Final report for publication

MIMIC Project
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Executive summary

MIMIC is the acronym of Mobility, InterModality and InterChanges. The project goal is to ‘break down the barriers to intermodality’ at passenger interchanges. Barriers are defined as all interchange-specific factors that influence travellers’ to choose single-mode (generally car-based) instead of intermodal journeys.

Study areas
The research plan has been developed according to four study areas, which help structure and identify project results.

1. **Door-to-door factors and demand responses.** With the aim of shifting people from car-based to intermodal options, MIMIC focuses on the determinants of intermodal choices by travellers. The project evaluates the relative weight on travellers’ choices between ‘interchange factors’ (e.g. up-to-the-minute information on service delays, co-ordinated timetables, presence of policemen or guards) and ‘trip factors’ (e.g. service reliability, traffic jams, waiting time), in order to assess the relative role and importance of the interchange site in intermodal journeys and to quantify demand responses when changing some ‘interchange factors’ (e.g. opening of shops, better surveillance). MIMIC also analyses how ‘trip factors’ and ‘interchange factors’ vary with ‘individual factors’ (e.g. by age, by gender).

2. **Catchment area** The analysis of an interchange’s catchment area aims to assess how location and feeder services play an important role in the success or failure of an interchange site. MIMIC analyses the multimodal access network, provides estimates of the potential market of the different feeding modes, and evaluates land-use characteristics. The main variables are the population living in the area, employees, shops and commercial centres, universities and schools, cinemas, land-use density and diversity, road and public transport network, bicycle and pedestrian routes.

3. **Types of barriers.** MIMIC subdivides barriers into seven groups (Logistical and operational, Psychological, Institutional and organisational, Physical design, Local planning and land use, Economic and social, Information). The project breaks down barriers into how serious they are and identifies the population to whom they apply. With this information, the project helps decision makers to choose among the many investment projects competing for the same pot of money and make a more reasoned decision about priorities. Barriers are analysed from different perspectives: users, non-users, local authorities, planners, transport operators, disabled, elderly, and other groups.
4. **Implementing cost-effective local solutions.** As a necessary and preliminary step towards achievement of the final output, recommendations and best practice guidelines, MIMIC identifies solutions that are suitable to local conditions at the test sites. These site-specific solutions are proposed in order to reduce barriers to intermodality and improve the attractiveness of the interchange, at the different levels (planning, decision, funding, designing, building and operating) at which the relevant actors are involved.

**Surveying and modelling tools**

Several surveying and modelling tools have been developed and tested to analyse the four MIMIC study areas.

Six cities were the field test for the use of MIMIC tools: Bilbao, Copenhagen, London, Rome, Tampere and Warsaw. Each involves one or more interchanges in an urban context, but they vary from park-and-ride sites, suburban distributors, central area bus/rail interchanges, to multimode facilities. Four more interchanges were examined in Austria, Germany and Switzerland to broaden the sample.

The tools are intended to help planners and designers to objectively assess an interchange and its relationships with the transport network and land-use characteristics. The tools are probably of most use in the design stages of interchanges, but they are valuable also at other stages in an interchange’s ‘life’ (interchanges under construction or even in operation).

**Questionnaires on door-to-door factors.** The questionnaires aim at identifying the most significant door-to-door factors (both ‘interchange’ and ‘trip’ factors) affecting individuals’ choices to make intermodal trips. Each interviewee is asked to evaluate the absolute importance given to each factor by circling a number from 1 (not important) through 10 (extremely important). The most important door-to-door factors are those given the highest marks.

**Questionnaires on barriers to intermodality.** The questionnaires aim at identifying the most significant barriers and attractive features for a broad sample of users/non-users of a specific interchange site. The interviewees are asked to indicate the importance they give to a number of barriers/attractive features by circling a number from 1 through 10. The most important barriers/attractive features are those given the highest marks.

**Interchange deconstruction.** Deconstruction breaks down an interchange into a series of components based around horizontal, vertical, information and physical design barriers and attractive features, and measures distance, time and energy consumed of the most direct route between modes.

**On-site investigation of the surrounding area.** On-site investigation aims at identifying and evaluating the most important characteristics (both transport modes and land-use characteristics) of the area surrounding an interchange. Land-use characteristics are given by density measures, relating to population, workers and
activities (shops, industries, etc.) in the area surrounding an interchange site. Transport modes characteristics are given by qualitative and quantitative measures about means, roads and services feeding the interchange site and capacity of parking areas.

**Questionnaire on revealed and stated preferences.** The purpose of the questionnaire is to capture data on present behaviour and stated preferences of users/non-users of an interchange site in relation to their intermodal trip choices. The objective is to identify conditions able to shift modal split from single-mode (generally car-based) options to intermodal ones. The mixed SP and RP information collected is then used to calibrate a Nested Logit choice model.

**Focus Group discussions.** Focus Group discussions enable views, experience and attitudes of specific users’ groups (e.g. disabled, elderly, cyclists) to be identified to enable problems and preferences to be contextualised within the interchange site and its catchment area. Focus Groups are an opportunity to explore in greater depth issues and topics raised through the questionnaires on barriers to intermodality.

**Key Actor interviews.** The purpose of Key Actor interviews is to identify differences between the stated intentions of planners, operators and regulators and the experience and preferences of interchange users. They also enable researchers to assess the role different actors/organisations play in creating new interchanges or changing existing ones.

**Video observation.** Video observation aims to actively observe travellers’ behaviour at an interchange site and record difficulties with barriers experienced by the different types of users. Video is also useful for observing and recording the use of amenities and attractive features of the interchange in the same way.

**Questionnaire on catchment area.** The purpose of the questionnaire is to identify catchment areas by feeder modes, included walking. Data collected through the questionnaire include origin and destination, time and purpose of trip and modes used.

**Nested Logit model.** The aim of the model is to quantify the importance of a number of interchange characteristics (e.g. safety, parking fee, distances to be walked) on travellers’ intermodal choices, in order to shift modal split from single-mode (generally car-based) options to intermodal ones. The model calibration relies on surveys of users and potential users, with both revealed and stated preference techniques.

**Micro-simulation model.** The aim of the model is to simulate the current and future behaviour of an interchange and test its functionality in a dynamic way. In particular, the model allows researchers to quantify times, distances and energy consumed to cross the terminal, considering deterministic and stochastic arrivals and departures of vehicles and passengers.
GIS tool. The aim is to show on thematic maps present and potential patronage of an interchange site (people living or working in the area), and the public and private transport networks in the area surrounding an interchange site.

Main results

Logistical and operational. The MIMIC research has highlighted that interchange often grows up in an unplanned manner, and most improvements at interchanges come about opportunistically, or when budget allows for change. Funding for interchange development is often lacking, which leads to competition between transport modes that ‘fight’ for the same pot of money. Services at interchanges are often not synchronised, with delays and missed connections as a consequence. Barriers inherent in serial ticketing are often encountered, with complex and costly ticketing systems, queues for ticketing and delays.

Psychological. Psychological barriers tend to be invisible, but are often as important as some of the more visible ones, or more so. Fear of crime is generally a serious deterrent to using public transport for most people. The type of fear and the people experiencing fear vary greatly from place to place. Fear of physical attack and violence and the danger of cycle and car thefts are problems experienced at most interchange sites. Fear is often greater in the area near the interchange than within the interchange itself, where there are generally enough people present to provide a feeling of security. Other psychological barriers are: a dislike of the notion of using public transport, which is translated into the creation of many subconscious ‘reasons’ for finding it not of use; reluctance to take the time needed to plan journeys (a prerequisite of most journeys involving interchange).

Institutional and organisational. Evidence from surveys shows that a large number of key players and bodies generally make the planning and building process of interchanges more complex, protracted and costly. Having different persons and bodies responsible for different areas and/or modes can lead to poor management and organisation of public transport and interchanges, with deleterious consequences (e.g. transport services are not synchronised, through-ticketing is not available, staff are not able to answer enquiries about onward travel). Deregulation and privatisation, without careful public control and co-ordination, have generally exacerbated integration problems. Marketing opportunities (e.g. of new interchanges) are often missed; most public transport marketing is of companies, or links in the network, rather than the intermodal aspects.

Physical design. Interchanges are often not designed in a functionally optimal manner. In many cases the chosen design is the result of an ‘architectural competition’, with the emphasis on the visual architecture of the building, the functionality taking a secondary role (e.g. poorly situated ticket offices, lack of lifts and ramps, lack of waiting areas). Some improved interchanges create a contrast between very high-quality concourses and any unimproved platforms or waiting areas, or consists of different parts, which do not match together well. Distances to be walked between services often exceed 200 m, with generally poor protection from rain or sun. Many routes between modes require level changes, with often no ramps,
escalators or lifts available. Facilities provided to passengers are generally poor; lack of seating and poorly maintained toilets are a common concern expressed by most users. The needs of special groups (e.g. disabled, elderly) are often not well thought out: steps and staircases and lack of guided routes for blind people make access to station and vehicles difficult to a large proportion of users.

**Local planning and land use.** Pedestrian access to interchanges very often involves difficult access over busy roads or through unpleasant (often unsafe) areas and in many cases requires long distances to be walked. Cyclists often find using interchanges difficult in access to the interchange (lack of cycle lanes), handling a bike in the interchange (presence of steps and staircases), and with cycle parking (unlockable cycle stands). Bus feeder services are often infrequent and uncomfortable. The capacity of parking areas at park-and-ride interchanges is generally inadequate, often with no dedicated areas for dropping off and picking up of passengers (kiss-and-ride).

**Economic and social.** Economic and social barriers tend to be less obvious than some others, but can be very important in terms of discouraging use of the public transport system. Cost of travel can be a serious deterrent to travelling by public transport, and can be a reason for social exclusion of people with low incomes. Potential business opportunities at the interchange site are often not exploited, with the consequence of no shopping facilities within the interchange. Opportunities of joint development, involving the private sector, are generally missed.

**Information.** Lack of information proved to be a serious barrier to intermodality. Pre-trip information is generally lacking, and many potential users are intimidated by the ‘unknown’ or by the complexity of journeys. Real-time information on delays and means’ arrivals and departures is rarely provided at interchanges, and many people find great difficulty in reading timetables and maps, especially foreigners, local ethnic minorities and people with learning difficulties. Staff are not generally trained in providing information about onward connections, and staff knowing the sign language are rarely available to people with hearing problems. Signing is generally judged unclear, and many people have difficulty with it. Acoustic signals and Braille maps are rarely available for the visually impaired.

**Guidelines for planning, design and management of interchanges**

**Logistical and operational.** More direction and control from central and regional governments is needed to oversee planning, co-ordination and investment in public transport and interchanges. The savings made possible by a more effective public transport network will be realised only after investments. With very frequent services, the relative timing of services at interchanges is of little importance. However, where services are less frequent there are very strong arguments for trying to time them to minimise waiting times. Information on expected duration of journey and frequency of connecting services at the interchange are very important. This can be done with electronics or announcements, and with timetables clearly visible on board vehicles. The implementation of unified tickets facilitates the use of all
transport modes and reduces costs for travellers as well as time spent queuing for tickets. A single ticket should allow travellers to use all transport modes in an area.

**Psychological.** All interchanges everywhere should have an ‘Interchange Personal Security Strategy’ to minimise fear of crime. This should always include: good surveillance both inside and outside the interchange site; programmes to train all staff employed in the interchange in personal care and assistance, and being approachable about fears for personal security; the use of CCTV (though passengers generally do not consider it a solution on its own); good lighting, both inside and outside the interchange; opening of shops and business activities in the interchange to make it a livelier and safer place. National-level action is needed to improve the image of interchanges at the general level; art and sculpture in transport locations, the livery on vehicles, and attention to detail in cleanliness and tidiness could back up national attempts to improve the image.

**Institutional and organisational.** An integrated strategy for interchange planning and building is essential. Interchange development should never be *ad hoc* as opportunities arise. Integrated interchange management is needed in all cases, with one person as a head. Clear lines for responsibility, easily understood by the travelling public, are needed; the public must understand to whom to direct complaints and be able to distinguish security staff from rail staff. Excessive competition between transport operators should be discouraged; a single *super partes* body should be responsible for timetable co-ordination and through-ticketing. A marketing plan needs to be prepared (possibly by a *super partes* body) to promote travel/amenity benefits of the new interchange. Marketing strategies should be developed alongside development plans.

**Physical design.** Aesthetic design is important but needs to be linked to functionality. In particular, it is important to consider aesthetic design aspects throughout the whole interchange if part of it is being improved. Where distances to be walked between modes exceed 200 m, short-distance transport systems can be a solution. Protection from rain or sun should be provided along all walking links. Level changes should be avoided. Where they are required, ramps, spacious lifts and escalators should be available. Alternative secondary, ‘stair-free’ routes, with lifts or escalators, need to be signed. Comfortable and safe waiting areas are always needed, with good access to real-time travel information and such amenities as toilets (baby-changing facilities and disabled access) and shops. It is also important to provide drivers and staff with reserved areas for rest, eating and drinking during layovers. Local signalised intersections should be provided with acoustic signals, and guided routes for the blind should be available inside and outside the interchange site. Low-floor vehicles, automatic ramps and at-level entry should be available for wheelchair users.

**Local planning and land use.** Better pedestrians links, possibly sheltered and physically separated from motorised traffic can encourage local use by walking. Cycle lanes, physically separated from motorised traffic and pedestrian flows, should be provided in the area surrounding any interchange site. Quality cycle storage, possibly guarded and covered, should be available at any interchange site. Frequent and reliable feeder services, with high-density pick up points, are important factors to
encouraging patronage in the local catchment area and reducing car use. Where interchanges are located in low-density areas, dial-a-ride services are an alternative to the construction of huge parking areas at the interchange site. The capacity of parking areas should be adequate to the demand of parking spaces; multilevel carparks over public transport stations, in particular, increase the capacity of parking areas, reduce distances to be walked to change modes and provide indoor, sheltered connections between transport means. Dedicated areas for dropping off and picking up of passengers (kiss-and-ride) should be provided at any interchange site. Close co-operation with the local community, by means of public consultation and participation, can be a cost-effective solution to build successful interchanges.

**Economic and social.** Cost of travel as a barrier can be overcome introducing through-ticketing or using concessionary fares and free tickets for those with low income. Shops and retail activities within an interchange can generate income for interchange owners and operators and reduce passengers’ fear of crime (a busy and lively environment is perceived as a safer one). Rents for shops should reflect each store’s contribution to the overall revenues. The cheaper rent of the large department stores is repaid by the benefits given to the other shops (in terms of more revenues) and to the community as a whole (in terms of a livelier and busier environment). A joint development project should be planned to generate revenue for the transit system. This revenue may take the form of a one-time cash payment for the sale of land, air or subterranean rights, or it may be a revenue stream from an instalment sale, lease, ground rent. Careful consideration of historic preservation requirements is imperative in the planning of an interchange. The preservation of a historic facility can bring financial benefits to a community through neighbourhood revitalisation, increased property values and tourism.

**Information.** Personalised pre-trip information needs to tell people exactly where to start, the times of each link, and such useful information as platform or bus-stop numbers. Pre-trip information should be available as widely as possible: telephone enquiry lines, internet, televideo, radio bulletins, kiosks, etc. Real-time information on delays, as well as on means’ arrivals and departures, should be provided at any interchange site. Clear maps detailing transport routes/services are needed and should be available at stations and bus stops and visitor information centres. Staff should be well-trained in providing information about all modes in the transport system and should be kept up to date with the current situation. Signing needs to be clear; information should be provided in a simple symbolic, pictorial and colour-coded manner. Acoustic signals and Braille maps can significantly help blind passengers. Staff who know sign language, induction loops in front of ticket counters and flashing lights on TV screens to call attention for those with hearing problems or big coloured signs would be very helpful.

**Conclusions and recommendations**

The MIMIC project has highlighted that there are significant gaps in knowledge about the optimal way of encouraging intermodality through improvements at interchanges. National literature on intermodality and interchanges was found to be poor in most countries. There are theories concerning ‘modal choice’ for specific
modes, but explanations of why people mix modes and how they use different combinations at different times (or often do not) are less well understood.

The MIMIC approach has helped to provide a way of thinking about the issues and has allowed a framework within which to work, but freedom to look at the issues from a number of different perspectives (e.g. elderly, disabled, commuters, planners, service operators). The project has helped to develop a series of tools that can help planners, designers and managers to systematically analyse interchanges, taking into account several kinds of barriers.

While MIMIC is probably of most use in the design stages of interchanges, the approach is of value at other stages in an interchange’s ‘life’. Under MIMIC it was possible to look at interchanges which were being planned (e.g. Tampere Intermodal), being constructed (e.g. Abando Intermodal), and in operation (e.g. Ponte Mammolo) using the same tools.

The MIMIC research has shown that travellers give great importance to the interchange when they choose whether to make intermodal trips. However, there are circumstances (e.g. consequences of urban sprawl or competition with better roads) where land-use and transport network characteristics of a city can substantially influence travellers’ intermodal choices, much more than barriers at the interchange. In all these cases removing barriers is a necessary condition for a successful interchange, but not a sufficient one.
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Preface

The research project MIMIC (Mobility, InterModality, and InterChanges) is part of the Directorate General VII Transport RTD Programme of the 4th Framework Programme funded by the EU Commission.

MIMIC has been carried out by a European consortium made up of seven countries (Austria, Denmark, Finland, Italy, Poland, Spain and United Kingdom) and co-ordinated by Regione Lazio. A list of all MIMIC partners, with their addresses, can be found at the end of this report.

The project goal is to study barriers to intermodality (see section 1.1 for definition of ‘barrier’), or more specifically ‘Breaking down the barriers to intermodality’ at passenger interchanges. The research plan has been developed according to four study areas, which help structure and identify project results:

1. Door-to-door factors and demand responses
2. Catchment area
3. Types of barriers
4. Implementing cost-effective local solutions

Several tools, for both surveying and modelling, have been developed to analyse the four study areas.

The surveying tools include various forms of interviews conducted. These include questionnaires to users and non-users; focus groups with target specific groups (e.g. local residents, local business people, people with physical and perceptual disabilities) and interviews with key actors involved in planning, design and management of passenger interchanges, in order to identify problems from the supply point of view.

In addition to interviews, surveying activities include: interchange deconstruction, to break down the various factors that impede effective and efficient intermodality at the interchange site; video observation, to actively observe travellers’ behaviour at a case study site and record difficulties with barriers experienced by the different types of users; and on-site investigation of the surrounding area, to identify and evaluate the most important characteristics of the area surrounding an interchange (population, employees, feeder modes, etc.). A GIS tool has been used to represent data collected through on-site investigation.
As for the modelling tools, a Nested Logit model has been developed to quantify demand responses to changes at the interchange site. The model calibration relies on surveys of users and potential users, with both revealed and stated preference techniques. MIMIC has also developed and tested a micro-simulation model. The aim was to represent the current and future behaviour of an interchange site, test its degree of congestion and quantify time, distance and energy consumed by passengers when changing modes.

In addition to surveying and modelling activities, MIMIC performed two tasks aimed at increasing knowledge of interchanges and intermodality:

?? A *Literature Review* to study literature from the seven participant countries plus The Netherlands, Belgium and Germany, under the headings of:

- Theory concerning intermodality,
- Barriers to intermodality,
- Ways of encouraging intermodality, and
- Design and location of interchanges

?? A *Policy Review*, looking at:

- Published statements on interchange and intermodality over the past ten years,
- The fit between theory and practice, and
- Examples of good practice.

