Urban transport interchanges: Importance-performance analysis for evaluating perceived quality

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ABSTRACT

As the world becomes more urbanised, public transport in cities must seek to provide viable alternatives to individual car transport. At an urban level, interchanges in public transport networks provide easy transfers between and within different transport modes and facilitate seamless travel. This study proposes a methodological framework with which to identify the factors that travellers view as key elements of an urban transport interchange. An attitudinal survey was undertaken in order to collect information about users' needs and perceptions in the Moncloa interchange in Madrid, Spain. The results obtained from an Importance-Performance Analysis (IPA) show that aspects related to the signposting of different facilities and transport services, the internal design of the interchange and the surrounding area, and safety and security are the greatest strengths of the interchange.

1. INTRODUCTION

The trend toward urban sprawl in European cities has led to steady growth in car usage and, consequently, to an increase in traffic levels. This has produced a rise in transport externalities, such as congestion, noise and air pollution. Sustainable urban mobility is therefore one of the current priorities for European policy makers. According to the EU Green Paper on Urban Mobility (EC, 2007), sustainable mobility seeks to address three challenges: reducing congestion; improving the quality of public transportation services to achieve a modal shift from private car to public transport; and promoting soft modes, walking and cycling.

As travel patterns become more complex, the attractiveness of public transport has lessened. Many travellers have to make transfers between different modes to complete their trips. Facilitating transfers and providing a seamless travel experience have become top priorities. Furthermore, travel time is a key variable influencing trip choices; good connectivity at public transport stops and stations is therefore critical to overall transportation network effectiveness (Iseki et al., 2010). Several studies have discussed the consequences of intermodal transfers and, more specifically, the importance of optimising transfer time for multimodal journeys (Deb and Chakroborty, 1998; Guihaire and Hao, 2008). In this context, urban transport interchanges play a key role as nodes of transport networks; they are one of the main measures in place to enhance public transport use and encourage modal redistribution (López-Lambas & Monzón, 2010).

Various studies have researched methods for evaluating customer satisfaction with the quality of public transport services (Stradling, 2007, Nathanail, 2008, dell´Olio, 2011, Oña et al. 2012; 2013). These evaluation methods, however, have rarely been adapted for measuring users' needs or their perceptions of the quality of urban transport interchanges.

Passengers' perspectives are of particular importance in determining the best policy measures for transport interchanges, as travel decisions are often motivated by the perceived quality of the services provided. Additionally, it is commonly accepted that the physical experiences and psychological reactions of travellers are significantly influenced by the design and operation of an interchange, which must be attractive for travellers and should also meet sustainability standards (GUIDE, 2000).

Hence, this research aims to identify key factors for improved urban transport interchanges based on users' perceptions. The study covers a set of attributes related to the design of the infrastructure, as well as efficiency and accessibility for users. An ad-hoc survey was designed in order to capture users' needs and perceptions and identify current levels of satisfaction with the services of urban transport interchanges. Moreover, a methodological framework has been developed and applied to the survey results to identify what users see as the greatest strengths and weaknesses of an interchange. This research is part of the City-HUB project, made possible by the 7FP (7th Framework Programme for Research and Technological Development).

This paper is structured as follows. Section 2 presents the literature review of customer satisfaction with public transport services and their facilities. Section 3 describes the methodology implemented to identify the main factors influencing travellers' preferences. The description of the case study and the design and implementation of the attitudinal survey are presented in Sections 4 and 5, respectively. A descriptive analysis of the survey results and user satisfaction ratings are analysed in Section 6. Finally, some recommendations for the transport interchanges are given along with the main conclusions of the study.

2. LITERATURE REVIEW

Little research has been carried out regarding customer satisfaction and service quality in the context of urban transport interchanges. The quality of a public transport system depends on several aspects of its performance, but is also related to the quality of the connections between different transport services (Guo and Wilson, 2007).

Some recent studies have begun to investigate the quality of public transport infrastructure due to a growing interest in developing smart and efficient facilities for intermodal transfers. This section presents several studies that have analysed user satisfaction with different aspects of the design and quality of public transport infrastructure as well as the perceived quality of transport services.

Iseki and Taylor (2010) used an importance-satisfaction analysis and ordered logistic regression models to examine transport users' perceptions of services and the built environment at stops and stations in the Los Angeles metropolitan area. They concluded that the most important determinant of user satisfaction had little to do with the physical characteristics of stops or stations and much more to do with access to frequent, reliable service in an environment of personal safety.

The same methodology used by Iseki and Taylor (2010) was applied by Cherry and Townsend (2012) to identify passengers' perceptions of the intermodal connections between subway stations and bus services in Bangkok, Thailand. They conducted a survey of subway and bus users and discovered high levels of dissatisfaction with specific aspects of the transfer but also with the overall experience. The results indicated that it was necessary to improve the coordination between the subway and bus services, particularly by improving accessibility to stops, and to ensure public safety.

