



Key factors for defining an efficient urban transport interchange: Users' perceptions



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ABSTRACT

The sustained increase in the urban population and the trend towards urban sprawl in European cities has led to a change in mobility patterns, and many public transport users now need to combine several modes or transport services at urban transport interchanges before they reach their final destination. Therefore, they have become an everyday experience for users where, in addition, users spend time inside. This paper aims to identify the key factors both from a functional and psychological perspective for defining an efficient transport interchange. Since the users' perceptions of their experience are particularly important for achieving the most appropriate policy measures for interchanges, an ad-hoc travellers' satisfaction survey was designed and carried out in three European transport interchanges. The assessment methodology used here – Principal Component Analysis – is proposed as a useful step-by-step procedure. The results of this research highlight the ambivalent nature of the urban transport interchanges. The key functional aspects identified contribute to make easier the transfer and reduce the waiting time, while the psychological factors make the stay more comfortable for users.

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1. Introduction

Cities worldwide are undergoing clear and continuous growth. More than half the world's population today lives in urban areas, and this trend is expected to continue rising. According to Heilig (2012), by 2050, 86% of the global population in developed regions will live in urban areas. Cities today are complex systems, with massive numbers of interconnected citizens, businesses, transport modes, services and utilities (Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014).

This sustained increase in the urban population and the trend towards urban sprawl in European cities has led to a shift in mobility patterns. The challenge facing all major cities is how to increase mobility while at the same time reducing congestion, accidents and pollution (COM., 2006). This rapid growth has gone hand in hand with greater demand for transportation facilities (Debnath, Chin, Haque, & Yuen, 2014). In urban areas – the scenario of most daily trips – distances travelled and travel times have risen dramatically (Banister, 2011), forcing many public transport users to combine different transport modes to complete their trips and decreasing the attractiveness of public transport versus the private car. Reducing the inconvenience inherent in transferring between modes is a basic principle for achieving sustainable mobility.

The Committee on Intermodal Transfer Facilities, Transportation Research Board (1974), already pointed out that the total effectiveness

of the transportation network is determined by intermodal transfer facilities. Iseki and Taylor (2009) noted that the attractiveness of Public Transport (PT) can be substantially increased by reducing the burden of walking, waiting and transferring. It is therefore crucial to establish the factors that optimize and determine the competitiveness of these terminals. At the urban level, transport interchanges are vital to ensuring smooth journeys for passengers and improving the overall efficiency of the public transport system (Abreu e Silva & Bazrafshan, 2013; Li, 2013). As defined by Edwards (2011), a transport interchange is a more complex transport facility than a conventional station, and allows travellers to transfer from one mode to another. Intermodal transfers are more onerous than intramodal transfers (Liu, Pendyala, & Polzin, 1997). Urban transport interchanges are located within cities and play a key role both as transport network nodes and as 'meeting places', thereby enhancing their function as a place and not as a barrier, and creating synergies unrelated to transport. Peek and van Hagen (2002) noted that this ambivalent nature creates opportunities for synergy between both functions: moving and staying. This dual approach can also be compared with the new concept of High Speed Rail stations within cities defined by Bertolini and Spit (1998).

As noted by Terzis and Last (2000), an efficient urban transport interchange must be competitive and, at the same time, be attractive for users given that their physical experiences and psychological reactions are significantly influenced by the design and operation of the interchange. Therefore, the main goal of this paper is to identify the key factors from the users' point of view that define an efficient urban transport interchange, i.e. seeking balance of this dual approach: functional

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and psychological. This was done by conducting a travellers' satisfaction survey in three European transport interchanges.

The paper is structured as follows. Section 2 presents the review of the literature into the key aspects and elements identified as important in the design, operation and management of multimodal passenger transport stations. Section 3 defines the main features of each case study. The data collection procedure and assessment methodology are described in Sections 4.1 and 4.2 respectively. The analysis of the key factors obtained and the interpretation of the results are presented in Section 5. Finally, Section 6 summarizes the main conclusions and offers some essential principles for defining an efficient urban transport interchange.

2. Multimodal transport stations: review of previous studies

Transport interchanges today are a crucial element in sustainable urban transport policies (COM, 2007), and yet there are no standards or regulations specifying the form these interchanges should take in Europe. In fact, the literature review reveals that most studies and research focus mainly on railway and underground stations. This section reviews the studies that identify the key aspects and elements for defining, operating and managing multimodal transport stations, and the most recent studies on the subject of urban transport interchanges.