Six cities were the field test for the use of MIMIC tools: Bilbao, Copenhagen, London, Rome, Tampere and Warsaw. Each site involves one or more interchanges in an urban context, but they vary from park-and-ride sites, suburban distributors, central area bus/rail interchanges, to multimode facilities. Another four interchanges were examined in Austria, Germany and Switzerland to broaden the sample. The analysis was limited to key actor interviews and interchange deconstruction.

Since the beginning, MIMIC has co-ordinated its activities with two other projects in the DG VII Transport RTD programme which have looked at interchanges and intermodality. All three projects are complementary, looking primarily at the role of interchanges in encouraging intermodality, but take different approaches to the issue. The differences reflect the complexity of intermodality.

**GUIDE** (*Group for Urban Interchanges, Development and Evaluation*) is concerned with taking an objective view of interchange with a view to understanding in general terms what makes for a successful interchange, and improving current practice by providing guidance on better practice. It involves a review of literature and expert evaluations of a large number of interchanges. GUIDE differentiates between interchange as an *activity* and interchange as a *location*, and looks at physical, network, operational and institutional and organisational characteristics.

**PIRATE** (*Promoting Interchange Rationale, Accessibility and Transfer Efficiency*) is concerned with developing a specific technique to solve problems at interchanges, based on discussion with users, non-users, professionals involved in the interchange,
and employees in the interchange. It works by scaling the perceived *importance* of various characteristics of the interchange, and scaling the perceived *performance* of the interchange in those characteristics. By comparing perceived importance against perceived performance an indication of where action should be taken is possible. The project has taken the technique which was piloted in earlier research, and has applied it to various types of interchange.

The report synthesises and discuss the most frequent barriers to intermodality identified through surveys in the MIMIC test sites, gives guidelines to remove such barriers and presents solutions and examples of good practice, in Europe and elsewhere (mainly U.S.A. and Japan).

The report is subdivided into three chapters. The four MIMIC study areas and the surveying and modelling tools to analyse them are described in chapter 1. Guidelines on how to plan, design and manage passenger interchanges are presented in chapter 2. Conclusions and recommendations are presented in chapter 3.

More detailed information on activities carried out and results achieved by MIMIC can be found in the previous Deliverables (see MIMIC reports, CD-ROM). MIMIC is present on Regione Lazio’s Web site (http://www.regione.lazio.it) and on ELTIS’ (*European Local Transport Information Service*) Web site (http://www.eltis.org). A common Web site for all three projects is http://www.interchanges.co.uk.
1 Study areas, tools and main results

1.1 Introduction
Transport problems have become more widespread and severe than ever in industrialised and developing countries alike. Fuel shortages are (temporarily) not a problem, but the general increase in road traffic and transport demand has resulted in congestion, delays, accidents and environmental problems well beyond what was considered acceptable so far.

As a consequence, the need to shift modal split from car to more environmentally friendly modes of transport, such as bicycles, walking and public transport (as stated in the DG VII task), has become a central aim of research. Passenger interchanges, in this context, can play a key role in shifting travellers from car to public transport. To this end, such feeder modes as walking, cycles and buses need to be encouraged and promoted to make the access to interchanges as easy, safe and comfortable as possible. Too often public transport operators have attempted merely to stabilise their market share rather than encourage large-scale modal shift. Similarly, use of non-motorised modes has remained secondary.

Existing literature on travel behaviour shows that a large number of factors determine the travel choices that individuals make, especially modal choices. These factors can be subdivided into three main groups: factors characteristic of the individual, factors characteristic of the whole trip and factors characteristic of the interchange.

MIMIC’s scope is mainly the interchange site and its catchment area. The project approach is based on the notion of ‘barriers to intermodality’, with ‘barriers’ defined as all those ‘interchange factors’ that influence travellers to choose single-mode (generally car-based) options instead of intermodal ones. The project aims to break down barriers according to how serious they are and whether they are relative or absolute, and the population to which they apply. This notion directs the project towards an objective assessment of interchanges, backed up by surveys and models to find out proportions of people affected by barriers and perceived importance of barriers. Barriers are analysed from the supply side as well, through interviews with planners, designers, transport operators, local authorities.

‘Interchange factors’ generally extend outside the interchange itself, involving feeding modes and characteristics of the surrounding areas. Poor and unreliable feeder services or unsafe and isolated areas to walk through are often serious barriers to intermodality and are directly connected to the location of the interchange site. For
this reason the MIMIC analysis extends outside the interchange itself to take in its catchment area as well.

### 1.2 Study areas

The project research plan is organised according to four study areas which help structure and identify results:

1. Door-to-door factors and demand responses;
2. Catchment area;
3. Types of barriers;
4. Implementing cost-effective local solutions.

#### 1.2.1. Door-to-door factors and demand responses

A key issue in improving intermodality is the provision of door-to-door solutions effective enough to compete with the car alternative. MIMIC focuses on the determinants of intermodal choices by travellers. The factors that can affect trip choices fall into one of the following three broad categories:

1. **individual factors** (e.g. age, gender, income, car ownership);
2. **trip factors** (e.g. number of transfers, ease of finding free parking in the origin or destination zone, waiting time);
3. **interchange factors** (e.g. parking cost, parking capacity, co-ordinated timetables, presence of stairs, presence of surveillance for security).

MIMIC evaluates the relative weight on travellers’ choices between ‘interchange factors’ and ‘trip factors’, in order to assess the relative role and importance of the interchange site in intermodal journeys and quantify demand responses when changing some ‘interchange factors’ (e.g. opening of shops, better surveillance). Moreover, MIMIC analyses how ‘trip factors’ and ‘interchange factors’ vary with ‘individual factors’ (e.g. by age, by gender).

The products of the analysis for this area are:

- the identification, ranking and rating of ‘trip’ and ‘interchange’ factors;
- a model to quantify demand responses when some of the ‘interchange factors’ change.

The analysis of this study area is based on:

1. A first questionnaire survey of users and non-users of the interchange. This survey makes it possible to identify, rank and rate the most important ‘trip’ and ‘interchange’ factors.
2. A second questionnaire survey of users and potential users that uses a joint revealed/stated preference technique. This type of survey aims at collecting data to calibrate a Nested Logit model.

3. A Nested Logit model to estimate demand responses to changes at the interchange site (for example, a planned improvement of the interchange such as the provision of shopping facilities).

1.2.2. Catchment area
The analysis of an interchange’s catchment area aims at assessing how location and feeder services play a significant role in the success or failure of an interchange site. Busy roads to cross, unsafe areas to walk through and poor feeder services all contribute in discouraging travellers from using an interchange.

MIMIC analyses the multimodal access network, provides estimates of the potential market of the different feeding modes, and evaluates land-use characteristics. The main variables are the population living in the area, employees, shops and commercial centres, universities and schools, cinemas, land-use density and diversity, road and public transport network, bicycle and pedestrian routes.

The products of the analysis for this area are:

?? size and boundaries of the market area for feeder modes;
?? the main characteristics of feeding modes (e.g. km of cycle paths in the surrounding area, average number of public transport vehicles in peak hour, capacity of parking areas, etc.);
?? the main land-use characteristics (e.g. population density, employees, shops, schools, etc.);
?? representation of the above analysis on thematic GIS maps.

The analysis of this study area is based on:

1. A questionnaire survey of users of the interchange, in order to identify catchment areas by feeder modes, including bicycling and walking.

2. An on-site investigation of the surrounding area to highlight the significant features of the access network and land-use characteristics of the area surrounding the interchange.

3. A GIS tool able to represent the most significant data collected through the questionnaire and the on-site investigation.

1.2.3. Types of barriers
As mentioned, barriers are all those negative ‘interchange factors’ able to move travellers towards car-based options instead of intermodal ones. MIMIC subdivides
Barriers can be absolute or relative. An *absolute* barrier is a barrier that cannot be circumvented and which therefore must be removed. An example would be a staircase for a person in a wheelchair. A *relative* barrier is one that is sufficient to discourage someone from using the interchange, but its relative gravity depends upon the situation. For example, the high cost of buying two tickets may well be a deterrent to making a journey but would not physically impede travel.

MIMIC breaks down barriers according to how serious they are and identifies the population to which they apply. With this information, the project helps decision makers to choose among the many investment projects competing for the same pot of money and make a more reasoned decision about priorities.

Barriers are analysed from different perspectives: users, non-users, local authorities, planners, transport operators, architects and designers, disabled, elderly, cyclists, schoolchildren.

The products of the analysis for this area are:

- the identification, ranking and rating of barriers from the point of view of users and non-users;
- the identification of problems, views and expectations of specific user groups (e.g. cyclists, local residents, elderly, environmental groups);
The identification of barriers from the supply side (e.g. planners, designers, transport operators, local authorities);

the evaluation of time, distance and energy consumed by passengers when changing modes at the interchange site.

The analysis of this study area is based on:

a questionnaire survey in order to identify barriers according to users and non-users;
an interchange deconstruction, based on maps, blueprints and on-site analysis, in order to measure distances and times of interchanging, and to quantify facilities and barriers at each interchange;
focus group discussions, to focus on needs of specific user groups;
key actor interviews, to analyse perspectives and opinions of local authorities, planners and designers, transport operators, architects and designers;
video observation, to provide first-hand evidence of patterns of behaviour;
a micro-simulation model of pedestrian and vehicle movements outside and inside the interchange, to quantify dynamically distance, time and energy consumed by passengers when changing mode at the interchange site.

1.2.4. Implementing cost-effective local solutions

As a necessary and preliminary step towards the achievement of the final output, recommendations and best practice guidelines, MIMIC identifies solutions that are suitable to local conditions at the test sites.

These site-specific solutions are proposed in order to reduce barriers to intermodality and improve the attractiveness of the interchange, at the different levels (planning, decision, funding, designing, building and operating) at which the relevant actors are involved.

The products of the analysis for this area are:

the synthesis of all information collected in the previous study areas;
the identification of the optimal actions (local solutions) to be undertaken in each interchange site to increase its attractiveness and patronage;
the identification of examples of good practice, in Europe and elsewhere;
the development of guidelines for planning, design and management of passenger interchanges.

The analysis of this study area is based on:

the results achieved through all the MIMIC surveying and modelling tools developed for the previous three study areas;
The investigation of other recent and significant case studies in Europe and elsewhere, to be addressed as examples of good practice.

The other case studies were selected on the basis of:

- partners’ knowledge and literature;
- case studies indicated by key actors and focus groups.

### 1.3 Surveying and modelling activities

A number of surveying and modelling tools were developed and tested to analyse the above mentioned study areas. These tools are intended to help planners and designers to objectively assess an interchange and its relationships with the transport network and land-use characteristics. The tools are probably of most use in the design stages of interchanges, but they are valuable also at other stages in an interchange’s ‘life’ (interchanges under construction or even in operation). The relevance of tools for the analysis of the first three study areas is synthesised in Table 1-2. All tools contribute in implementing cost-effective local solutions.

<table>
<thead>
<tr>
<th>Tools used for analysis</th>
<th>Study areas</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Door-to-door factors</td>
<td>Catchment area</td>
<td>Types of barriers</td>
</tr>
<tr>
<td>Questionnaires on door-to-door factors</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questionnaires on barriers to intermodality</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Interchange deconstruction</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>On-site investigation of the surrounding area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questionnaire on revealed and stated preferences</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus Group discussions</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Key Actor interviews</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Video observation</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Questionnaire on catchment area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nested Logit model</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Micro-simulation model</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>GIS tool</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The tools were tested on a number of sites in Europe. An in-depth investigation of selected interchanges was conducted in six cities: Bilbao (two interchanges), Copenhagen, London, Rome, Tampere and Warsaw. The investigation of the seven main sites is complemented by Key Actor interviews and deconstruction activities in...
four interchanges in German-speaking countries: Berlin Zoologischer Garten, Frankfurt Hauptbahnhof, Wien Mitte and Zurich Hauptbahnhof. The list of main and complementary sites and public transport services available there is given in Table 1-3.

Table 1-3. Main and complementary MIMIC sites and public transport services available

<table>
<thead>
<tr>
<th>City</th>
<th>Country</th>
<th>Interchanges</th>
<th>Bus</th>
<th>Railway</th>
<th>Underground</th>
<th>Tram</th>
<th>Light Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Termibús</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abando Intermodal</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilbao</td>
<td>ES</td>
<td>Valby</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copenhagen</td>
<td>DK</td>
<td>Tampere Intermodal</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>London</td>
<td>UK</td>
<td>Stratford</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rome</td>
<td>IT</td>
<td>Ponte Mammolo</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tampere</td>
<td>FI</td>
<td>Tampere Intermodal</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warsaw</td>
<td>PL</td>
<td>Wilanowska Pulawska</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Berlin</td>
<td>DE</td>
<td>Zoologischer Garten</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Frankfurt</td>
<td>DE</td>
<td>Hauptbahnhof</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Vienna</td>
<td>AT</td>
<td>Wien Mitte</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zurich</td>
<td>CH</td>
<td>Hauptbahnhof</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Each site is an interchange in an urban context, but they vary from park-and-ride sites (e.g. Ponte Mammolo), suburban distributors (e.g. Wilanowska Pulawska), central area bus/rail interchanges (e.g. Tampere Intermodal), to multimode facilities (e.g. Stratford).

While Tampere Intermodal and Valby are mainly bus/rail interchanges (it should be noted, however, that a significant patronage access Valby by cycle), the four sites in German-speaking countries (Berlin Zoologischer Garten, Frankfurt Hauptbahnhof, Wien Mitte and Zurich Hauptbahnhof) are complex railway stations with connections to underground, light rail, tram and bus services. No high-speed rail services are available at any of the four sites.

Termibús is mainly a bus station, but it has connections to underground and railway lines. Stratford and Abando Intermodal are complex multimode facilities (see section 2.3.2), served by rail, underground, bus and light rail (Stratford only) services.
Abando Intermodal is a central area interchange, while Stratford is located on the eastern edge of London.

As Stratford, Ponte Mammolo and Wilanowska Pulawska are both peripheral interchanges, the former on the eastern edge of Rome, the latter in the southern part of Warsaw. While Wilanowska Pulawska is mainly a public transport interchange (bus, tram and underground services are available), Ponte Mammolo is mainly a park-and-ride facility (see section 2.3.1), with more than 1500 car spaces available at the interchange site. Apart from park-and-ride, it is also an important peripheral bus/underground interchange.

Surveying and modelling tools have not been tested on all sites, but only where software availability and budget constraints permitted it. For tools tested at four sites or more, results were synthesised and presented in a general way through a number of tables and graphs (e.g. questionnaires on barriers to intermodality, Focus Group discussions, interchange deconstruction). In this way MIMIC provides the interested reader with a general European vision of the problem and results achieved.
Where the tools were tested at three sites or less (Nested Logit model, micro-simulation model, questionnaire on catchment area, questionnaire on revealed and stated preferences, video observation), the interest of the MIMIC team shifted mainly to the tool itself to prove its effectiveness in identifying problems and possible solutions to them. Table 1-4 lists which tools were tested on each MIMIC site.

It can be seen in Table 1-4 that various forms of interviews were carried out at all sites. These include questionnaires to users and non-users; focus groups with target specific groups (e.g. local residents, cyclists, disabled); interviews with key actors involved in planning, design and management of passenger interchanges.

Table 1-5 shows targets and sample sizes of interviews carried out through questionnaires. Figures reported are minimum sizes chosen for the MIMIC research, meaning that more interviews were carried out at some sites than at others.

Table 1-4. Surveying and modelling tools tested in the MIMIC sites

<table>
<thead>
<tr>
<th>Surveying and Modelling Tools</th>
<th>Bilbao</th>
<th>Copenhagen</th>
<th>London</th>
<th>Rome</th>
<th>Tampere</th>
<th>Warsaw</th>
<th>Berlin</th>
<th>Frankfurt</th>
<th>Vienna</th>
<th>Zurich</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaires on door-to-door factors</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Questionnaires on barriers to intermodality</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Interchange deconstruction</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>On-site investigation of the surrounding area</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Questionnaire on revealed and stated preferences</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Focus Group discussions</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Key Actor interviews</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Video observation</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Questionnaire on catchment area</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Nested Logit model</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Micro-simulation model</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
Table 1-5. Interviews through questionnaires: targets and samples.

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Target</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questionnaires on door-to-door factors</td>
<td>Users and non-users</td>
<td>300</td>
</tr>
<tr>
<td>Questionnaires on barriers to intermodality</td>
<td>Users and non-users</td>
<td>800</td>
</tr>
<tr>
<td>Questionnaire on revealed and stated preferences</td>
<td>Users and potential users</td>
<td>50</td>
</tr>
<tr>
<td>Questionnaire on catchment area</td>
<td>Users</td>
<td>200</td>
</tr>
</tbody>
</table>

Type and number of Focus Groups and Key Actors interviewed vary from site to site. As a whole, more than 50 Key Actor interviews and more than 30 Focus Group discussions were carried out. Particular attention was given to disabled among Focus Groups and service operators among Key Actors (see sections 1.9 and 1.10 for more details).

In the following sections all surveying and modelling tools are described, presenting examples of results achieved using the tools.

1.4 The questionnaires on door-to-door factors

Two questionnaires (‘Preliminary selection’ and ‘Full-scale analysis’) were developed to identify the most significant door-to-door factors affecting individuals’ choices to make intermodal trips. Both the questionnaires are designed to be carried out by telephone, in order to interview a broad sample of both users and non-users of an interchange site.

The two questionnaires are structured in series and correspond to two phases of analysis. The first one (‘Preliminary selection’) selects a limited number of factors (the most important ones according to the interviewees) by interviewing a small sample of people using the first questionnaire. The second phase analyses only factors selected through the first questionnaire, and requires a larger number of interviews.

The two-step procedure allows to analyse a large number of factors without having too long a questionnaire for the full-scale survey.

The first questionnaire has two parts:

?? Questions about respondent’s usual trip (time and purpose);
?? Questions identifying the most significant door-to-door factors (e.g. number of transfers, waiting time, parking conditions in destination);

The second questionnaire has four parts:
A. Background information on respondent’s family characteristics (e.g. family structure, number of cars and motorbikes owned);

B. Background information on respondent (e.g. gender, age, occupation);

C. Questions identifying the most significant door-to-door factors;

D. Questions about respondent’s present choice (revealed preferences).

The first questionnaire was filled in by a small sample of people (about 60 persons in each of the six MIMIC cities), while the second one was filled in by about 400–500 people in each city. All interviews were conducted during normal weekday conditions.

In the first questionnaire a list of more than 40 door-to-door factors was proposed to the interviewees. Each person interviewed was asked to evaluate the absolute importance given to each factor by circling a number from 1 (not important) through 10 (extremely important). Respondents could circle ‘N’ to indicate no opinion.

For each factor a mean mark, \( m(i) \), was then calculated according to the following expression:

\[
(a) \quad m(i) = \frac{\sum_{j=1}^{n_i} M_j(i)}{n - n_i}
\]

where:

- \( M_j(i) \) is the mark given to factor \( i \) by individual \( j \);
- \( i = 1, \ldots, K \) is the generic factor considered, with \( K \) the total number of door-to-door factors listed in the questionnaires;
- \( j = 1, \ldots, n \) is the generic individual interviewed, with \( n \) the total number of interviewees;
- \( n_i \) is the number of interviewees who circled an ‘N’ in the question referring to factor \( i \).

