenPass) 2019-2020).

[18] The (cheaper) Halbtax reduces the normal ticket price by 50 % for almost all public transport and train tickets (SBB - Schweizerische Bundesbahnen: https://www.sbb.ch/de/abos-billette.html).

Figure 17. Lake Geneva-Alps MOB train panorama view
(© Compagnie du Chemin de Fer MOB (GoldenPass) 2019-2020).

The pass allows using trains, busses and boats and many of those connections are included and can be used with the pass (red lines). It also includes the travel from and to Geneva airport and grants a 50 percent discount (black lines) or special offers (dotted lines) for the majority of mountain rails and cable cars. The Regional Pass can be purchased for different length of stay with different discounts, e.g. for five days with unlimited travel on two days and 50 % discount on the three remaining days.[19]

In Germany, the national railway operator Deutsche Bahn (DB) provides two kinds of tickets for integrating long distance trains and local transport across Germany: City-Ticket and City mobil. Both solutions aim to guarantee seamless access by local public transport. It allows to travel to the starting station and to use public transport for the last mile from the destination station. The City-Ticket includes free travel on local public transport services and is automatically included in tickets for long-distance journeys (100 km and more, both for domestic and international journeys). It is provided for over 120 towns and cities in Germany and is valid normally within a predefined area around the central station. City mobil enables within the online booking service to add the possibility to use local public transport to / from the station (e.g. as a local day/single trip ticket). This option can be chosen for more than

[19] Swiss RegionalPass: https://www.swissrailways.com/de/products/regionalalpspass. Regional Pass Lake Geneva-Alps: https://mob.ch/assets/media/offer/Regional_Pass/Regional_Pass_2019_recto_verso.pdf

100 towns and cities in Germany and can be activated during the purchase process of train tickets[20].

Another regional example can be found in the south-German region of the Black Forest. Here, the KONUS Guest Card[21] is designed for tourists and allows to travel within the area using buses and trains. The card is passed on to the guests at arrival in more than 145 hotels free of charge. The area includes about 140 villages and cities and nine integrated transportation networks (Figure 18). Travelling to the neighbouring cities of Freiburg and Karlsruhe is included, but express trains and cable cars need a separate ticket.

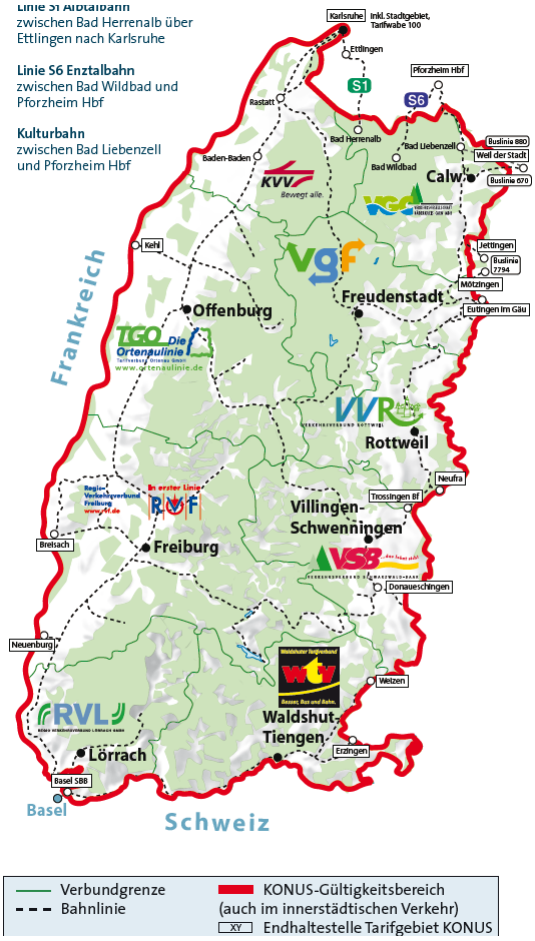


Figure 18. KONUS Guest Card area of validity within the Black Forest region (© Schwarzwald Tourismus GmbH, 2019).

[20] Deutsche Bahn DB: CityTicket: https://www.bahn.de/p/view/angebot/cityticket.shtml?dbkanal_007=L01_S01_D001_KIN0001_top-navi-flyout_angebote-cityticket_LZ01, City mobil: https://www.bahn.de/p/view/angebot/zusatzticket/city_mobil.shtml

[21] Konus Gästekarte: https://www.schwarzwald-tourismus.info/ferienregion-schwarzwald/gaestekarten/Gaestekarte-karte-fuer-gaeste-im-schwarzwald

As mentioned in the chapters above, spatial layout and wayfinding at a station are also important for intermodal connections. In addition, display of information as well as its accuracy, quality and legibility play a crucial role. Autogudovie in Monza and Brianza area show how the presence of an updated timetable at bus stops, especially at the most used ones, is essential to support public transport users, in particular non-regular or new users. A well-designed network map shows different lines and orientation points that can be identified with ease. Timetables can be provided separately but need to be easily recognizable (Monza and Brianza). Showcases should also contain information on ticketing (types, costs, where and how to buy tickets).[22]

Another aspect to consider is training for public transport employees, especially drivers, so they can offer better assistance and information to public transport users. An effective and acclaimed example is the two-day interactive customer experience training programme, which was developed by training facilitators in partnership with London's bus operating companies and Transport for London (TfL). It has involved groups of drivers meeting professional actors who creatively helped them recognise problems and build upon their existing customer experience and skills to meet challenges they face when interacting with passengers. Engaging and fun scenarios were used to emphasise that bus drivers play a crucial role in customers experience (strap line "Great journeys start with you"[23]). Protocols and trainings are provided and drivers are briefed with guidelines that include several aspects such as compliance with agency policies and values, responsibilities and accountabilities, integrity and confidentiality of corporate information. In addition, relationships with customers and colleagues are considered (e.g. suggestions on fair behaviour, professional appearance, assistance duties, emergency behaviour and aid duties, children conduct protocol, and criminal conduct protocol).

