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Joint analysis of intermodal long distance-last mile trips using urban interchanges in EU cities

Andres Monzon^{ab*}, Andrea Alonso^a, Maria Lopez-Lambas^{ab}

^aTRANSyT-UPM, Transport Research Center, Universidad Politecnica de Madrid, Spain

^bTransport and Territory Department, Civil Eng., Universidad Politecnica de Madrid, Spain

Abstract

This paper provides an analysis of long-short distance passenger interconnectivity in the European context. The analysis is based on the results of the project HERMES (EU 7th FP). In order to gather information about the barriers to intermodality, a series of interviews to stakeholders were carried out and complemented with surveys to passengers. Their outputs show weakness and strengths of four intermodal stations: Gothenburg Central Station (Sweden), Avenida de America Interchange in Madrid (Spain), Lleida-Zaragoza railway stations (Spain), and Part Dieu Intermodal Station in Lyon (France).

The stakeholders' surveys highlighted the main management features and characteristics of interchanges. The survey conducted to passengers gave an insight into the key requirements of long-short distance intermodal services. Passenger surveys provided information about the trip and their socioeconomic characteristics. In addition, they rated the importance and satisfaction of a series of aspects.

This paper identifies the most relevant elements of each interchange -their weakness and strengths. These findings consider both providers' and customers' perspectives. The most common weakness in terms of management is the lack of internal coordination among operators, managers and decision makers, which influences the quality of the information provided to passengers. The strengths of each interchange depend on the customers' personal profile. In some cases, the availability of a variety of cheap urban transport services is the most valued characteristic. In other cases, customers prefer good quality and comfortable facilities.

Those findings are consistent with the outputs of other EU funded projects like NODES and City-HUB that provide guidelines to the design and management of interchanges in response to travellers' desires and expectations.

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1. Introduction

Passengers' mobility in the city of tomorrow will be increasingly intermodal –as stated in the Integrated Urban Mobility Roadmap (2017)– with a balanced combination of soft modes, public transport, new mobility services, shared and private vehicles. The EU 2001 White Paper on Transport Policy pointed out the need to promote seamless journeys at the metropolitan and urban level in Europe. Therefore, the EU 2011 White Paper considers three pillars for enhancing intermodality: people, integration and technology. Moreover, the perception of the value of time needed for transfer (modal interfaces) is specifically addressed: a new vision is promoted based on new uses of travel time thanks to reliable information by connected passengers when moving between modes.

In this context, interchanges are key elements in urban and interurban mobility to achieve a *seamless mobility*. This is clear within urban trips where the rapid transfer among public transport means makes the difference between being competitive against car trips or not. A clear earmarked policy to achieve a full integration of the different transport modes is set in the agenda of many Public Transport Authorities. The integration covers three different dimensions: pricing, administrative and physical. The latter includes interchanges and information systems.

This integrated intermodal approach is important not only for trips within the city boundaries, but also for interconnecting long-short distance trips. Normally, trip decisions are taken considering the most convenient long distance mode (rail, bus, air), but the fact is that last mile links are becoming increasingly important, particularly in big metropolitan areas.

Literature about this topic shows that relatively little research has been conducted to the extent to which intermodal travelers' perspective is taken into account in quality analyses of PT service -Grothenhuis et al (2007) and Wardman et al (2001)-, since transport surveys mainly focus on single modes and do not consider the whole intermodal journey made up of several trips. The aim of this paper is to develop a methodology based on the perceived quality by customers of transport services about different aspects, so as to evaluate which aspects should be improved. The methodology is then applied to several intermodal passenger terminals, and the outcomes can lead to bridge the gaps in each case to provide seamless journeys.

Therefore, it is necessary to investigate the perceived quality of the connection between long-short trips. This research has two different approaches. Firstly, the stakeholders' approach: they are responsible both for the offer of the whole logistic trip chain and the services and facilities at the terminals. Secondly, it is crucial to take into account the travellers' vision and preferences, which is the most relevant point for the sake of the efficiency.

The paper is organized as follows. Section 2 introduces the research methodology based on different type of surveys. Then sections 3 and 4 present the results for stakeholders and travellers, respectively. Finally, section 5 summarizes some general conclusions and policy recommendations for improving design, management and quality of interchanges.