The most important door-to-door factors are those given the highest mean marks. Only the most important factors (the first 10 in the ranking) were included in the second questionnaire. The same criterion was adopted for the second questionnaire (marks from 1 through 10, ‘N’ to indicate no opinion).

On the basis of data collected through the second questionnaire, new mean marks were calculated for all factors listed in the questionnaire. The analysis of door-to-door factors was taken further, subdividing respondents into different categories (males and females, peak users and non-peak users, etc.) and calculating different mean marks for each category. A large number of tables and graphs were produced, in order to synthesise the main results for each category analysed.
Table 1-6 shows the most important door-to-door factors identified through the questionnaires. The symbol 'X' in a cell means that the factor was ranked as one of the three most important factors in the corresponding city.

The research proved that passengers are most sensitive to time spent waiting for public transport, especially when the perceived waiting time is considered. 'Waiting time' was ranked as one of the three most important factors in three cities out of five (as second factor in Copenhagen and Warsaw, as first in Rome).

The importance of waiting time is particularly significant for people making trips in peak hours (mainly workers and students), but it turns out to be a serious psychological barrier in sparsely populated interchanges and during night hours, when people fear for personal security. While uncoordinated services (causing long waiting times) may be an irritation for all travellers during daytime periods, this situation may result in an absolute barrier for women and other vulnerable groups who would like to avoid long waits late at night.

Waiting time is commonly reckoned to be perceived as being two/three times longer than in-vehicle time. Where services are frequent this is not so much of a problem, but there is a need for regional insurance that as many transport services can be synchronised to each other as possible. This is a role which requires local coordination.

The interviewees expressed also particular concern for ‘service reliability’, ranked as one of the three most important factors in two cities out of five. Delays, strikes and skipped trips are common and are one of the main reasons why people use cars instead of public transport. This is particularly evident in Copenhagen and Warsaw, but it is a problem in all the MIMIC cities.

Table 1-6 shows also the importance of information about public transport services and routes. ‘Information on service delays’ was mentioned in two cities, Tampere (where it is the most important factor) and Copenhagen, but also ‘information on routes and maps’ are important (Bilbao). The importance of information on delays is strictly connected to the importance people give to time-related factors, as mentioned above. The MIMIC cities seem to provide scarce real-time information to public transport users, both at bus stops and at interchanges. In some cases such an information is available only for some transport modes or some routes (e.g. Rome).

Also fear of crime proved to be a serious concern for travellers interviewed by the MIMIC team, especially women, elderly people and the mobility-impaired. ‘Security’ was ranked as the most important factor in Warsaw, but it proved to be a serious problem in Rome too. Psychological factors referring to personal security (e.g. presence of policemen or guards, general security, poor lighting) can deeply influence the choice of private car instead of public transport, especially during the night.

A strong effort should be made by governments and local authorities to improve feelings of personal security when travelling by public transport. Governments should provide guidance on how to reduce fears for personal security, while each
local area needs local research to find out exactly what are people’s greatest fears, and what would make them feel comfortable.

‘Traffic jam’ was ranked as the second most important factor in one city out of five (Rome). It introduces a random term in people’s travel time, which can become enormously important in large urban areas like London and Rome. In this case rail services get ahead of private modes, since they are not subject to road congestion.

‘Connections from the station to the final destination’ are perceived as a serious problem in Tampere, where this factor was ranked as the second most important one. Also ‘stairs’, ‘lack of ticket machines’ and ‘weather protection’ were mentioned in one city out of five.

1.5 The questionnaires on barriers to intermodality

Two questionnaires were developed in order to capture data on the most significant barriers and attractive features for a broad sample of users/non-users of an interchange site.

One questionnaire is home-based (although it can be carried out by telephone), while the other is designed to be carried out at the interchange site. The aim of the home-based questionnaire is to interview users and non-users living within 3 km of the interchange site. The other questionnaire is designed to be filled in by users only.

<table>
<thead>
<tr>
<th>Door-to-door factors</th>
<th>Bilbao</th>
<th>Copenhagen</th>
<th>Rome</th>
<th>Tampere</th>
<th>Warsaw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting time</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Information on delays</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Service reliability</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connections from the station to the final destination</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Information on routes and maps</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of ticket machines</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stairs</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic jam</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weather protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
The questionnaires follow a common five-part structure:

A. Questions about respondent’s awareness and general use of public transport (e.g. knowledge of transport services feeding the interchange, transport means most frequently used);

B. Questions about respondent’s use of the interchange (e.g. frequency, mode to mode);

C. Questions identifying barriers to public transport interchange (e.g. presence of stairs, fear of crime);

D. Questions identifying attractive features that would enhance the respondents’ experience of public transport (e.g. better surveillance, special information devices);

E. Background information on respondent (e.g. age, gender, employment status).

In parts C and D of the questionnaires the interviewees are asked to indicate the importance they give to a number of barriers/attractive features by circling a number from 1 (Not a problem if a barrier; No use at all if an attractive feature) through 10 (A very serious problem if a barrier; Extremely useful if an attractive feature). Respondents can circle ‘N’ to indicate no opinion.

The same criterion was adopted to identify the most important door-to-door factors (see previous section). Anyway, barriers and attractive features differ from door-to-door factors for two reasons:

?? Barriers and attractive features refer to the interchange only, while door-to-door factors cover the whole journey, from origin to destination.

?? Barriers and attractive features refer to a specific interchange site. As for door-to-door factors, MIMIC has analysed their absolute importance, without reference to any particular interchange site.

For each barrier/attractive feature a mean mark has then been calculated, as for door-to-door factors (see previous section). The most significant barriers and attractive features of an interchange site have then been identified on the basis of these mean marks.

The analysis of barriers and attractive features was taken further, by subdividing respondents into different categories (e.g. car users and public transport users, males and females, young people and the elderly) and calculating different mean marks for each category.

All interviews were conducted during normal weekday conditions. About 800 persons (400 interviews per questionnaire) were interviewed in each MIMIC city.
Table 1-7 shows the three most significant barriers identified in each of the seven MIMIC main test sites. The symbol ‘X’ in a cell means that the barrier was ranked as one of the three most important barriers in the corresponding site.

It can be noted that lack of information represents the most serious deterrent to intermodality. What users ask mainly for is ‘information on service delays’ (mentioned in four sites out of seven), which is considered the first most significant barrier at Stratford, Valby and Ponte Mammolo, but people complain also for ‘poor information for journey planning’ (mentioned in three sites, Valby, Termibús and Ponte Mammolo).

Failures in the area of information are often due to organisational and institutional causes, but are also related to the difficulty of providing comprehensive and understandable information about the interactions of complex transport networks. Such a difficulty is particularly evident in the United Kingdom, where the deregulation of the bus industry led to network changing become more frequent and irregular.

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Abando Intermodal</th>
<th>Termibús</th>
<th>Valby</th>
<th>Stratford</th>
<th>Ponte Mammolo</th>
<th>Tampere Intermodal</th>
<th>Warsaw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor information on service delays</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Poor information for journey planning</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Queuing for tickets</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fear of crime</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>General cleanliness</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of seating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor availability of staff</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Ticketing machines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Steps, staircases and slippery floors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

‘Queuing for tickets’ was ranked as one of the three most important barriers in three sites out of seven (Abando Intermodal, Termibús and Tampere Intermodal). At Tampere Intermodal, in particular, ‘queuing for tickets’ was cited as the most significant barrier. Queuing for tickets as a barrier is particularly serious where no through-ticketing is available. The lack of through-ticketing may be a quite expensive barrier to remove, but its removal can generate significant passenger demand. If different tickets are needed for different transport operators, passengers often face severe problems in getting tickets and using ticketing machines. ‘Ticketing
machines’ were mentioned as important barriers in two sites, Abando Intermodal and Wilanowska Puławska.

Having staff available is one of the highest passengers’ expectations in two sites out of seven (Ponte Mammolo and Stratford), not only for information but also for safety issues. The provision of staff to patrol the interchange and the need to feel personally safe (‘fear of crime’, mentioned in two sites) have emerged as significant issues in each survey, but particularly at Ponte Mammolo, Stratford and Wilanowska Puławska. Personal security was found to be a major barrier even where cities had maintained at the start of the project that it was not an issue. Women and elderly people are the most affected, but all people interviewed expressed concern.

‘Lack of seating’ was mentioned as the second most important barrier at both Valby and Tampere Intermodal. The absence of waiting areas and seats is perceived as a significant deterrent to use public transports especially by the elderly and people with mobility impediments, but a wide range of interviewees expressed concern in nearly all the sites.

In Tampere and Bilbao (Termibús) ‘general cleanliness’ emerged as a significant problem for passengers. Qualitative barriers, such as ‘general cleanliness’, are generally caused by institutional and organisational issues; the problem often is that a clean and good quality interchange is often no-one’s particular responsibility.

Presence of ‘steps, staircases and slippery floors’ emerged as a serious barrier only at Abando Intermodal.

1.6 Interchange de construction

Deconstruction of interchange sites was selected as a strategy to identify attractive features and barriers to intermodality and interchange, and to determine whether these are ‘absolute’ or ‘relative’ for different types of passengers while interchanging.

Barriers and attractive features were then used as assessment building blocks to evaluate measures to improve intermodality and interchange where new interchanges are being planned or existing ones evaluated.

The study was based on blueprints and maps of the interchange and its surrounding area. The desk research was complemented by an on-site investigation to study pedestrian routes inside and outside the terminal and to measure lift and escalator speeds.

The research has involved two kinds of deconstruction:

?? Visual Profiling Matrices
?? User Experience Time/Distance/Energy Matrices
Table 1-8. Visual Profiling Matrix

<table>
<thead>
<tr>
<th>Arrivals?</th>
<th></th>
<th>Departures?</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>)</td>
<td>%</td>
<td>2</td>
<td>)</td>
</tr>
<tr>
<td>Tram</td>
<td>R.</td>
<td>Tram</td>
<td>R.</td>
<td>Metro</td>
<td>R.</td>
</tr>
<tr>
<td>Tram</td>
<td>R.</td>
<td>Tram</td>
<td>R.</td>
<td>Car</td>
<td>R.</td>
</tr>
<tr>
<td>%</td>
<td>R. B. H. P.</td>
<td>R. H. P.</td>
<td>R.</td>
<td>Metro</td>
<td>R. B.</td>
</tr>
<tr>
<td>R. B. H. P.</td>
<td>R. B. H. P.</td>
<td>R.</td>
<td>Bus</td>
<td>R. B.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>R. B. H. P.</td>
<td>R.</td>
<td>Walking</td>
<td>R.</td>
<td></td>
</tr>
<tr>
<td>R.</td>
<td>Walking</td>
<td>R.</td>
<td>Walking</td>
<td>R.</td>
<td></td>
</tr>
</tbody>
</table>

R = Ramps
B = Ticket Barriers
H = Handrails
P = Pavement Obstacle

Visual Profiling Matrices break down an interchange into a series of components based around horizontal (moving walkways, ticket barriers, etc.), vertical (stairs, lifts, etc.), information (timetable, public address, etc.) and physical design (toilets, seating, telephones, etc.) barriers and attractive features.

Each matrix represents the possible interchange opportunities available at the site and identifies barriers/attractive features present during interchange between the different transport modes.

One of the four Visual Profiling Matrices is given in Table 1-8. The matrix refers to the Wilanowska Pulawska Interchange in Warsaw.
The aim of *User Experience Time/Distance/Energy Matrices* is to measure distance, time and energy consumed on the most direct route between modes and determine whether discrepancies existed between questionnaires’ results and the physical environment. *User Experience Time/Distance/Energy Matrices* divide users into three categories:

?? Type A: Fit unencumbered, walking adult

?? Type B: Fit encumbered adult (i.e. with luggage or prams), small children, older people, etc.

?? Type C: Wheelchair users (including mobility scooters)

Table 1-9 presents an example of a MIMIC User Experience Time/Distance/Energy Matrix for user type A.

**Table 1-9. User Experience Time/Distance/Energy Matrix (example)**

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Speed (m/s)</th>
<th>Time (s)</th>
<th>Energy (J)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal walking (outside)</td>
<td>200.0</td>
<td>1.34</td>
<td>149.2</td>
</tr>
<tr>
<td>Horizontal walking (inside)</td>
<td>50.0</td>
<td>1.34</td>
<td>37.3</td>
</tr>
<tr>
<td>Horizontal walking (platform distance)</td>
<td>10.0</td>
<td>1.34</td>
<td>7.5</td>
</tr>
<tr>
<td>Stairs up</td>
<td>3.5&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.30</td>
<td>11.7</td>
</tr>
<tr>
<td>Stairs down</td>
<td>4.1&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.34</td>
<td>12.1</td>
</tr>
<tr>
<td>Escalators</td>
<td>6.0&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.21</td>
<td>28.6</td>
</tr>
<tr>
<td>Lifts</td>
<td>6.0&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.35</td>
<td>57.1&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>260.0&lt;sup&gt;2&lt;/sup&gt;</strong></td>
<td>–</td>
<td><strong>303.5</strong></td>
</tr>
</tbody>
</table>

<sup>1</sup> Vertical distance (height).

<sup>2</sup> Horizontal walking only.

<sup>3</sup> Including lift stop time per landing = 40 s.

Not all mode changes were examined, but only those considered to be of particular relevance to the site, e.g. very long interchange or many physical barriers. Table 1-10 gives the best, worst and average connections, in terms of distance to be walked to change means of transport, for user type A (‘fit unencumbered, walking adult’). Eleven modal changes were analysed, considering five different transport modes (bus, car, light rail or tram, rail and underground). Data are based on a sample of nine MIMIC interchanges, where distance measures were carried out in detail.

Regarding best connections, the longest distance to be walked proved to be that between carparks and underground stations, over 200 m. Most modal changes are below 100 m (7 cases out of 11). The best connection is definitely that between rail and underground at Stratford (platform to platform), but also bus/car interchange at
Wilanowska Pławska (10 m) and bus/tram interchange at Frankfurt Hauptbahnhof and Zurich Hauptbahnhof (25 m) offer good examples.

As for worst connections, in 5 cases out of 11 distances are over 300 m (bus/light rail, rail/light rail, rail/rail, rail/bus, bus/bus). The worst connection is definitely that between coach and local bus (bus/bus) at Tampere Intermodal (618 m). In all sites where modal changes require more than 200 m to be walked, users mentioned distance as a serious barrier to intermodality.
Table 1-10. Distances to be walked between modes

<table>
<thead>
<tr>
<th>Connection</th>
<th>Distance (m)</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underground/Bus</td>
<td>Min</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>112</td>
</tr>
<tr>
<td>Underground/Car</td>
<td>Min</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>260</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>247</td>
</tr>
<tr>
<td>Underground/Light Rail and</td>
<td>Min</td>
<td>75</td>
</tr>
<tr>
<td>Underground/Tram</td>
<td>Max</td>
<td>226</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>133</td>
</tr>
<tr>
<td>Underground/Rail</td>
<td>Min</td>
<td>Plat. to plat.</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>156</td>
</tr>
<tr>
<td>Underground/Underground</td>
<td>Min</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>126</td>
</tr>
<tr>
<td>Rail/Light Rail and Rail/Tram</td>
<td>Min</td>
<td>123</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>443</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>227</td>
</tr>
<tr>
<td>Rail/Bus</td>
<td>Min</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>560</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>223</td>
</tr>
<tr>
<td>Rail/Rail</td>
<td>Min</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>488</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>177</td>
</tr>
<tr>
<td>Bus/Bus</td>
<td>Min</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>618</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>216</td>
</tr>
<tr>
<td>Bus/Car</td>
<td>Min</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>388</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>119</td>
</tr>
</tbody>
</table>

1 From train platform to coach parking.
2 From train platform to local bus.
1.7 On-site investigation of the surrounding area

On-site investigation aims at identifying and evaluating the most important characteristics (both transport modes and land-use characteristics) of the area surrounding an interchange.

These characteristics can significantly influence the demand for and use of transport modes. High-density land-use developments, for example, encourage walking and cycling between households and interchange sites and increase the attractiveness of the bus network. Experience has shown that higher density reduces dependence on the automobile. Thus high density promotes travel choice for public transport, bicycling and walking to the interchange.

The surrounding area was defined as four annuli, or concentric circular areas, lying 0–0.5, 0.5–1, 1–2, and 2–3 km from the interchange, which represents the centre of the circle.

The most significant land-use characteristics are given by density measures, relating to population, workers and activities (shops, industries, etc.) in the area surrounding an interchange site. A number of indicators were calculated and analysed in order to synthesise the characteristics of the areas surrounding the MIMIC sites. The main indicators are the following:

- **Population density**, defined as the ratio of population living in the surrounding area to the area itself (in km\(^2\));
- **Work ratio**, defined as the ratio of employees (i.e. jobs) in the surrounding area to the population living in the same area;
- **Shops ratio**, defined as the ratio of shops in the surrounding area to the area itself (in km\(^2\));
- **Facility X ratio**, defined as the ratio of a particular characteristic of a specified facility to the surrounding area. For a school the particular characteristic could be the number of students (i.e. School ratio = students/km\(^2\)), for a hospital it could be the number of beds available (i.e. Hospital ratio = beds/km\(^2\)).

More detailed indicators can be obtained by splitting the population into several age classes and calculating several age-related residential densities, as well as by identifying different economic sectors (e.g. retail employment, industry, agriculture, education) and evaluating several sector-related work ratios.

Transport mode characteristics are given by qualitative and quantitative measures about means, roads and services feeding the interchange site and capacity of parking areas.

Figure 1-1 summarises data collected on people living within 500 m, 1 km, 2 km and 3 km of each interchange site. The figure shows minimum, average and maximum values of population for each of the four distance classes considered.
The population living within 500 m of the interchange ranges from a minimum of about 1500 (Wilanowska Pulawska) to a maximum of 8600 (Valby). The average (of a sample of five sites) is about 4000. Ponte Mammolo, Stratford and Wilanowska Pulawska interchanges are situated in peripheral low population density areas, while population density is higher near Tampere Intermodal and Valby station.

The largest number of people living in the 1-km catchment area is about 20,600 (Tampere Intermodal), the minimum about 9500 (Wilanowska Pulawska). On average, about 15,000 people live in the 1-km catchment.

Although the 1-km area surrounding Stratford interchange is a peripheral low population density area, it is the area with the greatest number of people living in the 2-km catchment (about 65,000) and in the 3-km catchment (about 191,000). Ponte Mammolo is second in both cases, with about 61,000 (2-km catchment) and 122,500 (3-km catchment). Next in order come Wilanowska Puławska, Tampere Intermodal and Valby. Valby shows the minimum number of people living within 2 km (about 26,600) and within 3 km (about 38,300). On average, people living in the 2-km and 3-km catchment areas are about 50,000 and 100,000 respectively.

![Figure 1-1. Population distribution in function of the distance from the interchange site: minimum and maximum values.](image)

Like Figure 1-1, Figure 1-2 summarises data collected on jobs within 500 m, 1 km, 2 km and 3 km of each interchange site. Minimum, average and maximum values of jobs are given for each of the four distance classes considered.

The interchange with the most jobs within 500 m walking distance is Tampere Intermodal, with about 7800, while Ponte Mammolo has the fewest, with about 400 people working in that area. The same occurs in the 1-km catchment, with a minimum of about 2400 jobs (Ponte Mammolo) and a maximum of about 15,600 jobs.
These figures reflect the central location of the Finnish site and the peripheral one of the Italian site. On average, there are about 3000 jobs in the 500-m catchment area and about 7000 in the 1-km catchment area.