A survey carried out in the United States and Canada identified covered waiting areas and passenger information as the most common amenities provided at transfer facilities (Stern, 1996). This study analysed these facilities as transport nodes within a network, but disregarded other aspects. Desiderio (2004) pointed out that in urban environments, multimodal transport stations also establish relationships between users and the territory, and should thus be considered as an element in urban development strategies, due to their role as "city gates". They should generally be considered as multimodal facilities where travellers are not only passing through, but are also spending time (van Hagen, 2011). It is therefore crucial to take into consideration other aspects and elements that improve the users' experience.

The Station User Panel (2011) developed seven 'Railway Station Usability Principles' for the government of Victoria (Australia) in order to improve railway station effectiveness taking into consideration the users' experience of the rail system. These principles were: accessibility, ease of navigation, comfort & amenities, information, safety, local area integration and community ownership & activity. Peek and van Hagen (2002) also identified safety and comfort as important requisites in railway station operation. However, visual features such as layout and visible presence of staff were identified as key aspects for improving stations from the 'meeting place' perspective (Peek & van Hagen, 2002). Garmendia, Ribalaygua, and Ureña (2012) concluded that the 'station as a place' approach produced different outcomes, usually depending on the size of the city. Durmisevic and Sariyildiz (2001) focused their research on analysing various techniques for building underground stations and examined their efficiency, again taking into account the human factor. This study defined important 'functional aspects' for the operation of the station – internal connections of the spaces and efficiency of movement – and 'psychological aspects' – such as public safety and comfort – that are more closely related to the user's experience of a station as a space.

Terzis and Last (2000) carried out one of the first research works into the subject of urban transport interchanges. This study concluded that accessibility, facilities, image and information provision were the most relevant aspects in the design and operation of interchanges. Desiderio (2004) focused on analysing the factors that determine the quality of intermodal interchanges considering both users' and operators' requirements. These factors were classified into six different categories: accessibility & external circulation, physical design, shops & amenities, security & psychological factors, information and ticketing.

The latest research on urban transport interchanges found that these multimodal facilities also depend on other factors such as the position in the network, the urban environment and the modes involved (Harmer et al., 2014). Hernandez, Monzon, and De Oña (2015) proposed a

methodological framework to identify the strengths and weaknesses of transport interchanges. The results showed information, transfer conditions and safety & security to be the most relevant aspects.

In summary, the literature review essentially reveals there are two types of aspects to take into consideration in the design, operation and management of passenger multimodal transport stations, and particularly in railway and underground stations. Most studies identify information provision and accessibility as the most relevant functional features, while safety & security and comfort as the most important psychological aspects. The other relevant aspects identified are listed below:

- Layout
- Internal connections
- Ease of movement
- Waiting areas
- Services and facilities

But, how should an existing or new urban transport interchange perform? Which fundamental functional and psychological aspects are fundamental from the users' point of view? This study aims to identify the key factors and provide essential principles for reducing the transfer inconvenience and thus, improving the user's experience at urban transport interchanges.

3. Description of the case studies

According to Pitsiava-Latinopoulou and Iordanopoulos (2012), the location, the transport modes involved and the passengers' characteristics are key variables for determining the category of a multimodal transport station. European case studies were therefore selected to provide a balance in terms of geography, seeking a heterogeneous range of transport modes, size and the role of the interchange within the city in order to evaluate different types of the interchanges. Additionally, the typology was selected following the classification criteria developed by PORTAL (2003) that defined the transport interchanges according to their location in the network: peripheral interchanges, sub-centre interchanges and city centre interchanges, respectively. The interchanges selected were Ilford Railway Station (London, UK), Moncloa (Madrid, Spain) and Kamppi (Helsinki, Finland). Table 1 provides a brief description of the main features of each interchange. Additionally, it shows the transport modes involved at each case study and indicates the daily demand of the main modes in each transport interchange.

Kamppi and Moncloa are fairly new urban interchanges, built and refurbished in 2006 and 2008 respectively. Conversely, Ilford was built in 1839 and rebuilt in 1980. The transport modes and services involved in the interchanges vary. Users travel mainly by metro and bus in Kamppi and Moncloa, and by rail in Ilford. The role of the Moncloa interchange is basically local and regional with only a few national services, while the Kamppi interchange also includes the main national bus station. There is also one international bus service (i.e. to St. Petersburg). The Ilford interchange is predominantly a railway station and focuses on local services, mainly for local commuter trips.

It is worth noting that all three interchanges play a key role in multimodal trips in their corresponding cities and cover a wide spectrum of interchange types and geographical distributions.

4. Methodological framework assessment

The above review highlights several points that are relevant to travellers' decision-making, and particularly that they find transfers to be stressful and/or time-consuming, thus discouraging PT use (Iseki & Taylor, 2009). It is therefore essential to determine which attributes and factors define an efficient urban transport interchange from the users' point of view. This section presents the data collected in each case study in order to capture the users' views, along with the targeted

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