2. Research approach and case studies

Many research works have analyzed the complex role of interchanges as urban mobility nodes (Edwards, 2011). Following Bertolini proposal (2006), multimodal stations should have a clear spatial dimension becoming reference sites in cities. Interchanges have at the same time a transport function (transfer among modes) and social utility, because they are attraction poles within city fabric (Monzón and Di Ciommo, 2016). But there are still many research gaps to understand how design, manage, organize facilities and connect public transport services.

The HERMES project (2010) analysed those research gaps about interchanges and their key performance factors (Dell'Asin et al, 2014). To that end, a research methodology was designed to collect the structured opinions of interchange managers and developers about interchange needs and problems. In a second stage, this vision was contrasted with the passenger perceptions: needs, problems, quality, etc. The methodology was based in semi-structured surveys, designed to address the responsibilities and perceptions of several type of stakeholders and users.

The surveys combined some general questions about the required characteristics of interchanges and transfer conditions among modes. The general statements were complemented with the opinions about a selection of case

studies: interchanges along Europe. We have selected five land transport terminals in three different countries, all of them playing a role in long distance-last mile connections. Their characteristics are shown in Table 1.

Table 1. General characteristics of the selected interchanges.

	Avda. America. Madrid-Spain	Part-Dieu. Lyon-France	Gothenburg Sweden	Zaragoza, HSR Spain	Lleida, HSR Spain
General features					
population (millions)	6.5	1.3	1.0	0.8	0.4
Location	-Central in the core city -One of the 5 main transport hub in the city	-In the outskirts of the core city -Main train station in the city	-Central in the core city -Main passenger transport hub in the city	-In the outskirts of the core city -Main train station in the city	-In the outskirts of the core city -The only long distance train station in the city
passengers/year	27.9 mill.	22.8 mill.	16.8 mill.	4.7 mill.	0.5 mill.
Long distance services (>100km)					
Train	n.s	-HSR (national & international) -conventional (national)	-Conventional (national& international)	-HSR (national) -conventional (national & international)	-HSR (national) -conventional (national)
Bus	-National & international	-National	-National & international	-National & international	n.s.
Short distance services (<100km)					
Bus lines	-14 metropolitan -10 urban	-1 metropolitan -14 urban	-14 metropolitan -9 urban	-2 metropolitan - 4 urban	- 4 urban
Metro lines	-4 metro	-1metro -1 tram	-1 tram	n.s	n.s
Commuter train	n.s	-2 lines	-2 lines	-1 line	-1 line
Car-parking	-253 spaces	-5,500 spaces -Car rental	-Parking -Kiss & Ride -Car rental	-1,800 spaces	-Kiss & Ride
Taxi stop	yes	yes	close to station	yes	yes
Additional services	-night bus lines -24 h airport line	-Bicycle & moped parking	-Collective taxi	-Touristic bus -Bicycle parking	n.s.
No. of travellers surveys collected	383	745	603	230	122

3. The stakeholders vision

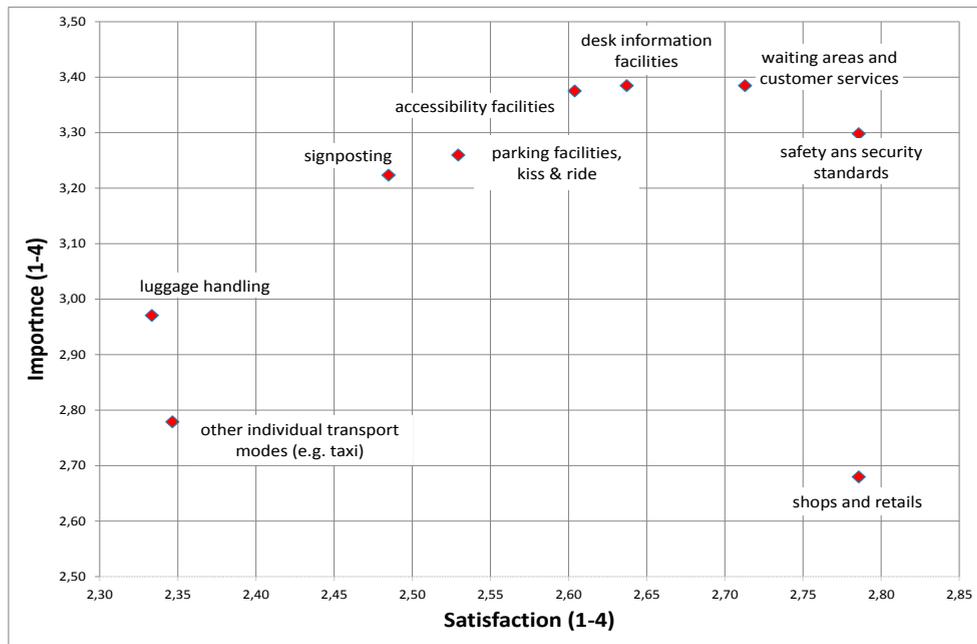
Four different types of stakeholders groups were identified: Public Decision Makers (G1), Terminal Managers (G2), Transport Operators (G3) and Users' Associations (G4). A specific semi-structured questionnaire was designed to collect their views on six different interconnectivity domains: physical, logical, economical, contractual, institutional and legal & regulatory. Each questionnaire presented a general part to cross-compare countries, and an interconnection specific part developed looking at the case studies and the different terminals/interchanges typologies. The questionnaires were delivered among stakeholders from 15 different EU countries, getting 148 answers, which means a 57% response rate. They were grouped according to the 4 stakeholders groups: public decision makers (44), terminal managers (38), transport operators (36) and user associations (30).