The interchange with largest population in the 2-km catchment area (about 42,000) and in the 3-km catchment area (about 65,000) is Wilanowska Pulawska. Ponte Mammolo is again the site with the fewest jobs: about 14,300 in the 2-km catchment and about 26,400 in the 3-km catchment. On average, there are about 26,000 jobs in the 2-km catchment area and about 42,000 in the 3-km catchment area.

![Figure 1-2. Job distribution in function of the distance from the interchange site: minimum and maximum values.](image)

### 1.8 The questionnaire on revealed and stated preferences

The purpose of the questionnaire on revealed and stated preferences is to capture data on present behaviour (revealed preferences, RP) and stated preferences (SP) of users/non-users of an interchange site in relation to their intermodal trip choices.

The objective is to identify conditions able to shift modal split from single-mode (generally car-based) options to intermodal ones.

The mixed SP and RP information collected is then used to calibrate a Nested Logit choice model (see section 1.13). The questionnaire and the model allow designers and planners to test the consequences and effectiveness of different actions at the interchange site.

At the Ponte Mammolo Interchange in Rome, the local MIMIC team tested travellers’ reactions to:

?? Reduced walking distance between parking areas and the station main entrance;
?? Opening of a shopping centre in the Metro station;
?? Increased number of CCTV and policemen inside and outside the Metro station and better lighting;
?? Increased parking fee for park-and-ride users.

About 50 people were interviewed in Rome. Interviews were carried out face-to-face, owing to the extensive use of images and photos in the questionnaire.

The questionnaire has four parts:

A. Filter questions, to distinguish those who use a means because they have no alternative from those who would be able to shift easily to another transport means under specific conditions;

B. Questions about the respondent’s present behaviour (RP);

C. Questions about the respondent’s stated preferences (SP);

D. Background information on the respondent (e.g. age, gender).

In parts B and C individuals not excluded by filter questions are asked about what they are doing at the moment (part B) and what they would choose to do (part C) in a number of hypothetical situations (‘scenarios’). Each scenario presents different values (‘levels’) of the four actions (‘attributes’) mentioned above. The analysis of results is rooted in theories of utility and econometrics.

The number of scenarios was reduced to a minimum by using different methods:

(a) Using ‘fractional factorial’ designs;

(b) Removing options that ‘dominate’ or are ‘dominated’ by all other options in the choice set;

(c) Separating the options into ‘blocks’, so that the full choice set is completed by groups of respondents, each responding to a different sub-set of options.

1.9 Focus Group discussions

Focus Group discussions enable views, experience and attitudes of specific user groups to be identified so that problems and preferences can be examined in the context of the interchange site and its catchment area.

Focus Groups offer an opportunity to explore in greater depth issues and topics raised through the questionnaires on barriers to intermodality. Focus Groups included the disabled, cyclists, schoolchildren and youth groups, the elderly and women’s associations.
In each MIMIC city a list of issues and related questions was prepared in advance of each session, structured according to the seven barriers headings. A brief introduction was prepared to provide participants with a broad understanding of the scope and objectives of the MIMIC project.

Each Focus Group discussion involved use of stimulus material (visual aids, video clips, photographs, slides, plans, maps, charts, etc.) illustrating particular features of the interchange itself if it existed, or what was planned in the case of future or ongoing development. Maps of the catchment area indicating particular feeder routes, transport corridors, etc., were also used.

The interviews were audio-taped. One person acted as chair and another operated the tape recorder and took notes. After each group discussion a summary of the conversation was written up, thus integrating minutes taken during the discussion.

Table 1-11 shows groups interviewed in the seven main MIMIC sites. Focus Groups involved mainly disabled (6 sites), schoolchildren and youth groups (5 sites), cyclists (4 sites), elderly (4 sites), shopkeepers and business associations (4 sites) and local residents and tenants associations (3 sites), but also women’s associations, commuters, people with learning difficulties, bus drivers and booking-clerks, environmental groups and pressure groups (1 site each).

Table 1-11. Focus Groups interviewed in the main MIMIC sites

<table>
<thead>
<tr>
<th>Focus Groups interviewed</th>
<th>Abando</th>
<th>Intermodal</th>
<th>Termibus</th>
<th>Valby</th>
<th>Stratford</th>
<th>Ponte</th>
<th>Mammolo</th>
<th>Tampere</th>
<th>Intermodal</th>
<th>Wilanowska</th>
<th>Pulawska</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schoolchildren and youth groups</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Elderly</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Disabled</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>People with learning difficulties</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Cyclists</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
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<td></td>
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<tr>
<td>Commuters</td>
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<td></td>
<td></td>
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<td>X</td>
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<tr>
<td>Pressure groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Local residents and tenants associations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Shopkeepers and business associations</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Women’s associations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Environmental groups</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Bus drivers and booking-clerks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Table 1-12 lists the most important barriers to intermodality cited by people with severe physical or perceptual disabilities. The symbol ‘X’ in a cell means that the barrier was ranked as one of the three most important barriers in the corresponding site. At Abando Intermodal and Termibús separate Focus Group discussions were held with physically disabled and with persons with vision and hearing problems. Consequently, for both sites six barriers (instead of three) were considered for the analysis.

The most serious barriers to intermodality proved to be ‘difficult access to vehicles’ and ‘difficult access to information’, both mentioned at four sites out of six. Difficult access to vehicles is particularly evident at Valby, where regional and long-distance trains are not accessible to the disabled, but similar concern was expressed at Ponte Mammolo (‘buses are not equipped to receive and transport the disabled’), Termibús (‘coach floors are too high’) and Stratford (‘feeder journeys a problem’).

It is mainly people with vision and hearing problems who are affected by difficult access to information. Lack of brochures and signs in Braille was mentioned at Abando Intermodal, Termibús and Ponte Mammolo, while lack of trained staff (the interviewees wanted staff who know sign language) proved to be a severe barrier at Stratford and both the Spanish sites.

‘Long distances between modes’ were mentioned for three sites out of six (Ponte Mammolo, Tampere Intermodal and Termibús). At Tampere Intermodal, in particular, long distance is considered the most important barrier to intermodality.

Table 1-12. The most important barriers identified through Focus Groups with disabled

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Abando Intermodal</th>
<th>Termibús</th>
<th>Valby</th>
<th>Stratford</th>
<th>Ponte Mammolo</th>
<th>Tampere Intermodal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to vehicles</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Access to information</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Long distances between modes</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Inadequate lighting</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Steps and staircases</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of special car spaces</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

‘Inadequate lighting’ represents a problem at three sites (Abando Intermodal, Termibús and Tampere Intermodal), while ‘steps and staircases’ were mentioned as an absolute barrier at two sites (Abando Intermodal and Valby). Finally, the
interviewees complained of ‘lack of special car spaces’ at two sites (Abando Intermodal and Termibus).

It should be noted that at nearly all the MIMIC sites toilets and services are equipped for people with disabilities. Problems are faced only at Abando Intermodal, where unequipped toilets were mentioned as a barrier.

1.10 Key Actor interviews

Key Actors are persons who have a significant role in planning, designing, operating interchanges or who have a significant interest in being consulted during the planning and design phases.

The information collected through the questionnaires on barriers to intermodality (i.e. the most significant barriers according to interchange users) was used to influence topics to be addressed in Key Actor interviews. The main purpose of Key Actor interviews is to identify differences between the stated intentions of planners, operators and regulators and the experience and preferences of interchange users.

Key Actor interviews have enabled problems and good practice to be analysed from a number of different perspectives, mainly on the supply side. They also enabled researchers to assess the role different actors/organisations play in creating new interchanges or changing existing ones.

Examples of Key Actors are listed below:

?? Architects and designers
?? Planners
?? Local authorities
?? Service operators

Interviews were written up as short reports of significant issues discussed which are organised under the seven barrier headings.

Table 1-13 shows Key Actors interviewed at the eleven MIMIC sites. The MIMIC team interviewed mainly service operators (9 sites), road and traffic engineers (5 sites), planners (5 sites), architects and designers (4 sites), interchange managers (3 sites), but also staff managers, responsible for marketing and service regulators (2 sites each), transport police, real estate owners and local authorities (1 site each).

Table 1-14 shows the five most significant barriers to intermodality cited by service operators at nine different MIMIC sites. The symbol ‘X’ in a cell means that the barrier was ranked as one of the three most important barriers in the corresponding site. The interviewees are mainly rail operators with the exception of Tampere Intermodal, Ponte Mammolo (both bus operators) and Stratford (underground operator).
The most important barrier that emerged from interviews with service operators is ‘lack of integration and co-ordination’. It was mentioned as one of the first three most significant barriers at six sites out of nine. Poorly integrated management of interchanges with different bodies responsible for different modes and areas is a serious barrier to use. Lack of integration and co-ordination leads to several problems, including lack of timetable co-ordination between modes and lack of an integrated passenger information system.

‘Fear for personal security’ emerged as a serious problem at three sites out of nine, thus confirming results from questionnaires on barriers to intermodality (see section 1.5). Crime is feared particularly at Berlin Zoologischer Garten, due to a bad image that derives from the drug scene there during the 1980s, as well as at Frankfurt Hauptbahnhof, which is located in a night-club and prostitution quarter, but at Ponte Mammolo too service operators complained of lack of proper surveillance.

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‘Difficult access for the disabled’ was mentioned at three sites as one of the three most important barriers to intermodality. This barrier is particularly evident at Valby, where lack of lifts and presence of steps make access impossible for the disabled, but also at Zurich Hauptbahnhof boarding of trains is impossible for wheelchair users without help. At Berlin Zoologischer Garten, on the other hand, the use of lifts requires long ways round. These findings confirm the level of concern expressed by the disabled during Focus Group discussion (see section 1.9).

At two sites (Abando Intermodal and Zurich Hauptbahnhof) Key Actors complained of ‘lack of parking spaces for cars and bicycles’, while ‘poor feeder services’ proved to be a serious deterrent to interchange at Stratford and Tampere Intermodal.

Table 1-14. The most important barriers identified through interviews with service operators

<table>
<thead>
<tr>
<th>Barriers</th>
<th>MAIN SITES</th>
<th>COMPLEMENTARY SITES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abando</td>
<td>Intermodal</td>
</tr>
<tr>
<td>Lack of integration and co-ordination</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fear for personal security</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Difficult access for the disabled</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Lack of parking spaces for cars and bicycles</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Poor feeder services</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

1.11 Video observation

Video observation aims at actively observing travellers’ behaviour at an interchange site and record difficulties with barriers experienced by the different types of users.

Video is particularly useful at targeting and tracking travellers through a sequence of actions and tasks providing evidence of the impact of barriers and obstacles on accessing, exiting and using the interchange and moving from one mode to another. Video is also useful in observing and recording the use of amenities and attractive features of the interchange in the same way.

Observation has covered both busy and quiet periods of a standard working day. The amount of video material collected varies from site to site, according to local needs.
The main uses of video observation are in dissemination, but also in providing stimulus material for Focus Group discussions (see section 1.9). The use for which video material was intended has determined the amount and type needed.

Stimulus material for Focus Group discussions was edited into sections explaining a ‘point’ to be communicated to the group, and was edited into a short (under five minutes) presentation showing a variety of shots subdivided into clearly defined topic areas.

Dissemination material depended on the type of media:
- For a promotional video documentary-type footage was produced;
- For a CD shorter, stand-alone footage was produced with a maximum of 15 seconds, showing a clearly defined image (e.g. people using escalators, stairs).

1.12 The questionnaire on catchment area

The purpose of the questionnaire is to identify catchment areas by feeder modes, included walking. The questionnaire was designed to be run at the interchange, since it aims at collecting data about users of the interchange site.

People waiting for public transport are as a rule much more willing to fill in a questionnaire than those using private cars (park-and-ride users). The questionnaire is therefore quite short; both car and public transport users need only a couple of minutes to fill it in. All interviews were conducted during normal weekday conditions. About 200 people were interviewed at each MIMIC site.

Data collected through the questionnaire include origin and destination, time and purpose of trip and modes used and can be represented using a GIS tool (see section 1.15) or simple pies and histograms, as shown in Figures 1-3, 1-4 and 1-5.

Figures 1-3, 1-4 and 1-5 show the distance distribution of users accessing the interchange by car (park-and-ride or kiss-and-ride), local bus and walking. Data refer to Ponte Mammolo and Tampere Intermodal, where the questionnaire was carried out. Each column represents the absolute number of users covering the distance reported on the x-axis to get to the terminal.

In Figure 1-3 it can be seen that distance distribution of users accessing by car is widely spread, ranging from 1 km or less to over 100 km. In Rome people generally use car for journeys of 10 km or less (about 80% of the sample), while at Tampere the average distance covered by car is about 15 km.

The variances of walkers (see Figure 1-5) and local bus users (see Figure 1-4) are smaller. Pedestrians generally do not walk more than 5 km (in Rome 70% of the sample walk less than 1 km), while bus distribution ranges from a minimum of 500 m to a maximum of 25 km, with an average journey length of about 5 km at both sites.
Figure 1-3. Access distance distribution by car

Figure 1-4. Access distance distribution by local bus
The theory of choice behaviour is based on the classical concept of individuals’ deriving utility from the consumption of a particular product (or, in general, from a particular choice). Utility represents the satisfaction or benefit a person enjoys when spending his/her resources on different things. It implies an overall value attached to a product by an individual. Individuals are assumed to choose the products with the maximum utility.

The most common utility construct is a linear model, in which the combination of attributes is additive. An error term is included in the utility equation, in order to reflect unobservable elements of choice behaviour.

The aim of a travel demand model is to measure the relationship between travellers’ behaviour (i.e. their modal choices) and a number of variables (e.g. safety, parking fee, distances to be walked, etc.), in order to obtain estimates of demand elasticity. The MIMIC researchers, in particular, aimed at quantifying the importance of a number of ‘interchange factors’ (see section 1.1 for definition of ‘interchange factors’) on travellers’ intermodal choices, in order to shift modal split from single-mode (generally car-based) options to intermodal ones.

The MIMIC team calibrated two Nested Logit models, one in Copenhagen, the other in Rome. Both models used a joint RP/SP estimation technique. The theoretical framework for combining data sources and the specification of the model and the likelihood functions are not discussed here (see the Literature List for some references); the joint use of RP/SP data requires a special method. If RP and SP data were simply mixed to estimate choice models, an error would show up in both the measured components and in the unmeasured components (variance) captured in the...
models themselves. The calibration based on data collected through the questionnaire on revealed and stated preferences (see section 1.8).

The Danish model focused mainly on public transport users (trains and buses), while the Italian one considered car users and park-and-ride users.

Figure 1-6 illustrates how modal shares change in function of the parking fee. It can be seen how the reduction of park-and-ride users when the fee increases benefits mainly public transport (bus + metro). Results refer to park-and-ride users interviewed at the Ponte Mammolo Interchange in Rome. The Nested Logit model proved that an increase of parking fee influences modal choices of park-and-ride users much more than changes in surveillance and walking distance or the opening of a commercial centre.

Figure 1-6 can be the starting point for a cost-benefit analysis when the goal is to optimise feeder modes patronage at an interchange site. If construction costs for parking areas are considered, the Logit model can suggest the optimal fee to prevent construction of enormous parking areas just beside empty bus terminuses.

Several of these graphs were drawn to represent the relative impact on modal choices of different changes at the interchange site.
1.14 Micro-simulation model

A *simulation* is a technique for using computers to imitate, or *simulate*, the operations of various kinds of real-world facilities or processes. The facility or process of interest is usually called a *system*, and in order to study it scientifically it is often necessary to make a set of assumptions about how it works. These assumptions, which usually take the form of mathematical or logical relationships, constitute a *model* that is used to try to gain some understanding of how the corresponding system behaves. In a *simulation* a computer is used to evaluate a model numerically, and data are gathered in order to estimate the desired true characteristics of the system.

Through micro-simulation the MIMIC team modelled the current and future behaviour of the Ponte Mammolo Interchange in Rome and tested its degree of congestion. The specific objective of the MIMIC micro-simulation was to determine how long it takes the passengers to go from one means of transport to another, the distance to be walked and the energy consumed to cross the terminal, once the distributions of the arrivals and departures of vehicles and the distributions of passengers alighting from each means are given.

Table 1-15 shows the time spent changing mode for each of the five modal changes analysed with the micro-simulation model. Times listed in Table 1-15 comprehend waiting times and delays due to crowding effects (station entrance, escalators, etc.). Similar tables were developed for distances walked between services and energy consumed to change modes. When the terminal is overcrowded, some travellers can choose longer but less crowded paths to reach their mode. This was not found to be the case of the Ponte Mammolo Interchange. The terminal is quite small, so that alternative paths are not available to travellers. Consequently, distances to be walked between services are ‘static’ and do not change with pedestrian flows.

<table>
<thead>
<tr>
<th>Connection</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local bus ? Metro (eastbound)</td>
<td>215.83</td>
</tr>
<tr>
<td>Local bus ? Metro (westbound)</td>
<td>216.35</td>
</tr>
<tr>
<td>Regional bus (arrivals) ? Metro (eastbound)</td>
<td>161.19</td>
</tr>
<tr>
<td>Regional bus (arrivals) ? Metro (westbound)</td>
<td>157.92</td>
</tr>
<tr>
<td>Regional bus (arrivals) ? Local bus</td>
<td>239.69</td>
</tr>
</tbody>
</table>

Using micro-simulation, the MIMIC team analysed arrivals and departures of vehicles at the interchange (see Table 1-16). Car entrance into and exit from the parking areas were studied, quantifying time to enter the parking area, find a free space and park the car, as well as time spent to reach the exit and wait to merge. As for buses, delays at intersections and congestion effects were quantified. The analysis should be extended to all transport modes affected by congestion.
Table 1-16. Accessing and egressing times

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>Accessing time (s)</th>
<th>Egressing time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private car</td>
<td>43.2</td>
<td>21.3¹</td>
</tr>
<tr>
<td>Local bus</td>
<td>12.1</td>
<td>17.4</td>
</tr>
</tbody>
</table>

¹ Egressing flow = 5 veh./min.

Figure 1-7 shows the average waiting time when egressing the carpark in function of the egressing flow. A similar analysis was carried out for road crossings around the Ponte Mammolo Interchange.

The micro-simulation model also made it possible to study the effect of different management (such as the introduction of new traffic lights or one-way streets, or increasing or decreasing the buses lines) on the facility’s overall behaviour.

The micro-simulation model is a ‘dynamic’ deconstruction. Data collected in a ‘static’ way through maps, blueprints and on-site measurements (e.g. distances, presence of stairs, escalators and lifts, frequency of public transport modes, vehicle and passenger flows, capacity of parking areas) are here computed and presented in a dynamic way, making it possible to simulate and represent the behaviour of the whole system.
The interchange is represented as a collection of *active objects*, members of different classes: cars, buses, metro trains and pedestrians. Each object can move on different paths and has its own properties. The model represents their movements and their interference.

The system was analysed on two different scales:

1. the car, metro and bus movement was implemented by choosing, as an analysis zone, a large enough area comprising the terminal and the streets connected to it; this zone is represented in Figure 1-8;

2. the pedestrian movement was studied on two levels. The first one is an area comprising the bus termini and the terminal ground floor; the second one includes the terminal first floor and the metro station. Both levels are shown in Figure 1-9.