[22] http://monzabrianza.autoguidovie.it/files/monzaBrianza/Linee/mappa_della_rete/Mappa%20Brianza.pdf and http://monzabrianza.autoguidovie.it/files/monzaBrianza/Orari/Invernale_scolastico/Linea%20z222_FER%20INV.pdf

[23] Further information on bus driver training: http://content.tfl.gov.uk/csopp-20170302-part-1-item06-customer-information-strategy-and-programme.pdf
https://www.stepsdrama.com/portfolio_page/customer-experience-training-for-london-bus-drivers/

6. Walkability around Stations

The walkability and pedestrian accessibility around railway stations was extensively discussed by the RAISE-IT partners. Previous research unveiled that the pedestrian connection between station and city is one of the main missing links in the intermodal transport chain which is especially evident in some examples of high-speed rail stations (Moyano et al., 2019). As Coffel et al. (2012) point out, walking is the dominant access mode for frequently used stations in the city centre and in nearby high-density residential areas. Generally, good pedestrian access and good walkability, is an important factor for all types of intermodal stations and provides connections to surrounding neighbourhoods as destination or catchment areas (Hogdson et al., 2015; Mepham, 2016). The area in the direct proximity of an interchange is often under control of several different organisations and the station or transport operators have a limited control over design or management of the space.

Nevertheless, it functions as a gateway to the public transport network and represents the interface to the surrounding area and often also to the city centre. Thus, connections by the most common mode of access, i.e. walking is of great importance, but also provision for access by bicycle, taxi or even the private car (TfL, 2009). As Desiderio (2002) points out, users who walk towards the (main) entrance get easily disorientated when the space is not legible to users. A clear relationship between external and internal design is needed, especially at busy hubs. Here, pedestrians should not need to cross car parking areas, bus or tram stops or other facilities in order to enter the station. The access for pedestrians of any kind e.g. elderly, passengers with luggage or pushchairs, children, disabled or mobility impaired persons, should be given priority over any other access to facilities for other modes, which can be located in further distances from platforms (see Figure 19 for a pedestrian orientated access hierarchy).

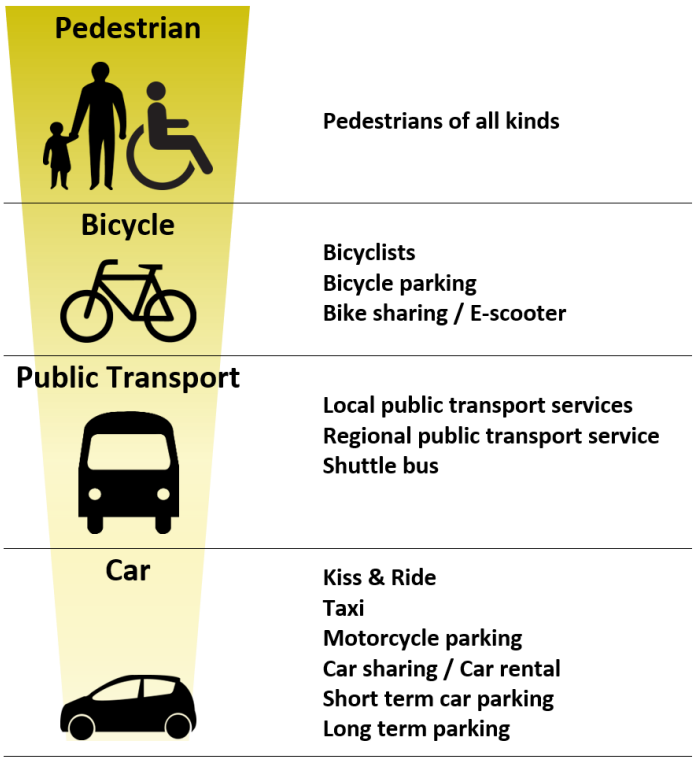


Figure 19. Station access hierarchy (source: own illustration by Welsch & Dembowski (© ILS[24]) adapted on Washington Metropolitan Area Transit Authority 2008: 1-5).

6.1 Lessons from RAISE-IT Case Studies

It is therefore important to promote the necessity of improving the walkability from and to railway stations. The value of walking should be discussed in the context of a mode choice from both, the objective and the subjective perspective. The RAISE-IT methodology has evaluated the walkability using indicators related to four key criteria: urban structure, design of the street, obstacles and traffic safety, and personal impressions. The case studies have revealed a variety of issues concerning the improvement of the walkability around rail station. Those points are for example:

- **Pedestrian sidewalks:** (-) narrow sidewalks and the discontinuity of the sidewalks will make pedestrian uncomfortable to walk (e.g. Utrechtsweg in Arnhem, Figure 20; Via Serra in Brignole). However, this is often a structural problem due to the narrow width of the street being shared with motor traffic. Another example is the conflict between bus route and pedestrian access from the main road to the station entrance.

