City-HUBs Sustainable and Efficient Urban Transport Interchanges

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Interchange place

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Once the need for interchanges is clearly stated, it is necessary to mark a clear roadmap to achieve people-focused, seamless and efficient transport interchanges. This is a multifaceted task that should consider multiple aspects within the complexity of urban areas. Developing or designing interchanges is an intensive and complex process that involves different stakeholders, produces various impacts and also creates new city landmarks (Figure 3.1).

Madrid Regional Transport Authority redefined a transport interchange station as not only an ‘area whose permanent purpose is to facilitate the interchange of people between various modes of transportation’ but also an ‘area whose purpose is to minimise the inevitable sensation of having to change from one mode of transportation to another’ (Consortio Regional de Transportes de Madrid 2010). Di Ciommo et al. (2014) show that users identify the improvement of city-hubs with the quality of time spent inside them. The current challenge of interchanges is to facilitate transfer from the use of private motorised vehicles to the shared use of cars (i.e. car sharing or carpooling), to the use of public transport and non-motorised modes. It
is, in a certain way, a planning principle. The pivot of intermodal transport when designing interchange spaces will be a comfortable and practicable connection by constructing platforms, integrating information systems, installing bike and ride options and defining pedestrian flows around an interchange. Travel intermodality is not only a planning principle, but also a policy that aims to provide passengers with a seamless journey using different modes of transport in a combined trip chain.

For decades, transport investments were based on the contraposition between public and private modes of transport. Today, when increasing urban sprawl and related low residential density have already increased car dependency, even in Europe (Lucas and Jones 2009), mechanised trip dependency is a fact. Because of current land use patterns and urban sprawl, it is quite impossible to travel less, as wished (Banister 1999); therefore, the only option for policy makers is to plan for better travel. More than 20% of current commuting trips in Europe could be intermodal, and between 10% and 20% of travel time would be spent in intermodal transfer. In this context, interchange infrastructures are part of innovative transport planning measures oriented to achieve more sustainable urban mobility patterns.

In this new kind of intermodality, a key role will be played by providing information about transport-related attributes such as travel time, travel costs and environmental quality standards. All these elements might be
seen not only as a service to users but also as an instrument to change their travel behaviour. While economic theory suggests that individuals base choices on the attributes of the choice set (information content), the way that information and services are presented (information and space contexts) also has a strong effect on travellers’ behaviour. Choice architecture theory shows that small features incorporated into the environment of choice making act as ‘nudges’ to help individuals overcome cognitive biases and to highlight better choices for them – without restricting their freedom of choice. This literature suggests examples of how influencing travel behaviour through the design of transport infrastructure helps to promote desirable travel options (Avineri 2012).

Bertolini (2006) discussed the previous consideration of a multimodal passenger interchange as a ‘non-place’. The objective of the City-HUBs book is to define guidelines for transforming a ‘non-place’ into a pleasant meeting and transport ‘interchange place’. The main benefits of urban interchanges relate not only to time saving, but also to a better use of waiting time. They are oriented to increase potential combinations of both private transport (i.e. bike, car and ride sharing) and public transport modes (i.e. bus, rail and metro), urban integration and land use and improved operational business models.

On the one hand, a transport interchange includes features related to its internal workings (way-finding, opportunity space, distances between modes, etc.), and on the other hand, the interchange is immersed in a relationship with its urban environment where each is affected by the other. Using some key aspects of the interchange, the aim of this chapter is to provide a typology for classifying interchanges.

### 3.1 Identifying a Typology of Interchanges

According to Grémy and Le Moan (1977), ‘to develop a typology is to distinguish, within a set of units (individuals, groups of individuals, social events, social environments, etc.), that can be considered homogeneous from a certain point of view’. The content of this notion of homogeneity is usually based on a similarly defined subset of features to describe the studied units. A typology must meet two additional requirements: completeness and exclusiveness of type. In the case of transport interchanges, the use of a typology is motivated by the impossibility of reaching a single model of understanding how an interchange works.

In particular, in the case of the interchange, the procedure we proposed for constructing a typology was divided into two phases. The first phase includes the analysis of basic aspects of functions and logistics of an interchange which give an idea of the order of magnitude of the interchange size. The second phase makes use of this size together with the surrounding local constraints of the interchange to produce the interchange typology.
3.2 THE INTERCHANGE PLACE IN THE CITY

The empirical work on interchange typology was based on a qualitative survey undertaken at 16 selected interchanges through interviews with practitioners, transport planners from transport authorities, transport operators or those in charge of interchange business development. This information has been complemented by the detailed analysis of five pilot case studies. The analysis focused on the functions and logistics aspects, including daily passenger traffic, types and number of transport modes, services and facilities and the location in the city, as well as local impacts.