![Figure 1-8. Layout of the first simulator. The small rectangles are the buses; the Metro is represented as a set of six rectangles; the squares are cars.](image)

The average value of the means’ arrivals and departures, the car flows and the passenger flows were measured on site and can be varied for testing purposes. The capacity and speed of the transport means, the passengers’ speed, and some other parameters can also be changed. The morning rush hour (7:30–8:30 a.m.) was simulated.
Figure 1-9. Layout of the second simulator. The rectangles are the buses; the Metro is represented as a set of six rectangles and the points are the pedestrians. The numbers near the local bus termini indicate the different bus lines.

An animation of the discrete event simulations was made with a post-processing animator. Animation is useful in both the inspection and the presentation phase. It is the most immediate tool for analysing the system response because it is reproduced and visualised step by step.

1.15 GIS tool

A Geographic Information System (GIS) has the capability of greatly improving the interchange planning and development. GIS can provide accurate density measures across any surface to highlight the concentration of population and activities. In particular, it can help transport operators and planners to develop an efficient transport feeder network to an interchange site, easily identifying areas with high population and/or activities density.

GIS is used to collate and manage a variety of data inputs and outputs:

1. geocoding of survey data: household and activity locations, including employment sites, non-work activity centres and public transport stops;

2. analysis of demographic characteristics such as household size, age, access to cars and occupation of household members;

3. analysis of land use (residential, commercial and industrial);
4. analysis of interchange accessibility by different feeder modes;

5. mapping and display of model outputs, such as the static traffic assignments by different modes to the interchange and the dynamic traffic micro-simulations.

A GIS tool was used to represent land-use and transport characteristics of the area surrounding five MIMIC sites. The aim was to identify present and potential patronage of the interchange site (people living or working in the area) and analyse public and private transport modes feeding the interchange.

Four different thematic maps were drawn at each site:

Map A1: road network of the surrounding area;
Map A2: public transport network of the surrounding area;
Map B1: population density by annulus;
Map B2: work ratio by annulus.

Maps B1 and B2 consider four annuli, or concentric circular areas, lying 0–0.5, 0.5–1, 1–2, and 2–3 km from the interchange, which represents the centre of the circle.

Figure 1-10. Population density by annulus around Stratford.
Figure 1-10 shows population living in the area surrounding the Stratford Interchange in London. Similar maps were drawn for the other main MIMIC test sites.

Figure 1-11 presents a cross-comparison of data on population collected at five sites (see also section 1.7). Population values vary from site to site, mainly as a result of the interchange’s location (central or peripheral). The average population living in the 500-m catchment is about 4000, but at three sites out of five the value is 2500 or less. As for the 1-km catchment, at two sites population living in the area is about 10,000 people, and in the other three about 20,000.

People living in the 2-km catchment varies from about 50,000 to about 60,000, with the only exception of Valby (only 26,600). The range of variation is wider for the 3-km catchment, from a minimum of about 38,300 (Valby) to a maximum of about 191,000 (Stratford), with an average value of about 100,000 people living in the area.

![Population distribution in function of the distance from the interchange site: site-specific values.](image)

1.16 Links and relations between tools

Surveying and modelling tools are strictly linked to one another, so that some of them provide information to be used as input to other tools (see Figure 1-12).

The questionnaire on revealed and stated preferences tested travellers’ reactions to a number of changes at the interchange site (e.g. reduced walking distances, better surveillance). The ‘interchange factors’ where changes occur are those identified as the most significant ‘interchange factors’ through the questionnaires on door-to-door factors. This procedure is mainly designed for interchanges planned or under
construction. If the interchange is already in operation, the best actions (able to influence travellers’ modal choices) can be identified through the questionnaires on barriers to intermodality and correspond to the removal of the most significant barriers mentioned by interchange users. Data collected through the RP/SP questionnaire (i.e. actual modal choices and stated intentions in a number of hypothetical scenarios) were used to calibrate the demand model.

Questionnaires on barriers to intermodality identified statistically the most significant barriers from the point of view of interchange users. Topics and issues raised through the questionnaires have then been discussed and explored in greater depth with specific user groups (Focus Group discussions). For example, if fear of crime emerged as one of the most serious barriers from the questionnaires, Focus Group discussions enabled researchers to identify what people feared most, which areas were considered to be most dangerous, what would be the best solutions to be undertaken. Findings from the questionnaires have also been discussed with Key Actors, in order to identify differences between the stated intentions of planners, operators and regulators and the experience and preferences of interchange users.

Physical barriers identified through the questionnaires (e.g. long distances to be walked to change mode, presence of steps or staircases) were filmed (video observation) to actively observe travellers’ behaviour at the interchange site and record difficulties with barriers experienced by the different types of users.

Pedestrian routes inside and outside the terminal and lift and escalators speeds collected through interchange deconstruction provided input data to the micro-simulation model. In addition, interchange deconstruction identified the presence of staircases, steps, dangerous crossings, pavement obstacles and other physical barriers to be filmed and actively analysed through video observation.

Information on feeder modes (e.g. type, frequency and routes of public transport means, capacity of parking areas for cars and cycles) and road network (e.g. vehicle flows on surrounding roads, location of intersections, traffic lights and pedestrian crossings) collected through on-site investigation was used as input for the micro-simulation model, in order to represent pedestrian and vehicle flows inside and outside the interchange site.

Knowledge of type and frequency of public transport feeder modes and capacity of parking areas for private means helped to identify the most important (in terms of users/hour) feeder modes whose market was to be analysed through the questionnaire on catchment area.

Data collected through questionnaire on catchment area and on-site investigation (population density, work ratio, public and private transport networks, size and boundaries of the market area for feeder modes) were represented on thematic GIS maps.

Figure 1-12 shows how the tools were applied in four in-serial phases.
The first phase involved running the questionnaires on barriers to intermodality and door-to-door factors and the activities of deconstruction and on-site investigation. This phase provided the basic data to be used by most of the other tools.

The second phase was based on data collected in the first phase (the most serious barriers to intermodality according to interchange users, the most important door-to-door factors according to users and non-users, distance, time and energy consumed by passengers when changing modes, the most important transport and land-use characteristics of the area surrounding the interchange) and comprehended the questionnaire on revealed and stated preferences, Focus Group discussions, Key Actor interviews, video observation and the questionnaire on catchment area.

The third phase involved modelling activities (micro-simulation and Nested Logit) and a GIS representation of the most significant features of the access network and land-use characteristics of the area surrounding the interchange.

The fourth phase coincide with the fourth MIMIC study area (Implementing cost-effective local solutions) and aimed at:

1. synthesising all information collected through all the surveying and modelling tools, in order to identify what was wrong with each interchange site from different perspectives (users, non-users, transport operators, disabled, elderly, etc.);

2. developing local solutions to increase the interchange’s attractivity and patronage, i.e. the best actions to be undertaken to remove or improve the most significant barriers;

3. identifying examples of good practice in Europe and elsewhere, to look at when planning, designing or managing an interchange;

4. drawing guidelines for planning, design and management of passenger interchanges to be used in a variety of sites, in operation, planned or under construction.

Even if surveying and modelling findings differed from site to site, many common features were identified. On the basis of these, and given the range of experiences covered in the project, MIMIC has developed general guidelines to be applied in a variety of other European realities. A number of examples of good practice to remove or improve barriers to intermodality were found, in Europe and elsewhere. Guidelines and examples of good practice are the content of chapter 2.
Figure 1-12. Links and relations among tools
2 Guidelines for planning, design and management of interchanges

2.1 Introduction
In this chapter guidelines for planning, design and management of interchanges are presented. These guidelines are based on results achieved using the tools described in the previous chapter.

Table 2-1 lists the main (i.e., most frequently mentioned) barriers identified through surveys in the eleven MIMIC sites (the seven main case studies, plus the four complementary sites in Austria, Germany and Switzerland). In section 2.2 guidelines to remove such barriers are given and examples of good practice, in Europe and elsewhere, presented. Guidelines and examples of good practice are framed according to the seven barrier headings identified by the project (see chapter 1). Each of the seven subsections ends with a table synthesising proposed solutions and examples of good practice.

In section 2.3 specific guidelines are given for three different types of interchanges:

?? Park-and-ride interchanges,
?? Complex interchanges, and
?? Airport connections.

Barriers are ranked on the basis of two parameters (Table 2-1):

1. *Number of sites* where the barrier proved to be a significant one (the seven main case studies, plus the four complementary sites in Austria, Germany and Switzerland);

2. *Categories of interviewees* (i.e. users, focus groups and key actors) who cited the barrier in one of the sites.
Table 2-1. Main barriers identified by the MIMIC research

<table>
<thead>
<tr>
<th>Typology of barriers</th>
<th>Main barriers</th>
<th>Sites</th>
<th>Users and Focus Groups</th>
<th>Key Actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistical and operational</td>
<td>Poor or inappropriate funding from State and Local Authorities.</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Poor/lack of time synchronisation between services.</td>
<td>+</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Incomplete through-ticketing.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Queuing for tickets.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insufficient number of ticketing machines.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological</td>
<td>Fear of physical attack and violence.</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Thefts of cycles.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thefts of cars and car radios.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thefts and acts of vandalism to shops and retail activities.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional and organisational</td>
<td>Poor integration in planning and building interchanges.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poorly integrated interchange management.</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Competition on passengers and double services.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marketing opportunities often missed.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical design</td>
<td>Long distances to be walked between services.</td>
<td>++</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steps and staircases.</td>
<td>++</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of comfortable waiting areas and seating.</td>
<td>+</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Toilets not properly maintained or not equipped for wheelchair users.</td>
<td>+</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Poor cleanliness.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of services for people working at the interchange.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Access to vehicles for disabled persons.</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Lack of reserved car spaces for the disabled.</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local planning and land use</td>
<td>Pedestrian access over busy roads.</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Pedestrian access through unsafe areas.</td>
<td>++</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of cycle lanes and/or cycle access over busy roads.</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Typology of barriers</strong></td>
<td><strong>Main barriers</strong></td>
<td><strong>Sites</strong></td>
<td><strong>Users and Focus Groups</strong></td>
<td><strong>Key Actors</strong></td>
</tr>
<tr>
<td>--------------------------</td>
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</tr>
<tr>
<td></td>
<td>Lack of secure and covered cycle parking.</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Poor public transport services feeding the interchange.</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Problems of dropping off and picking up passengers, with no provision in many cases.</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Lack of parking areas or insufficient car spaces.</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Lack of public consultation and participation.</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Economic and social</td>
<td>Cost of public transport services.</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If waiting times are short the opening of shops is not viable according to shopkeepers.</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of shops and retail activities.</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Information</td>
<td>Lack of information on routes and services.</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>No integrated passenger information system.</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Real-time information lacking or available only for some transport modes.</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Staff not on hand to help passengers (both for information and personal security).</td>
<td>++</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of signing or signs of poor quality.</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Lack of acoustic signals and Braille maps for blind people.</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

‘Sites’: ‘+’ if the barrier was cited at 3 sites or less;  
‘++’ if the barrier was cited at 4 or 5 sites;  
‘+++’ if the barrier was cited at 6 or more sites (up to 11).  

‘Key Actors’: ‘+’ if the barrier was cited at least by at least one key actor at one of the sites.  

‘Users & Focus Groups’: ‘+’ if the barrier has been cited by users or at least by a focus group at one of the sites.
2.2 General guidelines for interchanges

Because many barriers are common to many sites, it is possible to draw some general guidelines for most situations. These guidelines are presented here under the seven barrier headings identified by the project.

2.2.1 Logistical and operational

While many cities map out cycle networks and quality bus system networks, less often is there a long-term strategy and plan for interchanges. The MIMIC research has highlighted that interchange often grows up in an unplanned manner, and where many transport modes meet an ‘interchange’ is established. Moreover, most improvements at interchanges come about opportunistically, or when budget allows for change.

Logistics and operation are the key aspects of an interchange and its catchment area. Transfer between modes requires timing and synchronisation of transport modes as well as simple and straightforward links between modes, in order to reduce delays to a minimum. Through-ticketing helps to reduce barriers (and delays) inherent in serial ticketing (e.g. queues for tickets, use of ticketing machines).

Funding and control from governments

Intermodality generally requires large investments, and extensive funding for interchange development is consequently needed. The savings made possible by a more effective public transport network will be realised only after investments. Moreover, adequate funding can often foster co-operation between transport modes.

More direction and control from central and regional governments is needed to oversee planning, co-ordination and investment in public transport and interchanges. Good practice is given by Italy, Denmark and Austria.

Italy has decentralised policy and strategy for action on interchanges to regional and municipality level through the 29 articles of Law no. 122/89. The policy is focused on reducing car use in urban areas by encouraging (including by financial support) the development of parking at public transport interchanges and the establishment of urban pedestrian routes.

Central government policy in Denmark is supported by mention of part funding for interchange development. Policy statements stress the role of interchange design to promote intermodal trips.

In Austria, the national plan details measures to improve location and development of interchanges, as well as moves to increase density around interchange and integration of cycle and pedestrian networks with public transport.

Key Actor interviews are an effective tool with which to study and discuss funding problems with the main actors involved.
Timing and synchronisation of services
With very frequent services, the relative timing of services at interchanges is of little importance. If services operate every five minutes or so, it is unlikely that detailed changes to timing would have much impact on the time-barrier of waiting that passengers perceive. However, where services are less frequent there are very strong arguments for trying to time them to minimise waiting times (while assuring passengers that the incoming service will not be delayed and make them miss a connection with their outgoing service).

Information on expected duration of journey and frequency of connecting services at the interchange are very important. This can be done with electronics or announcements, and with timetables clearly visible on board vehicles.

A micro-simulation model can be effectively used to dynamically analyse arrivals and departures of transport means and to quantify waiting times.

Issues of ticketing and fare structures
The implementation of unified tickets facilitates the use of all transport modes and reduces costs for travellers as well as time spent queuing for tickets. A single ticket should allow travellers to use all transport modes in an area.

Barriers inherent in serial ticketing should be removed wherever possible. Issues of through-ticketing and complexity of ticketing systems are common barriers to intermodality, especially among those who have low levels of knowledge about a transport system.

If there is a need for different ticket systems, they should be available from one ticket office/machine. Seasonal travel cards already exist in many cities (e.g. London, Rome) and are a good example to look at.

Key Actor interviews with transport operators and local authorities and Focus Group discussions with passenger pressure groups are effective tools to analyse the issue both from the supply and the demand side.

Table 2-2 synthesises proposed solutions and examples of good practice to overcome logistical and operational barriers.
Table 2-2. Logistical and operational barriers: proposed solutions and examples of good practice

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Examples of good practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>More direction and control from central and regional government to oversee planning, co-ordination and investment in public transport and interchanges and develop an integrated interchange planning policy.</td>
<td>Italy (Law 122/89)</td>
</tr>
<tr>
<td></td>
<td>Austria (National Transport Plan)</td>
</tr>
<tr>
<td>Increase national and/or regional funding for interchange development.</td>
<td>Italy (Law 122/89)</td>
</tr>
<tr>
<td></td>
<td>Denmark</td>
</tr>
<tr>
<td>The implementation of unified tickets, which facilitates the use of all transport modes and reduces costs for travellers as well as time spent queuing for tickets.</td>
<td>London</td>
</tr>
<tr>
<td></td>
<td>Rome</td>
</tr>
</tbody>
</table>

2.2.2. Psychological

Psychological barriers tend to be invisible, but are often as important as some of the more visible ones, or more so. Among the many areas they cover are:

?? A dislike of the notion of using public transport, which is translated into the creation of many subconscious ‘reasons’ for finding it not of use;

?? Reluctance to take the time needed to plan journeys (a prerequisite of most journeys involving interchange);

?? A fear of crime (one of the key barriers to public transport use and intermodality; see Table 2-1).

The nature of such barriers makes it difficult to provide simple cross-national answers to the problems raised, but some factors stand out and deserve mention here.

Fear of crime

Fear of crime is generally a serious deterrent to using public transport for most people. The type of fear and the people experiencing fear vary greatly from place to place. Fear of physical attack and violence and the danger of cycle and car thefts are problems experienced at most interchange sites. Women and elderly people are the most affected, but all travellers are concerned.

Fear is often greater in the area near the interchange than within the interchange itself, where there are generally enough people present to provide a feeling of security. The presence of vagrants, beggars and drug addicts in the surrounding area increases the feeling of insecurity. In some cases the location of the interchange itself (e.g. in a night-club/prostitution district) increases fear of crime.
In many cases the rumours and news stories about assault and non-availability of staff create a fear that can be more ‘real’ than reports about newspaper exaggeration and about diminishing numbers in the criminal statistics.

Transport policy needs to be linked to anti-crime and other social policy to improve feelings of personal security when travelling by public transport. Governments should provide guidance on how to reduce fears for personal security. Each local area, on the other hand, needs local research to find out exactly what people fear most and what would make them feel comfortable.

The type of solutions suggested varies from place to place. All interchanges everywhere should have an ‘Interchange Personal Security Strategy’ to minimise this major barrier. This should always include:

(a) Good surveillance (policemen, guards, staff) both inside and outside the interchange site, especially in parking areas (if any) or along outdoor walkways; see Figure 2-2.

(b) Programmes to train all staff employed in the interchange in personal care and assistance, and being approachable about fears for personal security; see Figure 2-1.

(c) The use of CCTV (though passengers generally do not consider it a solution on its own); see Figure 2-2.

(d) Good lighting, both inside and outside the interchange. Dark spots, pillars, recesses, low ceiling heights and overuse of concrete should be avoided. Open spaces, with extensive use of glass and transparent walls, increase the feeling of security (see Figure 2-3). Natural lighting and outside views should be designed (or opened up) wherever possible. These can reduce the stress of mild feelings of claustrophobia and give a sense of being ‘in the real world’.

(e) Opening of shops and business activities in the interchange. Busy interchanges generally feel safe since they provide a social function as a retail, leisure, meeting place as well as an interchange. Incorporating shops and business activities in the interchange helps create a busy and lively place (see also section 2.2.6, Economic development).

Other research has shown that a combination of improved lighting, CCTV, staff training, and staff presence both on stations and on trains has led to an increase in the number of women passengers. In any case, measures to remove the fear of crime should extend outside the interchange construction.

Questionnaires on barriers to intermodality and door-to-door factors, Focus Group discussions and Key Actor interviews can be used to identify the level of anxiety and possible exclusion from public transport use experienced by many local people and employees within interchange catchment areas. A Nested Logit model can be used to quantify travellers’ reactions to an improvement of surveillance at an interchange site.
Figure 2-1. Presentation of staff at the bus terminal, New York. Source: MIMIC archive.

Figure 2-2. Security control centre at the bus terminal, New York. Visible staff and a good surveillance system reduce fear of crime. Source: MIMIC archive.
Lack of knowledge as a barrier to use

The general knowledge of public transport systems among those who do not use them regularly is often not good. Most people lack training on journey planning and the lack of this skill is a major barrier to use.

The main ways in which this barrier can be overcome are dealt with in section 2.2.7, on information (pre-trip and on-trip information), but it should be remembered that the lack of knowledge has psychological aspects. People may be unwilling to admit their low level of knowledge (or may even be ‘proud’ of it), and special ways will be needed to tell different groups how to obtain the information they need.