[24] Icons by Jan Garde (ILS) and www.pixabay.com

Delays or a tight bus schedule could put bus drivers in a conflict of objectives when they should accept a zebra pedestrian crossing. (-) Similar, in Genova Piazza Principe, the north side of the station is not well accessible due to a hill side and a retaining wall, even though a stairway was built in order to mitigate the barrier effect. (+) Pedestrianisation is one of the best solutions to encourage people to walk, but it is normally found within the shopping area of the city centre. Arnhem presents a good practice which is extending a pedestrianised street from the station to the city centre.

- **Tunnel walkway:** In many cases, rail tracks are dividing a city in the two parts and therefore stations have two main entrances. A tunnel is often used to provide a connection between those two parts of a city, but in many cases is not a good solution. Often, a tunnel tends to create an unpleasant, long and narrow dark space, walls are often covered with graffities and such places are also used as a shelter e.g. by homeless people. (-) This type of situation is witnessed in all studied stations apart from Frankfurt am Main (terminus model). A dark tunnel walkway is often used as a solution for connecting the two parts of a city. It tends to create an unpleasant, long and narrow dark space, walls are often covered with graffities and such tunnels are also used by homeless people as a shelter (Figure 20).
  (+) Nijmegen has shown a clean white tiled wall and bright lighting on their tunnel, whereas Brignole has used student's art work on the wall of the tunnel that was unfortunately covered again with graffiti.

Figure 20. Arnhem: Narrow pedestrian sidewalk on Utrechtsweg (left © Otsuka).
Tunnel walkway in Genova Brignole (right © Otsuka).

- **Cater for all types of users:** (-) the necessity for special measures to improve the walkability for disabled people was raised at roundtable in Genova. The improvement of sidewalks is especially required in terms of widening pedestrian walks, linking tactile paving for visual impaired people, monitoring the functionality of traffic lights equipped with sounders and reducing speed limits on some roads (e.g. Via Serra) as the speed of cars can create difficulties for the hearing impaired. The design of sidewalks should be carefully considered for catering the needs from all pedestrians.
- **Priorities on pedestrians**: (-) the conflict of accesses by cars, bicycles and pedestrians in crossings (e.g. Worringerplatz in Düsseldorf, Dammerstock/Rüppurr in Karlsruhe and the Westside development in Nijmegen) was observed. Pedestrians often find their walking routes confusing when traffic routes and traffic light arrangement for pedestrian crossing are complicated as well as there is no zebra crossing on tram tracks and busy roads. The interrupted, uneven surface or run-down conditions of pavements would add further negative image of pedestrian walkways; (+) Karlsruhe Hbf presented a good example for large public square in front of the station building. This area is designed to be low traffic owing to restricted car access thus good walkability and connection to the city centre is ensured (Figure 21).
- **Perceived safety**: (-) From the south entrance to pedestrian underpass at the Karlsruhe station there is a lower number of pedestrians and not well-lit entrance in the evening (Figure 21), which results in creating a dark and sparse space and people perceive this as an unsafe or isolated location.

Figure 21. Karlsruhe Hbf: Pedestrian friendly station square (left © Otsuka) and south entrance pedestrian access (right © Otsuka).

- **Bikeability around the station:** (-) In the surrounding of many stations, there is no good accessibility for cyclists and the lack of infrastructure is apparent (e.g. Düsseldorf, Frankfurt am Main Hbf and Nijmegen). It can be improved by building or extending high quality bicycle lanes to the station. There are cases where municipalities are fully aware of the issue, and for example, the city of Düsseldorf has a plan for future walking and cycling routes along the tram tracks between the rail station towards a close-by square, 5-minute walk from the station.
  (+) The redevelopment of the westside of Nijmegen station is planned to align with the improvement of local traffic infrastructure and new opportunities to opening up the waterfront area.
- **Traffic speed limit:** (-) Road in front of the station is the main barrier to pedestrian access and this would be reduced if traffic speed will be less than the current maximum speed of 50 km/h. However, this option has not been considered to be realistic by the City of Frankfurt due to its function as a federal road. The point is also echoed by the City of Düsseldorf as an unfeasible option for solving traffic issues in the city.

6.2 Further Examples from Stations and Guidelines

In order to improve walkability in the surrounding area, a good cooperation between different stakeholder is key (interagency coordination) in particular between the station operator or manager and the local administration. Preferably, train-service and other public transport providers will be included into planning and decision making together with those who provide extra services and facilities such as car- and bike-sharing or car and bicycle parking. In this process improvements of the immediate surrounding of the station especially the entrance area should be considered as well as those in the surrounding area (Table 1).

Table 1. Types of accessibility improvements for pedestrians and cyclist
(Source: Welsch & Dembowski (ILS) adapted table based on Coffel et al. 2012: 57)

Type of Improvement	Station entrance	Surrounding area
Pedestrians		
Provide paved sidewalks at least 1.8 m width	✓	✓
Remove sidewalk clutter, especially near station entrances	✓	✓
Provide several entrances to the station building	✓	✓
Reduce speed limit on adjacent roads		✓
Build ground level pedestrian crossings, install pedestrian friendly traffic lights and safety improvements at busy junctions		✓
Provide weather-protected connections to adjacent land use		✓
If ground level solutions are not available, build overpasses and/or underpasses	✓	✓
Improve lighting and night visibility	✓	✓
Install wayfinding on the way to station	✓	
Cyclists		
Provide dedicated bicycle lanes	✓	
Provide bicycle paths, separated from other modes		✓
Provide accessible, secure and sheltered bicycle parking and / or storage at stations	✓	

A good example is the redevelopment of Aschaffenburg train station, Germany. the newly build station building offered the opportunity to create a new pedestrian access to a formerly cut-off city district via a well-designed tunnel. Thus, the walkable catchment area was enlarged, ensuring barrier free access to all tracks, a good wayfinding system and new car parking facilities (and some bicycle parking as well). The station was winner of the “station of the year” competition in 2012 by Allianz pro Schiene[25]. Another good practice is found in the tunnel walkway of Lugano Station that is well-designed with a creative neon lighting as well as a wide and bright tunnel in Köln, close to the central station. All of these designs help in improving people´s perceived safety and thus enhancing the use of the connecting tunnels (Figure 22).