The analysis of the collected information and opinions identified two dimensions or groups of aspects that interact to define the needs of the interchange place and consequently the size of the building and its characteristics (see Figure 3.4).

The first group of aspects (Dimension A) is related to the internal functions and logistics of an interchange, including transport elements of the interchange and the services and facilities necessary to fulfil the transfer functions properly. This dimension determines the size of the terminal building.

The second group (Dimension B) includes the external aspects of the city environment that affect how the building could be in reality. This dimension includes the location of the interchange within the city and whether or not the interchange plan is in conflict with the existing land uses in the surrounding area.

3.2.1 Dimension A: Functions and logistics

The first group is related to the functions and logistics aspects, including demand, modes of transport and services and facilities. They are not independent and can be defined as follows:

- **Demand**: The number of passengers is the first aspect to define the interchange size, as this aspect determines the need for space and access characteristics. Three levels of this aspect are described: (1) less than 30,000, (2) between 30,000 and 120,000 and (3) over 120,000 passengers/day.
- **Modes of transport**: The second aspect is related to the modes of transport included in the interchange and their degree of importance. Three different levels resulted from the qualitative analysis: (1) interchanges with buses as the dominant mode of transport, (2) interchanges with rail as the dominant mode of transport and (3) two or more public transport modes or different lines of the same mode jointly (Figure 3.2).
- **Services and facilities**: This aspect is related to the number and quality of services and facilities located at an interchange. Services and facilities will depend on the volume of passengers transferring in the
Interchange. It could have three different levels, including: (1) a few kiosks or vending machines; (2) a few retail shops, cafés or food facilities for travellers; or (3) a shopping mall integrated with the interchange.

3.2.2 Dimension B: Local constraints

This dimension has three interrelated aspects to consider in an aggregated way. The first is related to the relative location of the interchange with respect to the main local demand attractions. However, the building of the interchange is also affected by the kind of activities developed around it. If the city considers the transport interchange as part of its urban development plan of the area it is even more important. The description of these aspects is as follows:

- **Location in the city**: The geographical aspect of an interchange is related to its location in the city. The qualitative analysis of 21 interchanges shows that urban interchanges could be classified as being located in: (1) suburban areas; (2) at the entrance to the city, where major public and private transport modes connect the outer and inner city or a different part of the city; or (3) in the city centre, where people interchange mainly for moving inside the city or within the peripheral urban areas.

- **Surrounding area features**: The activities located in the surrounding area could support or become a limitation to the activities associated with the interchange. Green areas or heavy industry could be a limitation, but a large commercial centre or sport field could foster the use of the interchange for access to transport and the use of services inside (Figure 3.3).

- **Integrated development plan**: The interchange infrastructure could be part of a local development plan to encourage economic and urban
development, especially when urban regeneration policies are needed. Commercial development, new housing and offices are more likely to occur when an interchange is integrated into a development plan. The consequent involvement of local government will be required when the interchange infrastructure is integrated into a local development plan.

3.2.3 Interchange place size and typology

The left-hand side of Figure 3.4 shows the causal relationships between the two dimensions of the interchange place: functions and logistics, and local constraints. The functions and logistics aspects define the physical size of the interchange (i.e. the building structure of the terminal) and its form (i.e. design). Therefore, interchanges are characterised by a flow of travellers, the number of public transport modes that serve the interchange and their associated retail and commercial outlets among other services and facilities. All together, these attributes will determine the need for space and the setting for all these activities in an ordered and coordinated way. The interchange size would be classified as small, medium or landmark.

A small interchange place is characterised by low passenger flows, a small number of transport modes that service the interchange and only a few kiosks or basic facilities inside. A medium interchange place is characterised by an intermediate flow of passengers, a considerable number of transport modes and some retail and food facilities for travellers. A city landmark fits with a higher flow of travellers, a complete range of public and private transport modes and significant retail and/or an integrated shopping mall.
However, the amount of space dedicated to the interchange is also affected by the local constraints, which determine the particular features of the building design. In the city centre, the interchange building will be more constrained than in a suburb where the availability of space allows the interchange infrastructure a wider area. The combination of the two dimensions of an interchange place could define the typology of an interchange as: cold/hot, partially integrated and fully integrated.