The methodology allows to collect opinions on each domain both, descriptive, as to better understanding of the interconnectivity problems, and secondly a valuation of the identified key elements of the interchange. Most of these questions asked to the respondents to give a value in a Likert scale 1-4. This was complemented with open questions on key-barriers and key-measures.

The results cover all the survey domains. Figure 1 summarizes some of the key findings about infrastructure and services at the interchange. The vertical axis shows the importance of the different elements. The highest scores

correspond to the waiting areas, accessibility standards and information desk. Secondly as important elements of the interchange are parking, safety & security and signage. The less important appeared to be luggage handling and shops. Nevertheless, the answers of the stakeholders about if those infrastructures and facilities are properly offered at the present time, shows a very different picture: satisfaction with all of them is particularly low for more than 40% of respondents; and the *very high* satisfaction score is really low, except for safety & security and for shops and retails.

Figure 1. Stakeholders' opinions on importance/satisfaction of infrastructures and services at interchanges.



Source: HERMES project (EU 7th FP) interviews to stakeholders

Information seems to be a key element of the perceived quality of the interchange because it becomes the link for connecting the different modes of transport, and also to orient travelers towards services and facilities. According to the stakeholders' opinions, routes, delays, timetables and luggage storage are very relevant: 90% consider them as important or very important. The lower importance score is assigned to luggage and the highest to timetables.

4. Users perceived quality and key interchange elements

The second types of surveys were addressed to capture users' perception on the quality of their transfer at interchanges. The total number of valid surveys collected in all of them among passengers transferring at the terminal were 2,083. The last row of table 1 indicates how many were collected in each of the interchanges.

Passengers were asked to evaluate a number of elements of the interchanges, including 'quality of the connections', 'quality and use of the indoor space', 'equipment and additional facilities', 'comfort' and 'sense of safety and security'. The level of satisfaction were asked using a Likert scale for a range from 1-very unsatisfied – to 5 – very satisfied-. Table 2 shows the average satisfaction which is denoted as Perceived Quality (PQ), calculated following the simple formulation:

$$PQ_{ij} = \frac{\sum_{k=1}^{n_{ij}} x_{ijk}}{n_{ij}} \quad (1)$$

Where i is each one of the valuated aspects (from 1 to 9); j each case study (from 1 to 5); k each passenger interviewed; n_{ij} the number of interviewees evaluating his level of satisfaction on the aspect for case study j ; x_{ijk} the level of satisfaction evaluated for the interviewee k for the aspect i in the case study j (from 1 very unsatisfied to 5 very satisfied).