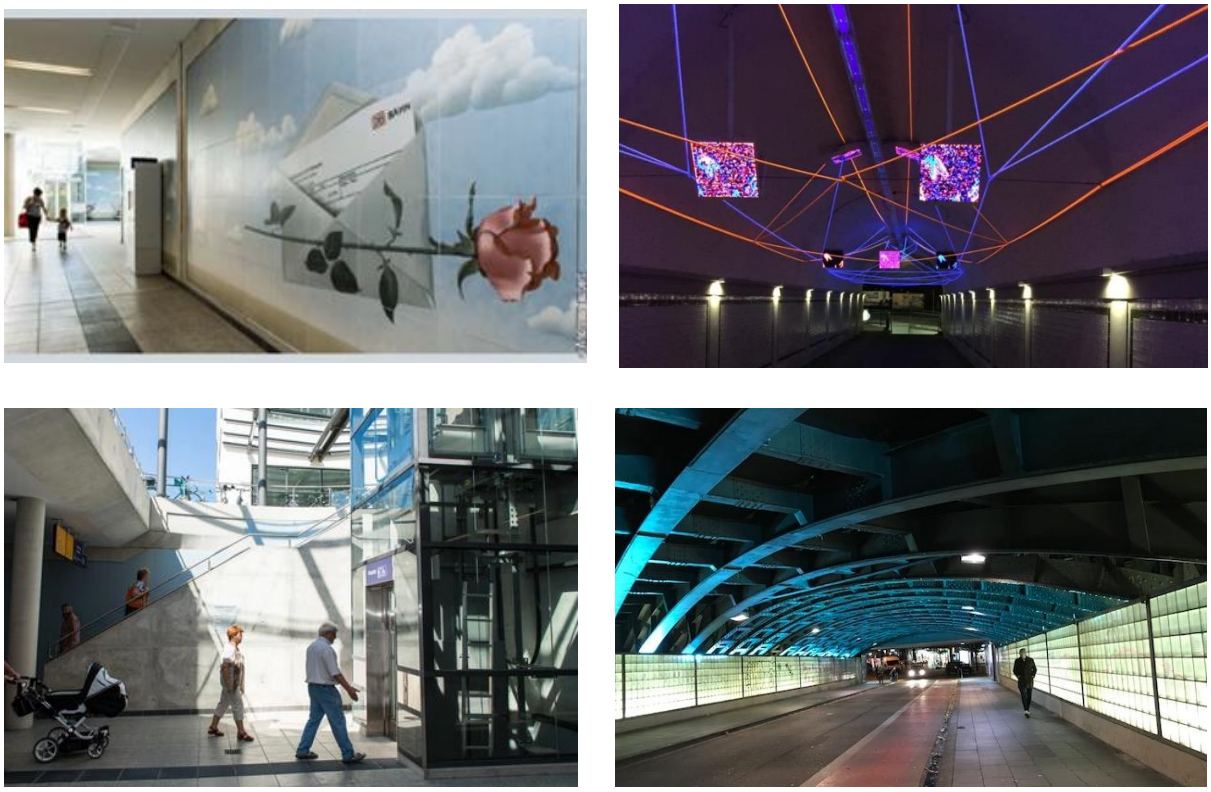


Figure 22. Aschaffenburg: Allianz pro Schiene Station of the year 2012 (left © Andreas Taubert). Well-designed tunnel walkways: Lugano station (right top © Endemann) and Köln (right bottom © Otsuka).

[25] Allianz pro Schiene: https://www.allianz-pro-schiene.de/wettbewerbe/bahnhof-des-jahres/bahnhof-aschaffenburg/

Gent Sint-Peters Station is a central transport hub in Belgium and the most important train station in Flanders. To better serve the needs of the users, a reconstruction started in 2007 in order to enhance passenger capacity and improve transfer options and renew the surrounding area together with additional facilities. The station is newly constructed, only the historical entrance building remained. There, a new glass roof connects the front entrance area to the station. Furthermore, new interchange areas were built underneath and above the 12 train tracks. Additional underground bicycle and car parking, new roofs for platforms, a new entry with recreational and pedestrian areas (former back side) and a new bus station were created as well as a new access road. The pedestrian tunnels and underground passages are designed well-lit and have a friendly atmosphere.[26]

In Bamberg, Germany, a proactive city administration monitored bicycle parking in the surrounding area of the station and revealed the need for further bicycle parking. The city bought an area for redevelopment at the back side of the station and built a tunnel to improve access to this site. There, a new bicycle parking station was built together with a Park&Ride location and two new bus stops and improved crossing opportunities for pedestrians and cyclists. The new “Radhaus” bicycle parking station is accessible 24/7 via a technical solution and is located within a historical building (Figure 23).

Figure 23. Radhaus at Bamberg Station (© Stadtwerke Bamberg).