Publicity campaigns can better acquaint citizens with the interchange functionality and facilities. The importance of personalised information for particular journeys cannot be overstated. Interactive information points, internet services and clear maps are needed to encourage people to learn the skills of journey planning (see section 2.2.7, Pre-trip information and On-trip information).
The image of public transport and interchanges

Many people have a negative image of public transport and all types of interchanges. The image of older interchanges is often very poor; advertisements show ‘losers’ waiting at bus stops, while successful people splash them with their cars. Living ‘life in the bus lane’ does not have the same image as ‘life in the fast lane’.

While national-level action is needed to improve this image at the general level, local action by operators and local planners can do much to improve the image. Art and sculpture in transport locations (see also section 2.2.6, Local cultural factors), the livery on vehicles, and attention to detail in cleanliness and tidiness could back up national attempts to improve the image. Amenities and retail shops can give a feeling of liveliness and vivacity, entertaining users while they wait for their transport.

High-quality interchanges would clearly improve the image of public transport travel. They could become a possible tool for the overall marketing of public transport.

Table 2-3 synthesises proposed solutions and examples of good practice to overcome psychological barriers.

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Examples of good practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff helpful and trained in personal care and assistance can reduce fears for personal security.</td>
<td>Hammersmith (London)</td>
</tr>
<tr>
<td></td>
<td>Bus/Coach Station (Leeds)</td>
</tr>
<tr>
<td></td>
<td>Paddington Terminus (London)</td>
</tr>
<tr>
<td></td>
<td>Bus terminal (New York)</td>
</tr>
<tr>
<td>Use of CCTV can reduce fears for personal security.</td>
<td>Wien Mitte (Vienna)</td>
</tr>
<tr>
<td></td>
<td>Bus terminal (New York)</td>
</tr>
<tr>
<td>Good lighting, both inside and outside the interchange, and extensive use of glass and transparent walls increase the feeling of security.</td>
<td>Canning Town (London)</td>
</tr>
<tr>
<td></td>
<td>Cardiff Terminus (Cardiff)</td>
</tr>
<tr>
<td></td>
<td>Paddington Terminus (London)</td>
</tr>
<tr>
<td></td>
<td>Blaak Station (Rotterdam)</td>
</tr>
<tr>
<td></td>
<td>DLR stations (London)</td>
</tr>
</tbody>
</table>

2.2.3. Institutional and organisational

Institutional and organisational barriers are often overlooked by transport planners. However, evidence from surveys suggests that the large number of key players and bodies generally makes the planning and building process of interchanges more complex, protracted and costly. Moreover, having different persons and bodies responsible for different areas and/or modes can lead to poor management and organisation of an interchange, with deleterious consequences (e.g. transport services are not synchronised, through-ticketing is not available, staff are not able to answer...
enquiries about onward travel). Centralised management of interchange matters that affect users is emphatically recommended.

In many cases there is lack of co-operation between different transport operators. This is especially true in the deregulated UK situation, but occurs elsewhere as well, especially where responsibility is split between companies.

Transport links tend to be marketed, sometimes quite well, but there is often a lack of co-ordination of marketing of all the links to an interchange, and of the advantages of using interchanges. Research into the marketing of interchange is therefore needed.

**Integration in planning, building and managing interchanges**

An integrated strategy for interchange planning and building is essential. Interchange development should never be *ad hoc* as opportunities arise. Moreover, lack of planning and design integration or political disagreement can cause severe delays to the construction of new interchanges.

Integrated interchange management is needed in all cases, with one person as a head. Uncoordinated signing in and around a site, lack of timetable co-ordination between transport modes, lack of an integrated passenger information system are all consequences of poor management integration. Clear lines for responsibility, easily understood by the travelling public, are needed; the public must understand to whom to direct complaints and be able to distinguish security staff from rail staff. Where transport staff give a poor impression through unhelpfulness, users perceive a severe barrier to intermodality (see also section 2.2.7, Information through staff).

Berlin Zoologischer Garten, Frankfurt Hauptbahnhof and Zurich Hauptbahnhof are good examples to look at. One single person (the 'Interchange Manager') is in charge of all the concerns of the interchange. The management has a hierarchical structure: several sub-departments are responsible for different fields of the station (security, rail services, economics, etc.).

Key Actor interviews are a powerful tool for analysing and discussing the problem with main actors involved to identify local solutions.

**Organisation of public transport**

Excessive competition between transport operators should be discouraged. A free transport market can bring about duplication of services and is often an obstacle to through-ticketing and synchronisation of transport services. Deregulation and privatisation without careful public control and co-ordination have generally exacerbated integration problems. There is often reluctance to provide easy links between competing transport operators, even when such co-operation could increase the overall market size. Competitive operators tend to be more interested in market *share* than overall market *size*. 
A single *super partes* body should be responsible for timetable co-ordination and through-ticketing. Interchange can be facilitated at informal locations, for example where two major bus corridors cross. Adjacent or proximate bus stops should be carefully positioned, with complementary measures to enable pedestrians to cross roads.

Good practice is given by Copenhagen, where transport operators are public and private, but a transport authority (the *super partes* body) is in charge of drawing up the transit plan (adjusted every fourth year), and every year stipulates the tariffs for bus and train fares within the region. The transport authority operates no buses itself but purchases bus operation from various bus contractors by tender. The involvement of private operators has significantly reduced costs for the collectivity.

Key Actor interviews with transport operators and local authorities are a way to analyse the issue.

**Marketing issues**

Marketing an interchange is often seen as an add-on. Most public transport marketing is of companies, or links in the network, rather than of the intermodal aspects. Marketing opportunities (e.g. of new interchanges) are often missed.

A marketing plan needs to be prepared (possibly by a *super partes* body) to promote travel/amenity benefits of the new interchange. Marketing strategies should be developed alongside development plans. The ‘environmentally friendly’ message could become a positive marketing message for transport planners and managers.

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Examples of good practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated staff policy and interchange management, with one person as head (the ‘interchange manager’).</td>
<td>Zoologischer Garten (Berlin) Hauptbahnhof (Frankfurt) Hauptbahnhof (Zurich)</td>
</tr>
<tr>
<td>Co-ordination between transport operators, which helps through-ticketing and synchronisation of transport services.</td>
<td>Copenhagen</td>
</tr>
</tbody>
</table>

**2.2.4. Physical design**

Interchanges are often not designed in a functionally optimal manner. In many cases the chosen design is the result of an ‘architectural competition’, with the emphasis on the visual architecture of the building, the functionality taking a secondary role (e.g. poorly situated ticket offices, lack of lifts and ramps, lack of waiting areas).
Some improved interchanges show a contrast between very high-quality concourses and unimproved platforms or waiting areas; others containing different unmatched parts.

There is a need for an integrated approach to design in terms of both architectural and transport-use design, as well as the characteristics of the site. Aesthetic design is important but should be linked to functionality, though spectacular and bold art design can bring the benefits of making the interchange a ‘landmark’. In a few special cases aesthetic design can attract non-passengers who may then use the transport provided (e.g. Blaak Station in Rotterdam). In particular, it is important to consider aesthetic design aspects throughout the whole interchange if part of an interchange is being improved.

Barriers due to physical design are often obvious but some of them can have a very serious impact on passengers’ travel choices, since they can be absolute barriers to some groups of people (e.g. a staircase for wheelchair users).

**Linkages between modes**

Distances to be walked between modes should be as short as possible. Where they exceed 200 m, short-distance transport systems, either continuous (moving walkways), semicontinuous (vehicles with slow speeds in stations) or discontinuous (shuttles), can be a solution. Protection from rain or sun should be provided along all walking links. Long distances can also be perceived as a psychological barrier when they involve passing through a ‘dangerous’ area.

Level changes should be avoided. Where they are required, ramps, spacious lifts and escalators should be available. Escalators should run both up and down wherever possible. The use of glass and transparent material for lifts prevents their misuse and reduces users’ fear of being trapped inside (see Figure 2-4). The most direct route may not be the most appropriate for all users; alternative secondary, ‘stair-free’ routes, with lifts or escalators, need to be signposted for people using wheelchairs, pushing baby carriages, carrying heavy luggage, wheeling bicycles, or otherwise impeded or encumbered.

Architectural plans should be analysed to test actual distance, convenience and accessibility of change over journeys between one route and another within the interchange. Relocation of services may be possible, with knowledge of travel patterns during the early planning stages for interchanges in the initial planning and design phase. Routes should be kept free of one another to avoid pedestrian conflicts and bunching.

Interchange deconstruction and the micro-simulation model are both powerful tools for analysing linkages between modes, quantifying distances, times and energy consumed, and studying the consequences of overcrowding.
Figure 2.4. Lift at Flemingsberg, Stockholm. The use of transparent material for the lift prevents its misuse and reduces users’ fear of being trapped.

Provision of facilities
A prime concern of passengers and potential passengers is good ‘basic services’: good ticket offices and ticket machines (to avoid long queues for tickets), clean toilets (with disabled and baby-changing facilities) and comfortable waiting areas. Telephones and cash points, shops, first aid and cafes should be included where possible.

Many improvements can be quite inexpensive but effective. These relate particularly to general cleanliness, information points, staff presence (rather than hidden away), good lighting and comfortable waiting areas.
Lack of seating is commonly mentioned as an area of concern for many people. The number of seats to be provided at an interchange site needs always to be related to the number of passengers waiting for services and to the duration of waiting time. On-site measures to quantify passenger flows are necessary for a proper design of waiting areas.

Long waits without seating are uncomfortable for anyone, and many people need seating even for short waits. Seating is required at stops and platforms (possibly with signs giving priority to those who need them). Comfortable and safe waiting areas need good access to real-time travel information and such amenities as toilets and shops. A good example of spacious and comfortable waiting areas is the Ponte Mammolo interchange (see Figure 2-5). Good examples of clean, staffed toilets are given by Paddington terminus in London and Ponte Mammolo in Rome.

![Figure 2-5. Spacious and comfortable waiting area at Ponte Mammolo, Rome. The waiting area provides real-time travel information on TV monitors. Source: MIMIC archive.](image)

The importance of waiting areas, clean toilets and other facilities can be analysed through questionnaires on barriers to intermodality and Focus Group discussions. A Nested Logit model can be used to quantify travellers’ reactions to changes at the interchange site (e.g. the construction of a new waiting area).

It is also important to provide drivers and staff with reserved areas for rest, eating and drinking during layovers. A large reserved area for regional bus staff is available
at Ponte Mammolo. The needs and expectations of drivers and staff can be analysed through Key Actor Interviews.

**Needs of special groups**

The needs of special groups are often not well thought out. These groups include the disabled, the elderly, mothers with prams, and people carrying heavy luggage. Those with poor vision or hearing, in particular, face special problems that are not often addressed when thought is given to interchange users.

Guidelines for special groups can be subdivided into four main categories:

1. **Access to station.** Changes in level should be avoided; where they are required, ramps, spacious lifts and escalators should be available. Distances between modes should be as short as possible; where they exceed 200 m, short-distance transport systems (e.g. moving walkways, shuttles) should be provided. Local signalised intersections should be provided with acoustic signals, and guided routes for the blind should be available inside and outside the interchange site. Good practice is given by the new underground stations on line A, recently opened in Rome (e.g. Musei Vaticani, Valle Aurelia), where lifts, ramps and guided routes for blind people with canes make the access possible to all passengers, and by Lund Central Station (see Figure 2-6, ramps for wheelchairs and prams).

2. **Access to vehicles.** Access to vehicles for disabled persons should be as easy as possible. Low-floor vehicles, automatic ramps and at-level entry should be available. An example of good practice is given by the Nørreport Minimetro Station, to be opened year 2001/2002, where automatic trains will run at level with platforms. At Nørreport Minimetro Station no gaps will be experienced and platform doors will protect all users against any mishap at platform edges.

3. **Access to information.** The hearing and visually impaired and people with learning difficulties generally ask for patient and trained staff, but tactile information systems, acoustic signals and induction loops are also effective solutions. These issues are described in more detail in section 2.2.7, Special information.

4. **Equipped facilities.** Toilets, telephones and other facilities provided at an interchange site should be accessible to all travellers. Reserved car spaces for disabled should be available at any interchange site and located as near as possible to the station entrance. Good practice is given by Ponte Mammolo, where reserved parking spaces and equipped toilets and telephones for disabled are provided.

Planners and operators need to consider the special barriers that affect each of many groups with special needs, with the knowledge that a large proportion of people fall or will fall into one of these groups at some stage in their life. Specialist Focus Groups should be considered at an early stage in physical design.
Table 2-5. Physical design barriers: proposed solutions and examples of good practice

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Examples of good practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectacular design can increase patronage (including non-passengers), if functionality goes first.</td>
<td>Blaak station (Rotterdam)</td>
</tr>
<tr>
<td>Short walking links between modes or short-distance transport systems can be a solution.</td>
<td>Abando Intermodal (Bilbao)</td>
</tr>
<tr>
<td></td>
<td>Canning Town (London)</td>
</tr>
<tr>
<td>Level changes should be avoided. Escalators (up and down) and spacious lifts should be available.</td>
<td>Laurentina (Rome)</td>
</tr>
<tr>
<td></td>
<td>Flemingsberg (Stockholm)</td>
</tr>
<tr>
<td>Comfortable and spacious waiting areas. Long waits without seating are uncomfortable for anyone, and many people need seating even for short waits.</td>
<td>Ponte Mammolo (Rome)</td>
</tr>
<tr>
<td>Reserved areas for drivers and staff for layovers.</td>
<td>Hammersmith (London)</td>
</tr>
<tr>
<td></td>
<td>Cardiff Terminus (Cardiff)</td>
</tr>
<tr>
<td>Ramps, lifts, special access routes for wheelchairs and blind people can make access to station easy to all travellers.</td>
<td>Valle Aurelia (Rome)</td>
</tr>
<tr>
<td></td>
<td>Musei Vaticani (Rome)</td>
</tr>
<tr>
<td>Public transport vehicles equipped to carry people with special needs. Low-floor vehicles, automatic ramps and at-level entry should be available.</td>
<td>Nørreport Minimetro (to be opened year 2001/2) (Copenhagen)</td>
</tr>
<tr>
<td>Reserved parking spaces and toilets for disabled.</td>
<td>Ponte Mammolo (Rome)</td>
</tr>
</tbody>
</table>
2.2.5. Local planning and land use

Because interchanges can become focal points in people’s mental maps of a city, they cannot be isolated from their surrounding areas but must be seen as part of a community, with impacts outside the building itself.

Planners and designers should pay particular attention to location, since it can significantly affect the success or failure of an interchange. The location of an interchange site can be a barrier to local access because of busy roads or other physical barriers (e.g. a river). Important interchanges often lack services to areas that could be important catchment areas. The analysis of the catchment area of any interchange site is highly recommended for obtaining information about the interchange’s potential patronage and its existing or planned feeder modes.

Close co-operation with the local community, by means of public consultation and participation, can be a cost-effective solution for building successful interchanges. However, both processes of have often been inadequate, and may have been more harmful than helpful when they have offered only lip service. Research and development of methods for public consultation and participation are needed in order to give people a say in design, and help design the interchanges with a view to the various needs of users and potential users. Adequate funding is also needed if consultation and participation are to work.

Feeder services

For most interchanges a proportion of users will arrive on foot or by bicycle, and the location of the interchange site is of great importance to potential patronage. Much local patronage is lost if the interchange is sited solely because of available land rather than for easy access.

Access on foot or by cycle should be strongly encouraged; the advantages deriving from environmentally friendly transport modes are self-evident. In Austria, the national plan details measures to improve location and development of interchanges, as well as moves to increase density around interchanges and integration of cycle and pedestrian networks with public transport.

Pedestrian access to interchanges very often involves difficult access over busy roads, or through unpleasant (often unsafe) areas and in many cases requires long distances to be walked.

Careful consideration of movement patterns is necessary to minimise vehicle and pedestrian conflict. A micro-simulation model is an extremely powerful and effective tool to analyse vehicle and pedestrian flows and interference and identify problems faced by pedestrians and cyclists, but also questionnaires on barriers to intermodality will aid.
Better pedestrians links, possibly sheltered and physically separated from motorised traffic (passengers seem to prefer pedestrian bridges to tunnels), the introduction of traffic lights and a better signage locating the station from the surrounding streets are measures which could encourage local use by walking. Good lighting and the presence of policemen or staff and good visibility can reduce fear of local crime.

Figure 2-7 shows sheltered walking links at Meadowhall, Sheffield. A pedestrian bridge is visible on the left side of the picture. An easy walk to the city centre is provided at Cardiff Terminus in Cardiff and the Bus/Coach Station in Leeds.

Bike-and-ride should be encouraged as well. Cyclists often find using interchanges difficult. This occurs in access to the interchange, handling a bike in the interchange, and with secure cycle parking.

There is great potential for increasing ridership by providing for easy cycle access and use. Cycle lanes, physically separated from motorised traffic and pedestrian flows, should be provided in the area surrounding any interchange site.

Quality cycle storage, possibly guarded and covered, should be provided in any interchange site. Cycle rental, shops and repair should be available at main interchange stations. Good solutions are given by Copenhagen Central Station, which is provided with a so-called bicycle centre, with bicycle parking, rental, shop and repair, and by Høje Taastrup, a suburban station in Copenhagen. Figure 2-8 is an example of a multilevel, covered parking building for bicycles in Japan.
The importance travellers give to cycle lanes and cycle storage can be quantified through questionnaires on barriers to intermodality.

Frequent and reliable feeder services, with high-density pick-up points, are important factors for encouraging patronage in the local catchment area and reducing car use (and, consequently, the need for car spaces at the interchange site). Some interchanges, however, are located in peripheral, low-density areas (see section 1.7). In these cases bus/tram feeder services are ineffective and expensive. Dial-a-ride services, mainly taxibuses or common taxis with special, cheaper conventions for public transport users, are an alternative to the construction of huge parking areas at the interchange site. Key Actor interviews and questionnaires on barriers to intermodality are useful tools for comparing the opinions of transport operators and users.

The integration of private cars with public transport needs to be carefully planned, and capacity of parking areas should be adequate to the demand of parking spaces. Good solutions in terms of capacity of parking areas are given by Ponte Mammolo (1520 car spaces), EUR Magliana and Laurentina Interchanges in Rome (more than 900 car spaces each) and Wien Mitte in Vienna (about 4640 car spaces, including parking lots alongside roads). Multilevel carparks over public transport stations, in particular, increase the capacity of parking areas, reduce distances to be walked to
change modes and provide indoor, sheltered connections between transport means. Figure 2-9 shows the multilevel carpark at the Laurentina Interchange in Rome.

Dedicated areas for dropping off and picking up of passengers (kiss-and-ride) should be provided at any interchange site. Dedicated areas for kiss-and-ride prevent cars from using inappropriate areas, creating an obstacle to public transport vehicles, pedestrians and cyclists.

Questionnaires on barriers to intermodality can be used to identify problems relating to park-and-ride and kiss-and-ride. The catchment area questionnaire can be used to identify catchment areas by feeder modes, included walking, and analyse distance distribution by different modes (see section 1.12).

![Multilevel carpark at the Laurentina Interchange, Rome.](image)

The carpark is next to the Metro station, so that distances to be walked are quite short. Source: MIMIC archive.

**Public consultation and participation**

Many of the mistakes in interchange design could be avoided by public consultation and participation. Local people often understand an area and its needs far better than paid ‘experts’, but need guidance and help from those experts to turn their desires into practical schemes. Local knowledge can often help shape a successful interchange.
Consultation needs to be carried out at several stages in the planning/design/construction process. It should never involve the presentation of a ‘preferred’ option along with other blatantly unsatisfactory options presented only to gain support for the ‘preferred’ one.