Eight different urban transport interchanges in the Lisbon metropolitan area (Portugal) were studied by Abreu e Silva and Bazrafshan (2013), who collected data regarding user satisfaction with the intermodal transfer facilities. They applied a structural equation model to ascertain the aspects of an interchange which most directly affected customer satisfaction. It was found that satisfaction levels were significantly influenced by the presence of guidance signs, as well as by the presence of litter and graffiti.

Finally, Cascetta and Carteni (2014) proposed a quantitative analysis of the perceived hedonic value of railways stations. The study compared two stations where the main difference was the architectural standards. They defined the "economic value of aesthetic quality" in railway stations: 35 euro cents per trip for students and 50 euro cents per trip for commuters. Their research concluded that a station's architectural quality has a significant impact on users' choices. Female travellers in particular showed a significant preference for station quality (+33% with respect to male travellers) (Cascetta and Carteni, 2014).

3. METHODOLOGICAL FRAMEWORK

An Importance-Performance Analysis (IPA) was employed to identify key elements of transport interchanges based on users' perceptions. The results can be used to guide strategic management and operation decisions for improving urban transport interchanges.

Different approaches can be used to determine the importance of individual attributes for the IPA. Traditional methods for determining the importance of a group of attributes tend to begin with a set of assumptions that are not usually valid for customer satisfaction research (e.g. regression models, structural equation models, discrete choice models, etc.) (Garver, 2003). A decision tree approach was applied in this study: the Classification and Regression Trees (CART) algorithm. This decision tree model is able to automatically identify the best predictors, the best threshold values and the importance of each independent variable in the model. It is a data-mining technique without model assumptions or predefined underlying relationships between dependent and independent variables.

The proposed methodological framework, then, combines the use of the CART algorithm for deriving the importance ratings of attributes and an IPA analysis based on the results of the CART and the satisfaction ratings collected in the traveller satisfaction survey. This methodological framework can be used to ascertain which aspects of an interchange need improvement and which can be considered its strengths.

3.1 IPA

Importance-performance analysis is one of the most widespread approaches used to evaluate service quality in public transportation (Martilla and James, 1977). In fact, it is one of the preferred methodologies of transport company managers because of its simplicity and graphical results (Foote and Stuart, 1998; Christopher et al., 1999; Figler et al., 2011). It has been applied to evaluate different public transport services, such as the BART (Bay Area Rapid Transit) system in San Francisco (Weinstein, 2000), high-speed railways in Taiwan and Korea (Chou et al., 2011), the quality of airline services in Taiwan (Chen and Chang, 2005) and the quality of intercity road transportation of passengers in Brazil (Freitas, 2013).

IPA is a quadrant analysis which uses the importance and performance ratings of different aspects of a service as coordinates on a two-dimensional grid split into four quadrants. This quadrant chart quantifies the importance users have assigned to each attribute (vertical axis) and shows the customers' ratings of the quality of each factor (horizontal axis). Managers should focus on the position of each attribute within the four quadrants of the IPA matrix, which shows the relative urgency of improvement (see Figure 1). Attributes placed on the right side of the quadrant chart have high performance scores, while those on the left side represent low performance values. Likewise, the quadrants on the top of the chart contain those attributes that are most important to travellers, whereas those placed on the bottom of the chart are of relatively low importance. For example, Quadrant A ("*Concentrate here*") contains the service characteristics which customers feel are important but with which they are dissatisfied. This implies that improvement efforts should be concentrated on these aspects of the service. On the other hand, Quadrant D ("*Possible overkill*") indicates attributes that are perceived to be of high quality but which are of less importance to users; transport managers should consider allocating their resources elsewhere.

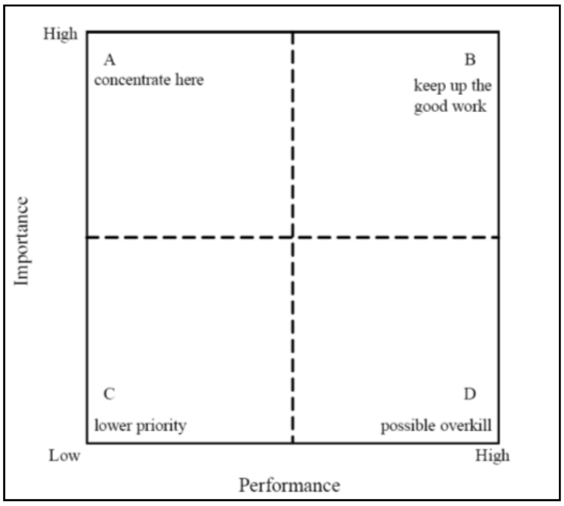

Figure 1 – Importance-performance analysis (IPA) (Martilla and James, 1977).

This approach allows for the identification of the relative urgency of the improvements required for each element of the service. This approach offers managers of transport interchanges a tool with which to prioritise the changes that need to be made.