[26] Project Gent Sint-Pieters: https://www.projectgentsintpieters.be/

Pasing train station was mentioned as a good example in the RAISE-IT expert workshop. It is one of the most important stations in München, Germany. Several national and international long distance and high-speed connections (ICE and IC) stop there as well as many regional trains and S-Bahn. Within the last years the station was refurbished in combination with the wider district, with a specific focus on the public space outside the station and on the improvements of intermodal connections. For example, a new stop for the extended local tram line was built in front of the station and the public space creates ample space for pedestrians and cyclists (Figure 24). The renewed Rotterdam station was also mentioned as a good example. It provides good pedestrian access to local tram line, as is can be seen in the figure of Rotterdam station square (Figure 24).

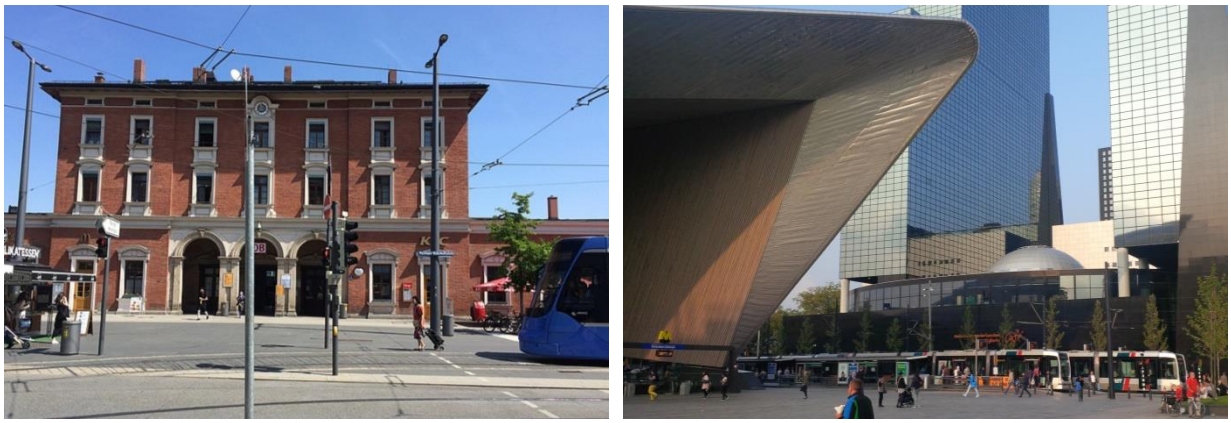


Figure 24. München Pasing Station building with new tram line (left © SchueleMuenchen[27]). Good accessibility from new Rotterdam Station building to tram stop (right © Endemann).

[27] Retrieved from Wikimedia Commons:https://commons.wikimedia.org/wiki/File:Pasinger_Bahnhof_Juli_2018.jpg

7. Optimal Use of Space in the Station Area

The previous chapter has emphasised the importance of improving the walkability in the surrounding area of the stations. To place more priorities on the accessibility of pedestrians and cyclists, there is a need to reconsider the traditional configuration of station infrastructure. In many cases prime locations of station squares have been allocated to access facilities to private cars and public transport, and thus new solutions are required to reverse the existing access hierarchy.

Over the last two decades railway stations have been playing a strategic role in restructuring their immediate surroundings through large-scale urban redevelopment projects which often aim to provide a better connection to city centres (Vickerman, 2015; Peters and Novy, 2012; Garmendia et al., 2012). As Banister and Hall (1993) maintained 'Railway Renaissance' in the post-industrial era, the steady expansion of high-speed rail networks in Europe has been witnessed, and it has helped in inviting new investment for development opportunities in station areas (Bertolini et al., 2012). The enhanced accessibility between stations and city centres has become one of the selling points from the perspective of a city centre regeneration strategy. It can also be said that an improved connection contributes to promoting a modal shift from car to rail journeys.

In the redevelopment process of railway station buildings and their surrounding area, a pleasant, convenient and seamless ground level access for pedestrians, cyclists and public transport users (e.g. tram, bus) should be the primary concern. To this end, station squares need to be redesigned based on the above-mentioned access hierarchy (Figure 19). Optimal use of space in the station area and improvements according to access hierarchy are closely linked to wayfinding and layout of facilities within the station and its surroundings, as already pointed out in the previous chapters.

7.1 Lessons from RAISE-IT Case Studies

Given the limited space of the station area, an optimal use of space should be the key agenda for future redevelopments of railway stations. There is an increasing demand on stations to accommodate new mobility related infrastructure (e.g. parking spaces for shared mobility, electronic car recharge stations) as well as commercial and business facilities. In parallel, traditional station facilities such as waiting areas and toilets often also require enhancement.

RAISE-IT examples pointed out following aspects concerning the optimal use of space:

- **The design of public spaces in the surrounding area of stations:** (-) The design of station squares is not considered in a holistic way. Patchwork approaches, for example, adding benches or bicycle parking spaces without strategic spatial planning, often result in the creation of a cluttered public space (e.g. Konrad-Adenauer-Platz in Düsseldorf, and the main station square of Frankfurt am Main Hbf);

  (-) The station environment around Frankfurt am Main Hbf is characterised by a fragmented organisation of space and a six lane road and tramway line in front of the station building function as a barrier and have a negative effect on pedestrians' accessibility.