One suggestion is to have a panel of potential users and local interest groups who could act as a kind of ‘steering group’ or ‘reference group’ to provide input into the process at various stages. These groups need to be brought up to date about the incorporation of their suggestions and needs with the station design. Through membership they will learn some of the more complex issues and will become more useful in ensuring that local concerns are addressed in the finished interchange.

Interchange design and operation need to be driven by user needs and perceptions. Local travel requirements and social/economic/cultural context should be investigated as part of design briefing.

Table 2-6. Barriers due to local planning and land use: proposed solutions and examples of good practice

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Examples of good practice</th>
</tr>
</thead>
</table>
| Better pedestrians links, possibly sheltered and physically separated from motorised traffic, the use of traffic lights and a better signage locating the station from the surrounding streets are measures which could encourage local use by walking. | Bus/coach Station (Leeds)  
Cardiff Terminus (Cardiff) |
| Cycle lanes, physically separated from motorised traffic and pedestrian flows, in the area surrounding the interchange site can substantially increase cycle access. | Central Station (Copenhagen)  
Tampere Intermodal (Tampere) |
| Large, guarded and covered cycle storage should be provided in any interchange site. Cycle rental, shops and repair should be available at main interchange stations. | Central Station (Copenhagen)  
Høje Taastrup (Copenhagen) |
| Frequent and reliable feeder services, with high-density pick up points, are important in encouraging patronage in the local catchment area and reducing car use. | Austria (National Transport Plan) |
| Capacity of parking areas should satisfy demand for car spaces. | Wien Mitte (Vienna)  
Ponte Mammolo (Rome)  
Laurentina (Rome)  
EUR Magliana (Rome) |
| Dropping off and picking up of passengers (kiss-and-ride) should be made as easy as possible. | Laurentina (Rome) |
2.2.6. Economic and social

Economic and social barriers tend to be less obvious than some others, but can be very important in terms of discouraging use of the public transport system. Cost of travel can be a serious deterrent to travelling by public transport, and can be a reason for the social exclusion of people with low incomes.

Potential business opportunities of the interchange site should be exploited, but they need careful thought in terms of priority to retail use and passenger use. Good and well-designed shopping facilities within the station can generate income for interchange owners and operators and create a livelier (and safer) environment. The involvement of the private sector through joint development should be fostered. Joint development can lower public sector costs, draw additional passengers to the system and improve the environment around the interchange.

Cost of travel as a barrier

The cost of travel as a barrier can be overcome in two ways. First, in a commercial environment, the marketing of different ticket types can help those with low incomes (e.g. students, elderly) by offering cheap tickets at times of low demand. With a more socially responsible view of transport, careful subsidisation using concessionary fares, free tickets or other methods can ensure that those with low incomes have access to transport and do not become socially excluded as a result of their low income.

Second, through-ticketing can reduce the cost of journeys involving modal interchange. To encourage intermodality through-ticketing is of prime importance. Where it is not fully available, its lack is generally seen as a major barrier to journeys involving interchange. Questionnaires on door-to-door factors and Focus Group discussions with elderly, students, etc. can identify how much cost of travel is perceived as a problem in a specific area.

![Multimodal travelcard for people over 65, Rome.](image)

Cards and discounts for low-income riders facilitate public transport and intermodality.

Source: MIMIC archive.
Economic development

A successful interchange is a place of activity with many people. As an important node in a public transport system, it has opportunities to become an area for economic development.

Good and well-designed shopping facilities within an interchange can generate income for interchange owners and operators, although there is a trade-off between retail space and passenger movement and waiting space. Interchanges should not adopt the ‘airport terminal’ mentality, whereby income from retail outlets is seen as more important than comfortable waiting space. If the only seats in an interchange are in cafes and bars, the balance has probably tipped too far.

The opening of shops and business activities in an interchange can also reduce passengers’ fear of crime. A busy and lively environment is perceived as a safer one (see section 2.2.2, Fear of crime).

In many cases an interchange may be too small to support a good range of facilities; it may also be so efficient that the short waiting times mean that facilities are not viable, since people will not be shopping while they wait (or will be there only for a short time). A new and separate commercial and business centre, able to attract also non-travellers, could be an effective solution (e.g. La Défense in Paris).

The problem is that not all shops are equal. Large department stores generate far more customer traffic for other shops and can significantly help the growth of other retail activities in an interchange site. The interchange manager (see section 2.2.3, Integration in planning, building and managing interchanges) can take advantage of their positive externalities and maximise the profits by charging rents that reflect each store’s contribution to the overall revenues. The cheaper rent of the large department stores is repaid by the benefits given to the other shops (in terms of more revenues) and to the community as a whole (in terms of a livelier and busier environment).

Good examples of lively and busy environments, with shops and retail activities, are given by Wien Mitte in Vienna (see Figure 2-11), Hammersmith and Liverpool Station in London, the tram station in Strasbourg and La Défense in Paris.

Focus Group discussions with business associations and merchants are a powerful tool for identifying obstacles to opening and managing retail activities within an interchange, and for finding solutions to remove these obstacles. Travellers’ reactions to the opening of shops or similar changes at the interchange site can be quantified through a Nested Logit model.
Joint development

Joint development projects are commercial, residential, industrial, or mixed-use developments undertaken in concert with transit facilities. They may include private and non-profit development activities usually associated with transit systems and interchanges that are new or being modernised or extended.

Joint development occurs when the public sector transfers some costs of an interchange to the private sector. Beyond lowering public sector costs, joint development can draw additional passengers to the system and improve the environment around the interchange. Moreover, joint development can increase the number of private interests who could benefit from locating near interchanges. The development of an interchange creates an attractive retail market and estate development opportunity that can result in financial gain for both the public and private sectors thanks to joint development.

The siting and development of transit services add to property values near transit stations, and the collocation of residential, commercial and retail establishments with the transit system enhances social and economic returns for the community. Joint development can both secure a revenue stream for the transit system and help shape the community that is being served by the transit system.
Therefore, a joint development project should be planned to generate revenue for the transit system from this added value. This revenue may take the form of a one-time cash payment for the sale of land, air or subterranean rights, or some other form of property rights. Or it may be a revenue stream from an instalment sale, lease, ground rent, or other compensation as agreed between the transit system and the developer.

**Local cultural factors**

Large interchanges provide an opportunity to reflect the local heritage and cultural identity of the area. Local planners and operators should incorporate special local features and qualities into the design of interchanges to give some idea of ‘ownership’ to local social groups.

Careful consideration of historic preservation requirements is imperative in the planning of an interchange. When an existing station or building will be used for an interchange, specific criteria must be followed in the restoration process. Any historic preservation project can bring pride to the community, but the restoration of a transportation facility is a unique opportunity to reclaim a property that has played a vital role in a community’s past and incorporate it into the daily lives of its potential users. The preservation of a historic facility can bring financial benefits to a community through neighbourhood revitalisation, increased property values and tourism. Good examples of preservation efforts to interchanges are Penn Station in Baltimore and South Station in Boston.

![Concert on the concourse, Keihan Uji Station, Kyoto.](image)

Figure 2-12. Concert on the concourse, Keihan Uji Station, Kyoto.
The interchange plays a vital role in the community’s daily life.
Source: Nacasa & Partners Inc., Tokyo.
Concerts, art exhibitions (e.g. pictures, sculptures) can improve the image of the interchange and public transport as a whole. To overcome the bad image of Berlin Zoologischer Garten, the management organises events such as concerts or painting competitions. In Japan, the waiting room of Yufuin Station in Oita is a picture gallery, while concerts are often held at Keihan Uji Station in Kyoto (see Figure 2-12).

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Examples of good practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concessionary fares, free tickets or other methods should ensure that those with low incomes have access to transport and do not become socially excluded.</td>
<td>Rome, Tampere, Warsaw</td>
</tr>
<tr>
<td>Good and well-designed shopping facilities within an interchange can generate income for interchange owners and operators. Moreover, a busy and lively environment is perceived as a safer one.</td>
<td>Wien Mitte (Vienna), Hammersmith (London), Liverpool Station (London), Tram Station (Strasbourg), La Défense (Paris)</td>
</tr>
<tr>
<td>Concerts and art exhibitions (e.g. pictures, sculptures) can improve the image of the interchange and public transport as a whole.</td>
<td>Yufuin Station (Oita), Keihan Uji Station (Kyoto), Zoologischer Garten (Berlin)</td>
</tr>
<tr>
<td>The preservation of a historic facility can bring financial benefits to a community through neighbourhood revitalisation, increased property values and tourism.</td>
<td>South Station (Boston), Penn Station (Baltimore)</td>
</tr>
</tbody>
</table>

### 2.2.7. Information

Information as a barrier can vary greatly. A distinction can be drawn between different types of user, based on two dimensions: frequency of use and regularity of use. The information needs of these groups are very different, with, for example, infrequent irregular users requiring good advance information on services available and times of services, while frequent regular users need this information less but that on delays and changes to timetables and services more.

**Pre-trip information**

Many people need personalised information before making a journey? those who are not timetable- or map-literate, those making a ‘one-off’ journey (or a regular journey for the first time). This personalised pre-trip information needs to tell people exactly where to start, the times of each link, and information such as platform numbers or bus stop numbers which might help them. Many potential users are intimidated by the ‘unknown’ or by the complexity of journeys.

People should get information outside the interchange? at home, in their offices, and in most public places. Information on how to access the public transport system (bus,
rail, or other modes) should be easily available, and attempts should be made to ensure that information is available as widely as possible: telephone enquiry lines, internet, televideo, radio bulletins, kiosks, etc.

In several cities (e.g. Berlin, Rome) internet web sites are available to provide end users with multimodal information on their trips. In Rome, a geographic information integrated service, InfoPoint, is available both on internet and through the consultation of street kiosks. The service is specialised in giving best routing information, having as input the starting point and the destination of the trip (an address or a specific place—museums, hotels, stations, airports, etc.). The InfoPoint system also provides the duration of the trip summing up three factors: time spent on-board, time spent walking and average waiting time at stops.

Figure 2-13 shows the InfoPoint web page, hosted by the ATAC web site (http://www.atac.roma.it). The importance of pre-trip information can be quantified through questionnaires on door-to-door factors.

![INFOPOINT](image)

**Figure 2-13. Best routing pre-trip information through the Internet and info-kiosks, Rome.**

The information on all public transport improves intermodality.

Source: ATAC web site.

**On-trip information**

A free transport market can cause problems for information provision (basically the lack of a common and coherent information system). Integrated information is needed on all transport modes with route maps and timetables of the various services.
Real-time information on delays, as well as on means’ arrivals and departures, should be provided at any interchange site (e.g. through TV monitors or Variable Message Signs—VMS). This kind of information is mainly requested by regular or frequent users, but all categories of travellers will benefit. Questionnaires on barriers to intermodality are a powerful tool to quantify how lack of real-time information at the interchange site affect travellers’ modal choices.

Figure 2-14 shows up-to-the-minute information on TV monitors on regional bus departures at Ponte Mammolo Interchange in Rome. An efficient VMS up-to-the-minute information system, showing the number of minutes remaining until the next train, can be found in most of London underground stations, e.g. Hammersmith and Canning Town.

Many people find timetables and maps very difficult to read, especially foreigners, local ethnic minorities and people with learning difficulties. Local bus route maps are considered particularly hard. Clear maps detailing transport routes/services are needed. These maps should be available at stations and bus stops and visitor information centres. In London, pocket maps of underground lines are available at most underground stations (see Figure 2-15). Interactive journey planners and touch-screen information systems (see Figure 2-16) should be provided to travellers at any interchange site.
Figure 2-15. Pocket underground map of London, available at most stations.
Source: London Transport.

Figure 2-16. Touch-screen information system, Madrid. The touch-screen information system, centrally located, is easily visible to travellers.
Source: CAPITALS PLUS project.
Information through staff

There is a general expectation that any uniformed staff member should be able to answer an enquiry about onward travel for any mode, service or route.

Staff should be well-trained in providing information about all modes in the transport system and should be kept up to date on the current situation. This may be achieved through combining with other facilities like tourist information bureaux and help points, as in New York (see Figure 2-17). Other examples of good practice are given by the so-called Service-Points at Berlin Zoologischer Garten and Frankfurt Hauptbahnhof, where the service staff provide information on timetables, locations of certain facilities, tourist information.

Staff members who know the sign language can be an important help for people with hearing problems and make their journeys much easier.

Users perceive transport staff as the first point of enquiry when accessing onward travel information. Although displays of real-time information are given high priority (see above), ‘when something goes wrong’ many people would prefer to speak to another person to seek advice and help.

Importance of staff at an interchange site can be analysed through questionnaires on barriers to intermodality and Focus Group discussions with elderly, disabled, etc.

Figure 2-17. Information point at the bus terminal, New York.
The info-point, located in the middle of one of the main corridors, is highly visible.
Source: MIMIC archive.
**Signing**

Signing needs to be clear and indicate the shortest way between modes as well as to facilities available to passengers (e.g. cafes, shops, toilets, telephones). Also alternative secondary, ‘stair-free’ routes, with lifts or escalators, need to be signed for people with mobility problems. Signing requirements increase with the size and complexity of the interchange and with the complexity of modal operations. Interchanges with many indirect and long paths, obstructed sight lines and distractions have greater signing needs.

Signing and information in different cities and countries should be co-ordinated. There is a need for an independent body to be given the task of developing a European-wide signing and information standard. Information should be provided in a simple symbolic, pictorial and colour-coded manner. Many people, especially those with learning difficulties, or who do not use the common local language, have difficulty with direction signing and other information. A large and effective use of coloured symbols can be found in most stations of the Paris ‘Metro’. Examples of good signing between modes are given by Canning Town in London, the bus/coach station in Leeds and the New Chitose Airport Station in Japan (see Figure 2-18).

Questionnaires on barriers to intermodality and Focus Group discussions are effective tools for studying how poor signing can be a barrier to intermodality and identify users’ expectations.

Figure 2-18. Signs and symbols at New Chitose Airport Station, Hokkaido. Information is provided in two languages and in simple symbols.
Source: Nacasa & Partners Inc., Tokyo.
**Special information**

Certain categories of passengers need special information (people with hearing or sight problems, people with learning difficulties). Acoustic signals and Braille maps can significantly help blind passengers. Good practice is given by the new underground stations on line A, recently opened in Rome (e.g. Musei Vaticani, Valle Aurelia), where Braille maps of the site and guided routes for blind people are available. Acoustic information for blind people can be found at most bus stops in Manchester (see Figure 2-19).

![Figure 2-19. Acoustic information for the blind, Manchester. Source: Great Manchester Passenger Transport Authority & Executive, 1999.](image)

Flashing lights on TV screens; or large coloured signs, would be very helpful to call attention for the hard of hearing; induction loops in front of ticket counters and staff knowing sign language (see Information through staff) would aid too.

Focus Group discussions with disabled persons (see section 1.9) are a good tool for identifying problems, views and expectations of travellers with special needs.
Table 2-8. Information barriers: proposed solutions and examples of good practice

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Examples of good practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-trip information should be easily available, and attempts should be made to ensure that information is available as widely as possible: telephone enquiry lines, internet, televideo, radio bulletins, kiosks, etc.</td>
<td>Rome&lt;br&gt;Berlin</td>
</tr>
<tr>
<td>Monitors and displays for up-to-the-minute information on services and delays for all transport modes available at the interchange.</td>
<td>Hammersmith (London)&lt;br&gt;Canning Town (London)&lt;br&gt;Ponte Mammolo (Rome)</td>
</tr>
<tr>
<td>Pocket maps and timetables should be available as widely as possible.</td>
<td>London</td>
</tr>
<tr>
<td>Helpful staff, tourist information bureaux and help points. Staff should be well-trained in providing information about all modes in the transport system and should be kept up to date with the current situation.</td>
<td>Bus terminal (New York)&lt;br&gt;Zoologischer Garten (Berlin)&lt;br&gt;Hauptbahnhof (Frankfurt)</td>
</tr>
<tr>
<td>Direction signing and similar information should be provided in a simple symbolic, pictorial and colour-coded manner to help foreigners and people with hearing problems.</td>
<td>Paris ‘Metro’&lt;br&gt;Airport Station (Chitose-city)</td>
</tr>
<tr>
<td>Site maps in Braille for blind persons.</td>
<td>Valle Aurelia (Rome)&lt;br&gt;Musei Vaticani (Rome)</td>
</tr>
<tr>
<td>Acoustic information for blind persons.</td>
<td>Bus stops in Manchester</td>
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</table>

2.3 Specific guidelines for different types of interchange

In this section are outlined synthetic guidelines that relate to specific types of interchange, rather than being specific to interchange as a whole. The specific types of interchanges analysed are park-and-ride interchanges, complex interchanges (with several modes and functions) and airports.

2.3.1. Park-and-ride interchanges (example: Rome)

Park-and-ride interchanges are passenger transfer facilities usually located on the outskirts of a city or rural areas. Their main aim is to foster the use of public transport modes, providing users with large car parking facilities in which to leave their cars and take public transport vehicles.

Usually a large variety of transit services are available to travellers, ranging from railway to underground, buses, trams and light railway.

The research has identified a set of features that a park-and-ride interchange should have in order to be successful. The core of the analysis is represented by surveys
carried out at the Ponte Mammolo Interchange in Rome (see Figure 2-20), but the research has been complemented by the study of other recent and significant sites in Europe.

Figure 2-20. Ponte Mammolo Interchange, Rome.
Source: MIMIC archive.

The main features recommended for park-and-ride interchanges are described below.

?? Distance to be walked between parking areas and the transit station should never exceed 200 m (e.g. the tram station in Strasbourg, La Défense in Paris, Laurentina Interchange in Rome). In general multilevel parking areas, under or over the transit station, seem preferable to at-level car parks, located near the station. The construction of moving walkways or other short-distance transport systems (e.g. shuttles) could be an effective solution in many existing interchanges. Where changes in level are required, ramps, escalators and lifts should be available (e.g. Laurentina Interchange in Rome).

?? Long distances are particularly arduous on rainy or hot summer days if no shelters are available along walking paths. Where possible, walkways should be built inside the terminal (e.g. the tram station in Strasbourg, La Défense in Paris). Otherwise, proper shelters should protect travellers when changing modes.

?? Fear of crime proved to be a significant barrier to intermodality, especially for women and night users. If parking areas and walking links are perceived as dangerous, the failure of the park-and-ride facility is a logical and obvious consequence. Fences or walls around all parking areas near passenger transfer facilities are needed. Presence of surveillance and security guards is highly recommended to reduce attacks, thefts and vandalism to vehicles.

?? The availability of an adequate number of car spaces is an essential requisite for an interchange to be successful. If people perceive that it is difficult to find a
place to leave their car, many potential park-and-ride users will prefer to drive directly to their destination. Local Authorities should finance the construction of parking areas near interchanges, with the aim of shifting car users towards a park-and-ride trip choice (e.g. EUR Magliana, Laurentina and Ponte Mammolo Interchanges in Rome).

An efficient park-and-ride interchange should be also provided with kiss-and-ride facilities. Proper drop and pick-up zones should be located near the main station entrance (e.g. Laurentina Interchange in Rome).