3.2.4 Local impacts of the interchange

Let us consider the right-hand side of Figure 3.4. The complete interchange with several activities located inside also has local impacts that include the consideration of the economic and land use effects in the vicinity of the interchange. There is a clear interrelation between the interchange’s size, local impacts and typology. This relationship creates a dynamic causal chain.

The considered variables for these local impacts are nearby shopping, new housing, new offices and job creation. They could be detailed as follows:

- **Nearby shopping**: Passengers using the interchange provide a business opportunity for the area where the interchange is located. This has been identified as having a clear effect on the activities of shops in the surrounding areas and the creation of new opportunities to serve travellers’ needs.
- **New housing**: Interchanges could have an impact on the local economy and land use. New housing can be constructed on top of or near to the interchanges. New housing development could be possible
when land use constraints are relatively low and vacant land is available for use nearby. When the interchange is part of an urban regeneration policy, this land could be designated as greenfield or brownfield.

- **New offices**: New offices can be placed on top of or near the interchange. Office development could be possible when land use constraints are reduced and an area of greenfield or brownfield land is available locally.

- **Job creation**: A key factor for evaluating the local economic impact of the interchange is related to job creation. No statistical study is available for estimating the number of new jobs at an interchange scale. However, our qualitative analysis shows that in some cases of interchange development, job creation is observed. This element requires the involvement of local government and the owners and businesses in interchanges.

### 3.2.5 Stakeholder involvement

When interchange construction or refurbishment produces new housing or offices, local government, owners and business stakeholders will be involved in defining policy goals and mapping out the opportunities for the interchange management.

When the interchange status analysis detects the presence of all or some of these local impacts, stakeholder involvement is needed and a more complex business model for managing and operating the interchange will be required.

Stakeholder involvement is based on the following:

- **Local government**: Local development plan and coordination of land uses in the surrounding area.

- **Developers and businesses**: When some local impacts exist on economic activities, such as nearby shopping, new housing, new offices and job creation.

- **Users** are always included, as well as **operators**, as they are closely associated with the functions and logistics aspects.

### 3.3 METHOD FOR AN INTERCHANGE TYPOLOGY

The key aspects of an interchange characterise it. By comparing them, we can propose a typology of interchanges. The interchange place is determined by the functions and logistics aspects (i.e. travel demand, modes of transport and services and facilities) and the local constraints (land uses and their territorial distribution and location in the city). Both interchange dimensions can be analysed separately, as shown in Tables 3.1 and 3.3.
The three aspects of Dimension A are presented in Table 3.1. The requirements for space in the interchange building are categorised in three levels: low, medium and high. We have assigned a score of one to three to each. These scores represent the relative space required by the different levels. Scores could be assigned in this simple way or be determined through ad hoc surveys among stakeholders. Such surveys could provide scores for each level and also the relative weight for each of the interchange aspects. In other words, through surveys, the stakeholders could state if, for example, the demand level should have a higher importance than the number of services and facilities. First, it is necessary to decide what level of space is required for each aspect of the interchange under study, as presented in Table 3.1. The appropriate size of an interchange can be settled by adding the scores for each of the three aspects of Dimension A: demand, modes of transport and services and facilities. The results are shown in Table 3.2, which proposes that the size of the interchange could be small, medium or landmark, according to the score ranges.

Once the size of the interchange is clearly fixed, we have to consider how the local constraints, included in Dimension B, could affect the interchange development. The aspects of Dimension B influence the needs for

<table>
<thead>
<tr>
<th>Dimension A aspects</th>
<th>Levels</th>
<th>Need for space in the interchange</th>
<th>Score level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand (users/day)</td>
<td>&lt;30,000</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>30–120,000</td>
<td>Medium</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;120,000</td>
<td>High</td>
<td>3</td>
</tr>
<tr>
<td>Modes of transport</td>
<td>Dominant – bus</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Dominant – rail</td>
<td>Medium</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Several modes and lines</td>
<td>High</td>
<td>3</td>
</tr>
<tr>
<td>Services and facilities</td>
<td>Kiosks, vending machines</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Several shops and basic facilities</td>
<td>Medium</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Integrated shopping mall with all facilities</td>
<td>High</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total score of Dimension A aspects</th>
<th>Interchange place size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3–4</td>
<td>Small</td>
<td>Low level for all functions and logistics aspects or at most one medium level.</td>
</tr>
<tr>
<td>5–7</td>
<td>Medium</td>
<td>Combination of levels for the three aspects that provide an intermediate average.</td>
</tr>
<tr>
<td>8–9</td>
<td>Landmark</td>
<td>High level for at least two of the three aspects that require large-scale building.</td>
</tr>
</tbody>
</table>
space associated with Dimension A aspects. Therefore, the need for space determined according to Table 3.1 scores could be more, or less, due to the influence of local constraints. The same improvement customising the values and weights, as before, could be undertaken if specific surveys to stakeholders were carried out.