- **Land ownership in the station and its surrounding area**: (-) The bicycle parking space at the station square of Karlsruhe Hbf is owned by the municipality but many users of the train services are actually parking their bicycles there. This was seen as problematic, both by the municipality and DB because they see this leads to a situation where no one takes responsibility for this type of places and users;

  (-) Mixed ownership of properties on Bertha-von-Suttner-Platz in Düsseldorf is one of the main obstacles for the creation of a harmonised station square. A municipal transport officer expressed the difficulty in mediating different interests because of fragmented property ownerships on the square and difficult negotiations with DB;

  (+) Arnhem applied the concept "under one roof and one business case" for the station and can be seen as a good example: NS and the municipality of Arnhem have worked together when they created a masterplan for Arnhem Centraal. This approach created a user-friendly public space where the boundary of land ownership has become invisible.

Another important factor is the way of handling the **renewal or redevelopment process** of railway stations. To fulfil modern station needs, many stations are going through refurbishment work on station buildings or some parts. Some cases developed a large-scale masterplan that include the station building and its surrounding area. To manage the redevelopment process following points should be taken into account.

- **Interim solutions**: (-) Realisation of a station redevelopment plan often take a long time. Therefore, the users have to put up with inconvenient construction sites for years. During the implementation of a station masterplan (it may take more than ten years), interim solutions for improving the station environment should be introduced. The underground passage of Frankfurt am Main Hbf is a typical example, in which underused spaces was left untouched while waiting for new implementation (Figure 25).
- **Design codes and other restrictions for station buildings**: (-) Strict design codes set by the architect for Arnhem Centraal station building do not meet the actual needs of station users. Customer surveys conducted by NS show that users prefer warm coloured walls and brighter lighting and rather dislike the grey colour of bare concrete walls which were the architect's original design choice;
  (-) The restrictions due to the protection of historic buildings imposes an extensive difficulty in renovating station buildings to be suitable for modern uses (e.g. Frankfurt, Genova Piazza Principe and Brignole, Figure 25).

Figure 25. Frankfurt am Main Hbf: Underground access from station to city centre (left © Otsuka). Historic building in Genova Brignole (right © Otsuka).

7.2 Further Examples from Stations and Guidelines

Swiss transport engineers suggest different cooperation models for intermodal stations, depending on the station size, function and the services that are provided. The cooperation models are aimed for integrating different stakeholders (e.g. city administration, transport operators, user groups or passenger organisation) and thus enhancing the station management and the provision of good quality services and facilities (SVI, 2013). A suitable cooperation model and a good management is of especial importance during phases of (re)-building, renewing or retro-fitting processes.

In Stuttgart (Germany) a major construction site is currently present during the phase of the redevelopment of the central station Stuttgart Hbf (Stuttgart 21[28]) and its surrounding urban areas. It started in 2010, and is expected to be completed in 2025. This means that station users have to put up with disruption caused by construction work over a period of minimum 15 years. Currently, there are two bridges connecting the old station building and temporal platforms crossing over a large construction site, and they are used for exhibiting information on construction methods and processes. In addition, some windows are installed from where people can take a look into the actual construction site (Figure 26).

Figure 26. Stuttgart Hbf: Bridges connect the old station building with the temporal platforms, providing information and a direct view on the construction site (© Otsuka).

[28]Official website DB (in German): http://www.bahnprojekt-stuttgart-ulm.de/aktuell/. Wikipedia: https://de.wikipedia.org/wiki/Stuttgart_21#Kommunikation_und_Rezeption

For the construction phase around Sint-Peters Station in Gent (Belgium) a comprehensive approach for informing the public about the progress and about changes of services was installed, that is still on going. They provide people with service and information points as well as leaflets, press releases and tours for site visits.[29]

Oerlikon Station is the second busiest railway node in Zurich, Switzerland, with approximately 90,000 travellers per day (Figure 27). It provides connections for the city and its agglomeration area with S-Bahn, regional trains, bus and tram. Kiss & Ride is provided, as well as car parking. Between 2004 and 2016 tracks, platforms, underground passages, as well as bus- and tram-stops and the public spaces of its surrounding area were renewed. The station access was improved also with respect to comfort and security. The edge platforms are on the same level as the surrounding area where bus- and tram-lines are provided. The surrounding area is an integrated zone, where priority is given to pedestrians and a speed limit of 20 km/h. Platforms are well connected via ramps and accompanied by a number of shops with convenient opening hours. Well designed and lit tunnel and a high number of people present add to the general level of (high) security in the area of the station, which has grown into an urban centre of its own where people also do shopping, meet and spend leisure time. This transformation was also an important trigger for the development of the neighbourhood area, where a new business district highlighted by the Andreas Tower (left on Figure 27) arose in close proximity.

Figure 27. Oerlikon: Station building (left © Roland zh[30]) and Andreas Tower (right © Peric)

[29] Project Gent Sint-Pieters: https://www.projectgentsintpieters.be/info-en-inspraak
[30] Retrieved from Wikimedia Commons: https://commons.wikimedia.org/wiki/File:Z%C3%BCrich_-_Oerlikon_-_Bahnhof_IMG_3941_ShiftN.jpg

Houten was also mentioned as a good example in the expert workshop. It is known as a planned “Satellite City” near Utrecht in the Netherlands. It is internationally known as a bicycle city, due to its bicycle-friendly city planning, high share of bicycle traffic and only a minimum of car-traffic inside the city. Houten got chosen as the top Cycling City of the Netherlands two times already due to continuous improvements. Due to its central location Houten is also a city of commuters to the larger centres nearby especially to Utrecht. These facts lead to the design of a railway station in Houten which is fully integrated into the cities structures, offering easy access for pedestrians and bicyclists to the platforms. The station itself is located on an easily accessible bridge while there is plenty of parking space for bicycles underneath (Figure 28).