2.3.2. Complex interchanges (example: London)
Complex interchanges have been defined as interchanges that fit one or more of the three following categories:

1. Several lines available on more than two different public transport modes coming together at a single site (e.g. bus, rail, metro);

2. Sites that are spread out or are physically complex (i.e., several different levels, different orientations or separated services);

3. Interchanges in which more than two different operating or managing agencies have an interest.

The main recommendations for complex interchanges are described below. They are mainly based on surveys at Abando Intermodal in Bilbao and Stratford in London (see Figure 2-21), but the research has been complemented by the study of other sites in Europe.

Planning complex interchanges requires a strategy that acknowledges the full range of interested parties and beneficiaries from the outset and takes account of

Figure 2-21. Stratford Regional Interchange, London.
Source: Chris Wilkinson Architects.
the different interests and agendas of the parties.

?? National frameworks or guidelines for funding complex interchanges need to be strengthened and improved to ensure that the financial impact of opportunities to improve intermodality are fully realised from the outset.

?? Development of interchanges must be set within a broad understanding of the market conditions and cultural context of the catchment area. This is even more important in the case of complex interchanges where the market opportunities for service development, variety of trip generation sources, user profiles, public transport options and feeder routes demand a more sophisticated and responsive scoping and planning model.

?? Actual distances between modes and the number of levels need to be tested. Routes should be kept free from each other to avoid pedestrian conflicts and bunching. Level changes must be made as easy as possible (with ramps, escalators and lifts), with automated doors where possible.

?? Particular consideration needs to be given to the signing of services, facilities and directions to platforms within interchanges. When the site arrangement and rail alignments are complex, passengers may not automatically pick up visual clues from the building about where to go next. This is of particular concern to travellers with physical disabilities.

?? It is important to train staff to be familiar with all modes feeding the interchange, and to be helpful to passengers. Travellers often expect that uniformed members of staff at interchanges, irrespective of their job, status or employer, will be the first point of contact when seeking physical help (say, for an older person), to provide information on directions to transport or service delays, or to provide personal security in an emergency.

?? An integrated approach to such issues as safety, communications and maintenance is needed where an interchange is complex by the nature of the number of different operators or agencies involved in running it. Training interchange staff to operate as an entity would benefit users and operators of complex interchanges (e.g. Berlin Zoologischer Garten, Frankfurt Hauptbahnhof, Zurich Hauptbahnhof). An integrated approach would also provide an opportunity to present a consistent image of an interchange as a major manifestation of public transport as a network and the interchanges as welcoming, safe public spaces.

2.3.3. **Airport connections, bus or rail (example: Copenhagen)**

The main recommendations for airport connections are described below. They are mainly based on surveys at Kastrup Airport in Copenhagen (see Figure 2-22), but the research has been complemented by the study of other sites in Europe.

?? Through-ticketing, or at least a discount system for train travel, is seen as important to air passengers using public transport to access the airport, since ticketing often seems complex to visitors from another country. In Copenhagen, the State Railways (DSB) offer free train travel from anywhere in Denmark to
Kastrup airport, provided the air carrier is SAS (Scandinavian Airlines System) or an SAS partner. At Stanstead (London) a rail carrier offers GO airline travellers discount ticket for rail travel to London.

?? Pre-rail-travel check-in is ideal for some traveller groups, as is after-rail-travel baggage delivery. The need depends also on the practicality of the train travel itself.

?? Simple, high-frequency timetables and maximum reliability is absolutely essential.

?? Special services are often important. Mixing of airport travellers and normal city rush-hour traffic can be quite confusing. Rolling stock on shared services may not be well-suited to airport travellers.

?? Luggage should be clearly visible from seats to relieve fear of theft.

?? Short walking distances at the interchange are crucial, or else luggage facilities with no changes in level are important. If changes in level are necessary, escalators and lifts are essential.

?? Rolling stock must be designed with luggage problems in mind.

?? Loudspeaker announcements and electronic light displays on suspended or wall signs should include a number of languages, or at least national languages plus one more.

Figure 2-22. Kastrup Airport, Copenhagen.
Source: MIMIC archive.
3 Conclusions and recommendations

During the research carried out for the MIMIC project, it has become apparent that little is known about a number of aspects of interchanges and intermodality. The project has provided a good opportunity to increase knowledge and to obtain useful tips from other cases abroad in order to better plan, design and manage interchanges.

The project has highlighted that there are significant gaps in our knowledge of the optimal way of encouraging intermodality through improvements at interchanges. National literature on intermodality and interchanges was found to be poor in most countries. There are theories concerning ‘modal choice’ for specific modes, but explanations of why people mix modes and how they use different combinations at different times (or often do not) are less well understood.

In addition there is a need for research into Local and National government requirements for a strategy of intermodality to be developed in local and regional areas. MIMIC proved that in most countries improvements at interchanges come about opportunistically, or when budget allows for change (e.g. Hammersmith, Stratford and Victoria in London), while there is rarely a long-term strategy and plan for interchanges.

The MIMIC approach has helped to provide a way of thinking about the issues and has allowed a framework within which to work, but freedom to look at the issues from a number of different perspectives (elderly, disabled, commuters, planners, service operators, etc.). The project has helped to develop a series of tools that can help planners, designers and managers to systematically analyse interchanges, taking into account several kinds of barriers (logistical and operational, psychological, institutional and organisational, physical design, local planning and land use, economic and social, information).

While MIMIC is probably of most use in the design stages of interchanges, the approach is of value at other stages in an interchange’s ‘life’. Under MIMIC it was possible to look at interchanges which were being planned (e.g. Tampere Intermodal), being constructed (e.g. Abando Intermodal), and in operation (e.g. Ponte Mammolo) using the same tools.

Interchanges need to be seen as part of national sustainable transport strategies. Few countries have developed a national strategy to improve intermodality and interchanges (for example, high-class park-and-ride interchanges—Transferia—are being piloted in a number of sites in The Netherlands); in some countries, the organisation of local government appears to be a barrier to progress towards such a strategy.
A strategic plan for interchange should include a few large-scale interchanges. Larger interchanges are able to support better facilities for travellers by virtue of the number of passengers using the system. Larger interchanges can be either the first unit of a new suburban pole with activities and population, able to attract people and business from the surrounding areas, or a key feature for urban redevelopment and regeneration improvements. Public participation and consultation can prevent many of the mistakes in interchange planning and design.

At most sites travellers face serious problems when accessing the interchange. Bus feeder modes are often poor and unreliable, pedestrian access to interchanges often involves difficult access over busy roads, or through unpleasant and unsafe areas, cycle lanes are in most cases lacking, the capacity of parking areas is often inadequate and in some cases parking areas are lacking.

Much can and must be done to improve interchanges and their catchment areas. Intermodality usually requires large investments, but, at the same time, the development of an interchange creates an attractive retail market and estate development opportunity. The opening of shops and business activities in an interchange can also reduce passengers’ fear of crime (e.g. Liverpool Station in London). The legislation should foster this financial and social gain for both the private and public sectors through joint development and project financing.

There is often great complexity and delays in implementing new interchanges. The plurality of funding sources and the large number of different bodies involved in decision making for an interchange can cause great delays or even make implementation impossible. In many cases the bodies involved are in competition, either financially or professionally, and this leads to poor managed low-quality interchanges. No timetable co-ordination, no through-ticketing, no common and coherent passenger information systems are often the consequences of lack of integration. Integrated interchange management is needed in all cases, with one single person—the 'Interchange Manager'—in charge of all the concerns of the interchange, as at Berlin Zoologischer Garten, Frankfurt Hauptbahnhof and Zurich Hauptbahnhof.

The MIMIC research suggests that deregulation and privatisation can have negative effects on the planning and co-ordination of interchanges. Research into the possibilities and likelihood of different directions for intermodality under different regulatory systems could be useful.

Fear of crime emerged as one of the most serious deterrent to travel by public transport. All cities found it a major problem, in differing degrees, and among different groups, and the fear concerned different types of crime (physical attack, thefts of cars, thefts of cycles, vandalism to shops, etc.). There is a wide need for linking transport policy to anti-crime and other social policy to improve feelings of personal safety when travelling by public transport. Governments should provide guidance on how to reduce fears for personal safety. Each local area needs local research to find out exactly what people fear most, and what would make them feel comfortable. In all MIMIC sites travellers asked for staff able to handle issues of personal security, physical help and information.
A prime concern of passengers and potential passengers in all sites is to have good ‘basic services’: good ticket offices and ticket machines (to avoid long queues for tickets), clean toilets (disabled and baby-changing facilities), seats and comfortable waiting areas. Telephones and cash points, shops, first aid and cafes should be included if possible.

National guidance to public transport designers and operators needs to give much emphasis to planning for people with special needs (e.g. the disabled, the elderly and the infirm, people on low income, parents with children/prams, travellers and shoppers with heavy luggage, foreign visitors, etc.). MIMIC has clearly proved the severity of barriers people with special needs face when travelling by public transport (lack of ramps and lifts for wheelchair users and prams, lack of acoustic messages, guided routes and Braille maps for the blind, lack of escalators and moving walkways for the elderly and people with heavy luggage, etc.). It should be understood that a large proportion of people fall or will fall into one of these groups at some stage in their life.

Passengers’ knowledge of transport services is often very poor, and, more important, their attempts to obtain information usually fail. Good, clear information on public transport services and delays is an essential requisite for many people. Pre-trip information through internet or mobile phones, on-trip information through monitors, maps and info-points are a major target, as well as clear, understandable signs. Lack of co-ordination of passenger information systems and signing was often mentioned as a problem and is generally the consequence of competition between transport operators. There is a need for an independent body to be given the task of developing a European-wide signing and information standard.

The MIMIC research has shown that travellers give great importance to the interchange when they choose whether or not to make intermodal trips. Table 3-1 summarises the ten most important door-to-door factors identified by the MIMIC research. Factors have been subdivided into two main groups: factors characteristic of the whole trip (e.g. waiting time, service reliability) and factors characteristic of the interchange (e.g. security, information on service delays). Six factors out of ten are ‘interchange’ factors; moreover, it should be noted that also ‘waiting time’ and ‘service reliability’, even if classified as ‘trip’ factors, are strictly related to an efficient interchange between transport modes. This result confirms the importance of the interchange as a key element in intermodal choices.
Table 3-1. Main door-to-door factors identified by the MIMIC research

<table>
<thead>
<tr>
<th>Door-to-door factors</th>
<th>Typology of factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting time</td>
<td>Trip</td>
</tr>
<tr>
<td>Information on service delays</td>
<td>Interchange</td>
</tr>
<tr>
<td>Security</td>
<td>Interchange</td>
</tr>
<tr>
<td>Service reliability</td>
<td>Trip</td>
</tr>
<tr>
<td>Connections from the station to the final destination</td>
<td>Trip</td>
</tr>
<tr>
<td>Information on routes and maps</td>
<td>Interchange</td>
</tr>
<tr>
<td>Lack of ticket machines</td>
<td>Interchange</td>
</tr>
<tr>
<td>Stairs</td>
<td>Interchange</td>
</tr>
<tr>
<td>Traffic jam</td>
<td>Trip</td>
</tr>
<tr>
<td>Weather protection</td>
<td>Interchange</td>
</tr>
</tbody>
</table>

It should be noted, however, that in some circumstances land-use and transport network characteristics of a city can substantially influence travellers’ intermodal choices much more than ‘interchange factors’ (barriers). In these cases public transport is not competitive with private means and intermodality does not attract travellers. As examples of circumstances of this kind we mention:

?? **Consequences of urban sprawl.** Public transport operators are not able to serve all the OD (Origin Destination) couples as they do in a compact city. Traffic flows in urban sprawl have plurality of destinations, while in a compact city the main destination is the Central Business District (CBD). In some instances, however, park-and-ride interchanges may have success in urban sprawl. It is the case of many suburban distributors in the United States, where car (or dial-a-ride services) takes the place of regular transit feeder services.

?? **Competition with better roads.** The presence of high-capacity freeways or highways linking the same areas connected by a rail or metro line reduces the attractiveness of intermodality. In these cases policy actions (e.g. road tolls) are necessary to make public transport competitive with private transport.

In all these cases removing barriers at the interchange is a necessary condition for a successful interchange, but not a sufficient one.
MIMIC reports, CD-ROM and Literature List

Reports and CD-ROM
The MIMIC project has been partially funded by the European Commission under the Directorate General VII Transport RTD Programme of the 4th Framework Programme. MIMIC has produced five reports, or ‘Deliverables’, to the European Commission, of which this report is the last.

D1 Inception report (restricted);

D2A Literature Review and Policy Situation Commentary (restricted);

D2B Evaluation Framework and Survey Plan (restricted);

D3 European experiences in passenger interchanges: an in-depth analysis of selected sites (restricted);

D4 Recommendations and guidelines for passengers interchange development (public; this report).

Deliverable 1 (Inception Report) provides the main project parameters: research focus and goal, study areas and related research products. The methodology to analyse the different study areas and the expected products is outlined. The operational plan of the project is presented; it is broken down into six workpackages (WPs): management and co-ordination (WP1), technical WPs (WP2–WP5), dissemination (WP6). WP plans are stated and further details on subtasks, resource allocation and responsibilities, timescale and milestones are provided.

The purpose of Deliverable 2A (Literature Review and Policy Situation Commentary) is to assess current practice, knowledge and status of the key areas of policy and theory, physical interfaces, functional integration, marketing and financing. Each partner carried out a national review, and where access to data was available to partners from other neighbouring countries, or countries sharing a common language, it has been included. Austria reviewed policy and practice in Germany; Denmark reviewed the Netherlands and Belgium.

Deliverable 2B (Evaluation Framework and Survey Plan) is a working document designed to structure and focus surveying and modelling activities at the 11 case study sites (the seven main test sites plus the four complementary sites in Austria, Germany and Switzerland). Deliverable 2B achieves this by providing research methodology and presenting surveying and modelling tools. This framework is based
on the notion of barriers to intermodality under the seven main barrier headings listed in chapter 1 (see Table 1-1). The methodology presented in Deliverable 2B has been further developed and improved during survey activities, and new tools have been added (e.g. the micro-simulation model and the GIS tool).

Deliverable 3 *(European experiences in passenger interchanges: an in-depth analysis of selected sites)* presents the final methodology and synthesises the main information gathered in the case studies, summarising similarities and differences, in order to provide a solid basis for the development of Deliverable 4.

Deliverable 4 *(Breaking down the barriers to intermodality—Recommendations and guidelines for passengers interchange development)* provides planners, designers and decision makers with recommendations and guidelines on how to improve transfers at interchanges, supported by a number of surveying and modelling tools which can be used at almost any type of interchange, existing or planned.

The CD-ROM presents MIMIC activities and findings in an easy and comprehensible way. Copies of the CD-ROM can be ordered from Ingegneria dei Trasporti S.r.l. (Rome).

**Literature List**

A considerable number of publications on intermodality and interchanges were reviewed and consulted during the research activities by the MIMIC team. These publications refer mainly to the MIMIC countries, but several reports from outside (mainly United States) have been included in the list. The list aims at providing interested readers with a solid world-wide basis of reference material on intermodality and interchanges.

The list is organised in five sub-lists: a general list regarding general publications on intermodality and interchanges, plus one list for each of the four MIMIC study areas, as follows:

1. General publications on intermodality and interchanges
2. Publications concerning factors affecting the whole door-to-door journey
3. Publications concerning the analysis of the catchment area
4. Publications concerning barriers at the interchange
5. Publications presenting good and effective solutions
3.1.1. General publications on intermodality and interchanges


Boesch, H. ‘Der Fußgänger als Passagier’ (‘The pedestrian as passenger’), Berichte zur Orts-, Regional- und Landesplanung, Institut für Orts-, Regional- und Landesplanung 73, ETH Zürich (1989).


Kunz, H.U. ‘Die Bahn kann die Straße doch entlasten’ (‘But still railways are able to relieve the road’), Innova, Basel (1989).


MVV–Münchner Verkehrs und Tarifverbund Report, München


3.1.2. Publications concerning factors affecting the whole door-to-door journey


Ben-Akiva, M., Morikawa, T. and Yamada, K. ‘Forecasting intercity rail ridership using revealed preference and stated preference data’, Transportation Research Record 1328.


Bradley, M.A. and Daly, A.J. ‘Estimation of Logit choice models using mixed stated preference and revealed preference information’, Proceedings from the 6th International Conference on Travel Behaviour, Quebec (September 1992).


Stokes, G. ‘Bus users and car choosers—an analysis of the 1988 South Yorkshire Household Travel Survey’, Published by South Yorkshire PTE (also TSU Ref 537), GB (1989).


Wood, C. ‘Cycling by train in Denmark’, Presentation to ‘Rail matters: walking and cycling by train’ Conference, Gloucester, GB (13 October 1994).

3.1.3. Publications concerning the analysis of the catchment area


Engineering Office A-Tie Ltd and Viisikko-Femman Ltd. ‘Valtakunnallisesti merkittävät matkakeskuksiset, projektisuvunitelma, 26/97’ (‘The Most Important
Travel Centres—Centralised Passenger Traffic Terminals in Finland, (26/97’), The Ministry of Transport and Communications, Finland, Helsinki (1997).


Institution of Highways and Transportation with the Department of Transport. ‘Roads and traffic in urban areas’, paper, GB (1987).


3.1.4. Publications concerning barriers at the interchange


HT, DSB and Banestyrelsen (the Copenhagen Regional Public Transport Company, the Danish State Railways and the Danish Rail Administration). ‘Masterplan for Bus- og togterminaler; Hovedstadsområdet’ (‘Master Plan for Bus- and Train terminals in the Copenhagen region’) (1977) 88 p (in Danish).

Hultgren, K. ‘Nödvändigt för somliga och underlättande för andra’ (‘Necessary to some and favourable to most others’), SJ, Tierp (1998).

Langzaam Verkeer VZW. ‘Recente ontwikkelingen rond stations en stationsvernieuwingen’ (‘Recent developments in station and station refurbishing’), Reader op Nederland, Studie in Opdracht van de Lijn en het Ministerium van Openbare Werken en Verkeer van de Vlaamse Gemeenschap, Langzaam Verkeer vzw, Leuven, Belgium (in Flemish).


3.1.5. **Publications presenting good and effective solutions**

ACT–Ambiente Città Territorio. ‘Definizione metaprogettuale del nodo di interscambio orientato all’ottimizzazione degli aspetti architettonici, funzionali, gestionali e della manutenzione’ (‘Meta-project definition of interchange aiming at optimising architectural, functional, management and maintenance features’), CNR (1993).

BAST. ‘Haltestellenformen an innerörtlichen Hauptverkehrsstraßen’ (‘Stops of public transport in municipal major roads’), Bericht der Bundesanstalt für Straßenwesen, Heft V12, Bergisch Gladbach (1994).


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## Acronyms and abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ATAC</td>
<td>Azienda Tranvie Autobus Comune di Roma (City Bus and Tram Company of Rome)</td>
</tr>
<tr>
<td>CCTV</td>
<td>Closed Circuit Television</td>
</tr>
<tr>
<td>DG</td>
<td>Directorate General</td>
</tr>
<tr>
<td>DLR</td>
<td>Docklands Light Railway</td>
</tr>
<tr>
<td>DSB</td>
<td>Danske Stats Baner (Danish State Railways)</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>RP</td>
<td>Revealed Preferences</td>
</tr>
<tr>
<td>RTD</td>
<td>Research and Technological Development</td>
</tr>
<tr>
<td>SP</td>
<td>Stated Preferences</td>
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