Table 3.3 shows how the different aspects of Dimension B would modify the size and characteristics of the interchange building. It proposes a value to modify the characteristics of the building: that is, whether it should be upgraded or not. The negative value means lower impacts and less constraints and the positive one signifies the need for more integration in the surrounding area. As an example, passenger terminals located in a suburban area, or at the entrance to a city, could be easier to design and to integrate than interchanges with the same flow of travellers and transport modes but located in the city centre.

The values given in Tables 3.1 (Table 3.2) and 3.3 define the interchange place typology. This typology includes the physical elements (size and type of building) and the qualitative aspects included in the local constraints considerations. The combination of both dimensions gives rise to the most suitable interchange typology. We propose the following three types of interchanges:

### 3.3.1 Hot or cold interchange

Depending on the climate, this category refers to the case where the interchange operates in an open-air environment. Generally, it is located in a suburban area and the type of activities around are not very significant. These interchanges can only offer a limited number of services, including ticket vending machines, kiosks or snack vending machines, with a limited degree of intermodal integration. At these interchanges, there can be a low to medium flow of passenger numbers, but the services provided will be
limited by the facility itself. The analogy referred to is similar to fuelling stations which are unmanned, offering basic services but with limited supporting infrastructure. Such interchanges are not part of the urban development plans of the area but rather a way to solve the problem of transfer in an ordered way (Figure 3.5).

### 3.3.2 Partially integrated

The partially integrated type involves a wider selection of services that are provided within the interchange but not necessarily providing all the services required by passengers. Normally, it is not located at the centre of the city, but it does have compatible types of land uses around it. The usual features are shelters and covered platform areas, shops and other small businesses. Typically, interchanges built in connection with existing terminals, such as train or bus stations, fall into this type of operational model. There, the existing facilities set limitations on the number of additional services, although in some cases these models have worked well in terms of revenue generation, when former station spaces have been converted into additional service areas. The selection of services available should not only be restricted by the availability of space but also be demand-driven. Limitations to such operational types come from the existing physical infrastructure; for instance, a railway station, even when refurbished, can only allow a limited space for retail, restaurants and other facilities (Figure 3.6).
3.3.3 Fully integrated

Fully integrated models are most common in newly developed interchanges, as the setting requires the design and construction of facilities so that the integration and mobility of passengers can be designed optimally. Located in the city centre, or at the access to the city, they are part of an integral development plan. In integrated interchanges, the driving force should be seeking mutual benefits from the integration of transport activities with commercial ones (Figure 3.7).

3.4 FURTHER USE OF INTERCHANGE TYPOLOGY

Interchange analysis is a complex activity that includes transport networks, services and urban aspects. Nevertheless, the analysis of each key aspect of the 21 existing interchanges studied allowed a typology to be developed related to the interchange logistic functions and size aspects, and local constraints, which will be useful in determining the interchange place design, the stakeholders’ involvement and the local impacts. The interchange typology demonstrates how to check the interchange status and identify the type of interchange being dealt with.

Chapter 4 will present the City-HUB life cycle focusing particularly on the governance process and stakeholders’ identification and involvement.
Each type of interchange deals with the organisation of services and facilities at an interchange. The facilities provided at any interchange could correspond to a minimum level of services or scaling up of additional facilities to meet users’ requirements of a larger interchange. This aspect will be analysed in detail in Chapter 5. The type of interchange depends on the level of traveller demand. When the services and facilities inside an interchange are higher, or lower, than the typology suggests, users’ satisfaction will be higher or lower as well, as shown in Chapter 6. Both the building size and design, the expected local impacts and the degree of stakeholders’ involvement will determine the business model to adopt for managing each type of interchange. These will be analysed in Chapter 7.

Figure 3.7 Fully integrated interchange. (Illustration by Divij Jhamb.)