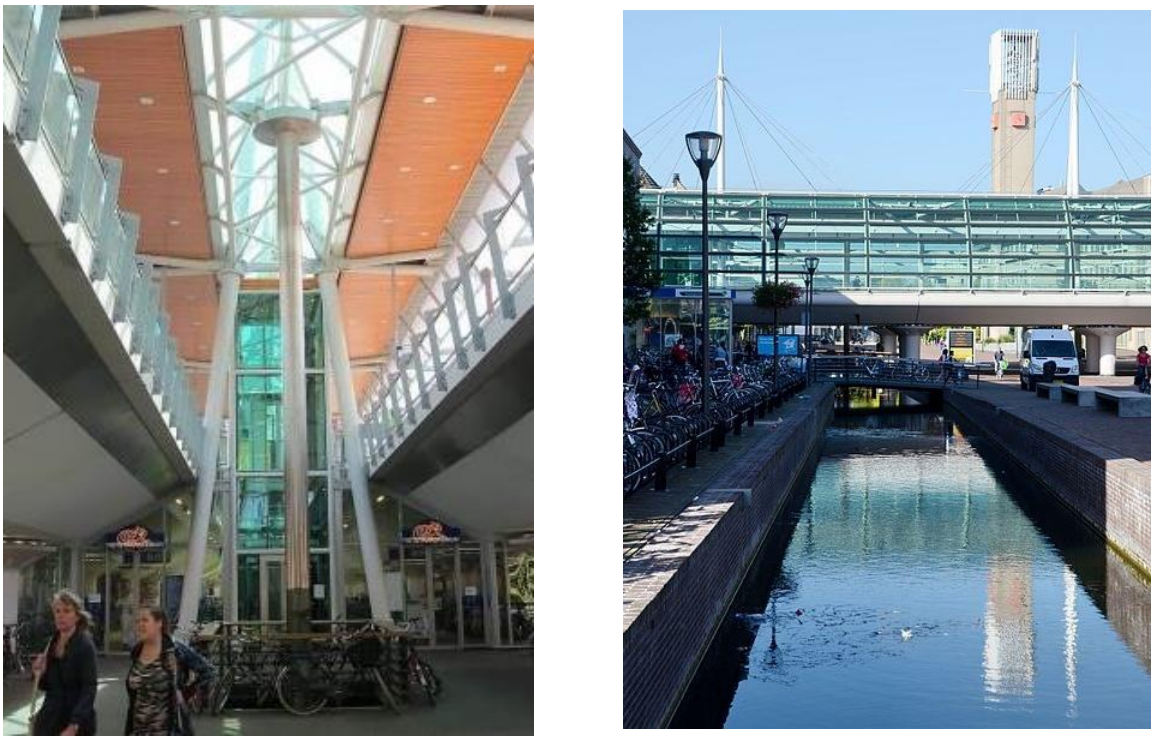


Figure 28. Houten station (left © Frenay; right © Henk Monster[31]).

[31] Retrieved from Wikimedia Commons: https://commons.wikimedia.org/wiki/File:Modern_railway_station_at_centre_of_Houten,_with_nice_reflections_-_panoramio.jpg

8. Acknowledgement

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9. References

Banister, D. and Hall, P. (1993): The second railway age, *Built Environment*, 19 (3/4), pp. 157–162.

Bertolini, L. Curtis, C. and Renne, J. (2012): Station Area Projects in Europe and Beyond: Towards Transit Oriented Development*, Built Environment*, 38 (1), pp. 31-50.

Booz A. (2012): Integrating Australia's Transport Systems: A Strategy for an Efficient Transport Future. Available at *http://www.infrastructure.org.au*

Coffel, K., Parks, J., Semler, C., Ryus, P., Sampson, D., Kachadoorian, C., Levinson, H. S. and Schofer, J. L. (2012): Guidelines for Providing Access to Public Transportation Stations. Washington, DC. *TCRP Report 153.* Available at: https://nacto.org/wp-content/uploads/2016/04/1-4_Coffell-et-al_Guidelines-for-Providing-Access-to-Public-Transportation-Stations_TCRP-153_2012.pdf

Delpiano, R. and Endemann, P. (2019): RAISE-IT Task 13 - Activity 3 "Corridor Concept". Guidelines for Seamless Interregional Passenger Rail along the Rhine-Alpine Corridor. (forthcoming).

Desiderio, N. (2002): Requirements of Users and Operatorson the Design and Operation of Intermodal Interchanges, *Schriftenreihe des Instituts für Verkehr Fachgebiet Verkehrsplanung und Verkehrstechnik,* Heft V 7. Available at: https://www.verkehr.tu-darmstadt.de/media/verkehr/fgvv/for/publik/S007.pdf

EU (1992): European Commission – White Paper "The future development of the common transport policy". Available at: http://aei.pitt.edu/1116/1/future_transport_policy_wp_COM_92_494.pdf

EU (2001): European Commission - White Paper "European transport policy for 2010: time to decide". Available at: https://ec.europa.eu/transport/sites/transport/files/themes/strategies/doc/2001_white_paper/lb_com_2001_0370_en.pdf

EU (2006): Keep Europe moving - Sustainable mobility for our continent Mid-term review of the European Commission's 2001 Transport White Paper. Communication from the Commission to the Council and the European Parliament. Available at: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0314:FIN:EN:PDF

EU (2011): European Commission - White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" COM/2011/0144 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52011DC0144&from=EN

EU (2013): Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32013R1315

Garmendia, M., Ribalaygua, C. and Urena, J.M. (2012): High speed rail: implication for cities, *Cities*, 29, pp. 26-31. Available at http://isiarticles.com/bundles/Article/pre/pdf/260.pdf

Hernandez, S. and Monzon, A. (2016): Key factors for defining an efficient urban transport interchange: User's perceptions, *Cities*, 50, pp. 158-167.