Table 2. Travellers' Perceived Quality (PQ_{ij}) for each element of the surveyed interchanges

	Av. America Madrid	Part-Dieu Lyon	Rail-Bus St. Gothenburg	Rail St. Zaragoza	Rail St. Lleida	Average for each element
1 Intermodal supply	3.42	3.71	3.78	2.38	2.37	3.13
2 Ease of interchanging	5.00	3.76	4.36	4.16	4.12	4.28
3 Use and availability of the indoor space	3.07	3.42	3.38	4.25	4.12	3.65
4 Waiting areas	2.88	2.59	3.36	4.06	3.53	3.28
5 Shops and leisure	3.13	3.18	4.25	3.19	2.93	3.34
6 Additional services	2.77	3.30	4.05	3.07	-	3.30
7 Accessibility to existing services	3.64	2.91	3.21	3.85	3.79	3.48
8 Cleanliness	3.46	3.53	3.62	4.11	4.13	3.77
9 Safety & security	3.49	3.13	3.54	3.92	4.08	3.63
Average of the interchange	3.43	3.28	3.73	3.67	3.63	3.56

Results shown in Table 2 indicate that Avenida de America and Part-Dieu obtain the lowest perceived quality in many aspects- i.e. shops and leisure, safety and security or cleanliness. Nevertheless, users' satisfaction levels do not only rely on the objective quality of a service, but also on their quality expectations (Muller et al, 2004; Hine and Scott, 2000), and quality expectations may vary depending on cultural or personal differences among many others. The interchanges compared here show heterogeneous users profiles, in different cultural and socio-economic contexts, and choosing different ways to travel. Because of that, directly comparisons of the rating for each aspect may lead to wrong conclusions, i.e., Part-Dieu Station is the worst valuated in question 2 – ease to interchange-, with an average of 3.76 over 5 (whilst the rest of the stations exceeds 4), but that does not necessarily mean that the stations should improve that specific aspect. In fact, examining only the scores for Part-Dieu it can be observed that the users show a higher level of satisfaction with the ease to interchange than with the rest of the aspects and, hence, they consider other fields for priority action. It is noteworthy that in Avenida de America and Part-Dieu, the average qualifications are lower than in the rest of the cases (3.43 y 3.28) maybe because of the users' higher expectative, and not because of the deficient service- in fact, they attract the highest number of passengers per year. On the contrary, Gothenburg has the higher average score (3.73), being the best evaluated in intermodal supply as well (3.78), which is quite surprising when comparing its transport services supply with that of Part-Dieu (see Table 1).

5. Conclusions and policy recommendations

Intermodality as a solution to transport problems is becoming more and more important, as EC documents highlight. Nevertheless, intermodality needs a proper operation of the transfer points, removing barriers to a seamless trip and improving certain key aspects. The results analyzed in this paper, can be applied to other contexts and cities. The NODES project (2015) shows how Interchanges play a key role in the integration of the urban mobility system and in enabling good intermodal solutions.

It is worth to highlight the importance of the right location and accessibility to the interchanges by public transport modes. When the access is good travelers find PT system more efficient (Monzon and di Ciommo, 2016); on the contrary, when they are poor, car and taxi become the main access modes. It is also relevant that most trips are done for leisure purposes and more than a half of the travelers are women. These two facts should be taken into account when designing the interchange and to identify the facilities to offer and the space dedicated to each of them. Regarding the interchange infrastructures and services, there is a clear perception of its importance, although

the present situation does not fulfill the expectations. Some key barriers that should be overtaken to improve the current unsatisfactory situation have been identified. There is a lack of coordination among stakeholders: planners, decision makers, operators and terminal managers. At the same time, different transport providers do not coordinate their services and timetables. Information provision appears to be a clear area of improvement, both inside the interchange and for the connecting services. Comfort appears to be very relevant for the elder above any other consideration.

Travelers clearly perceive the different elements which fulfill their satisfaction indexes, which include cleaning, security, quality of shops and accessibility levels. The satisfaction level on different aspects stated by customers, may be very useful in order to determine which particular areas should be improved in the provision of transport services- in this case intermodal services. In this regard, a number of theories remark the need to evaluate the quality through surveys. However, the level of satisfaction does not indicate quality directly, since it is highly dependent on the respondents' expectations, and on intrinsic characteristics of the aspects evaluated, and therefore is not an objective measure. Here, we have evaluated the quality of five intermodal interchanges through passengers' surveys, in order to determine the service areas that are worst performed. In the future, methodologies have to be developed allowing both vertical – in the same interchange among different aspects- and horizontal – for the same aspect among different interchanges- comparatives. However, the analytical process described has proved to be able to create schemes that define those quality aspects that need to be improved in each case as a priority.

The results indicate a way forward to develop new policies to design, manage and operate services at interchanges. Hence, make them more efficient and attractive is a key element to achieve a seamless mobility for connecting long and short distance trips.

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