Hodgson, J., King, C. and Hickman, R. (2015): Connecting European regions using innovative transport - Guidelines for good transport interchanges. London. Available at: https://sintropher.eu/sites/default/files/images/editors/Sin%20Station%20Guides%20web.pdf

Lidwell, W., Butler, J. and Holden, K. (2010): Universal principles of design - 125 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design. Foreword by Kimberly Elam. [2nd ed.]. Beverly, Massachusetts. Rockport Publishers.

MaaS Alliance (2018): Passenger Rights in Multimodal Transport - MaaS Alliance Vision Paper. Available at: https://maas-alliance.eu/wp-content/uploads/sites/7/2018/09/Vision-Paper-on-Multimodal-Passenger-rights-240918-FINAL.pdf

Mepham, D. (2016). Planning for Pedestrian Accessibility at Level Crossings and Railway Stations. Melbourne, Victoria. Victoria Walks. Available at http://www.victoriawalks.org.au/Assets/Files/Final%20level%20crossing%20report%209%20Dec%202016.pdf

Moyano, A., Coronado, J.M., Ruiz, R. and Romero, V. (2019): Station avenue: high-speed rail's missing link. Assessing pedestrian city-station routes for edge stations in Spanish small cities. *Journal of Housing and the Built Environment*, 34 (1), pp. 175-193.

Otsuka, N., Delmastro, T., Wittowsky, D., Pensa, S. and Damerau, M. (2019a): Assessing the accessibility of urban nodes: the case of TEN-T railway stations in Europe. *Applied Mobilities*. 4 (2), pp. 219-243.

Otsuka, N., Endemann, P. and Pensa, S. (2019b). RAISE-IT Expert Workshop: Results, Unpublished report, 23pp.

Peek, G.J. and van Hagen, M. (2002): Creating Synergy In and Around Stations: Three Strategies for Adding Value. *Transportation Research Record Journal of the Transportation Research Board,* 1793 (1), pp. 1-6.

Peters, D. and Novy, J. (2012): Rail Station Mega-Projects: Overlooked Centrepieces in the Complex Puzzle of Urban Restructuring in Europe, *Built Environment*, 38 (1), pp. 5-12.

SBB – Schweizerische Bundesbahnen: Abos und Billette. Available at https://www.sbb.ch/de/abos-billette.html

SVI - Schweizerische Vereinigung der Verkehrsingenieure und Verkehrsexperten (2013, ed.): Bahnhöfe und Haltestellen: Typisierung – Ausgestaltung – Kooperation. *SVI-Leitfaden*, 2013 (1) (Authors: Ernst Basler + Partner; Frank Bruns).

TfL - Transport for London (2007): Legible London - Yellow Book - A prototype wayfinding system for London. London. Available at: http://content.tfl.gov.uk/ll-yellow-book.pdf

TfL - Transport for London (2009): Interchange Best Practice Guidelines 2009 - Quick Reference Guide. London. Available at: http://content.tfl.gov.uk/interchange-best-practice-guidance.pdf

TfL - Transport for London (2018): Walking action plan - Making London the world's most walkable city. London. Available at: http://content.tfl.gov.uk/mts-walking-action-plan.pdf

TfL - Transport for London (2019): Pedestrian Comfort Guidance for London - Guidance Document. 2. Edition (first Edition 2010). London. Available at: http://content.tfl.gov.uk/pedestrian-comfort-guidance-technical-guide.pdf

Trendy Travel (2010): Trendy Travel Brochure. Available at: https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/trendy_travel_trendy_travel_prochure_en.pdf

Van Hagen, M. and Van Egmond, P. (2015): Station Experience Monitor, Unpublished report.

Van Hagen, M. (2015): Effect of Station Improvement Measures on Customer Satisfaction, *Journal of Traffic and Transportation Engineering*, 3 (1), pp. 7-18.

Van der Hoeven, F., van Nes, A., van der Spek, S., Albecoa, J., Skoniezki, P., Berends, H., Venema, A., van Hagen, M. and Cré, I. (2013): State of the Art (Deliverable 2.1 - Final). EU project: NODES. Available at http://www.nodes-interchanges.eu/documents/2014/05/nodes_wp2_d2-3_final-3.pdf

Van de Wetering, H., Artho, J., Willi, E., Reichert-Blaser, N., and Nübold, N (2007): Ausgestaltung von multimodalen Umsteigepunkten. Schlussbericht (Metron AG and Sozialforschungsstelle Universität Zürich). Forschungsprojekt SVI 2004/096.

Vickerman, R. (2015): High-speed rail and regional development: the case of intermediate stations, *Journal of Transport Geography*, 42, pp. 157-165.

Washington Metropolitan Area Transit Authority (2008): Station Site and Access Planning Manual. Available at: https://www.wmata.com/initiatives/plans/upload/SSAPM.pdf

10. Table and Figures

Table

Figures