3.2 CART

The Classification and Regression Trees (CART) algorithm is a methodology for building decision trees developed by Breiman et al. (1984). This technique has been widely employed in different sectors, such as business administration, agriculture, industry and engineering, and, most recently, in research analysing service quality in public transportation (de Oña et al. 2012). In this study, the CART model has been employed to obtain users' importance ratings of the attributes of an urban transport interchange.

The basic concept of decision trees is to divide a dataset into subsets that are "purer" than the parent set; the subsets are pure in the sense that they contain observations belonging to a single class. The process begins with all the data concentrated in a root node; a set of candidate split rules then is established, consisting of all possible splits for all variables included in the analysis. A variable used as a splitter is one that creates the greatest homogeneity in the child nodes. When a classification tree is built with the CART algorithm, these splits are evaluated and ranked using the Gini index as the splitting criterion. This criterion is applied recursively to the descendants to achieve child nodes of maximum "worth" in terms of homogeneity. The splitting process is applied recursively to each child node until all the data in the node are of the same class (the node is pure), their homogeneity cannot be improved, or a stopping criterion has been satisfied. The Gini index measures the impurity of each split as follows:

$$Worth = I\ (P) - \sum_{b=1}^{B} P(b) * I\sum b \quad (1)$$

where *I(P)* denotes the impurity of the parent node; *P(b),* the proportion of observations in the node assigned to a branch *b;* and *I(b)*, the impurity of a node *b*. Therefore, according to the Gini index, *I(t)* – the impurity of a node *t* – may be defined as follows:

$$I(t) = 1 - \sum_{i=1}^{J} \left(\frac{n_i}{n}\right)^2 \quad (2)$$

where *J* is the number of classes in the target variable, n_i is the number of cases belonging to the class *i*, and *n* is the total number of cases. If a node is “pure”, all the observations in the node belong to one class and *I(t)* will be equal to zero.

In order to reduce the complexity of the resulting tree, a cost-complexity pruning algorithm is applied to remove branches that add little to the predictive value of the tree. As more and more nodes are pruned away, simpler and simpler trees emerge. The final step is to select an optimal tree from the pruned trees. For this, a new dataset should be used. The original dataset is usually divided into two subsets, one for “learning” or “growing the tree” and the other for testing or “validation”. The optimal tree is the one which offers the lowest misclassification cost for the test data (de Oña et al., 2012).

One of the most valuable outcomes provided by the CART analysis is the quantification of the importance of the independent variables, which reflects the impact of predictor variables on the model. Breiman et al. (1984) devised the variable importance measure (VIM) for classification trees based on the weighted average of the reduction in the Gini impurity measure (Eq. 2) achieved by all splits using a variable x_j across all internal nodes of the tree, where the weight is the node size. The information is obtained for all the independent variables, making it easy to identify the most important factors (Kashani and Mohaymany, 2011). The optimal tree was applied in this study to determine the importance of the independent variables.

4. DESCRIPTION OF THE CASE STUDY

The Moncloa interchange was chosen as a case study to test this methodology. The interchange is situated on the north-western edge of Madrid, Spain, providing a gateway to the city for over 265,000 people a day. It hosts mainly local and regional bus services, as well as a few national bus lines. A Bus-HOV (high-occupancy vehicle) lane directly connects the interchange to the A-6 corridor, a feature which has produced a significant increase in the demand for regional bus journeys while reducing the total number of car journeys in the area. This interchange, refurbished in 2008, is served by 56 regional bus routes, offering over 4,000 bus journeys per day, with 310 journeys per hour between 8:00 and 10:00 a.m. The urban bus routes serve 125,000 passengers daily, with a total of 4,141

journeys. Additionally, the metro demand (metro lines 3 and 6) has likewise increased, from 44,076 passengers per day in 1995 to over 170,000 in 2010.
Today, Moncloa is the metro station with the highest daily demand in the city due its connection to the Circular line (line 6) which surrounds the city centre and links all the major lines of the metro network. The opening of this station has produced excellent results, not only in terms of increased demand, but also in reductions of surface-level bus journeys and improved journey times for both users and transport companies.

Regarding the design of the interchange, the bays for alighting bus passengers, located on the first subterranean level, are distributed into three different islands. There are a total of three vertical connections with the entrance hall – one for each island. Each island also connects to the lower level, where travel services, the retail area with cafés, restaurants and shopping and the metro station entrance hall are located. Temporary exhibitions and promotional campaigns are occasionally hosted on the lower level.

Figure 3 – Distribution and design of the Moncloa interchange.

5. DESIGN AND IMPLEMENTATION OF THE TRAVELLER SATISFACTION SURVEY

5.1 Design of the traveller satisfaction survey

An ad-hoc survey was used to collect information about users' perceptions and needs regarding the Moncloa interchange.

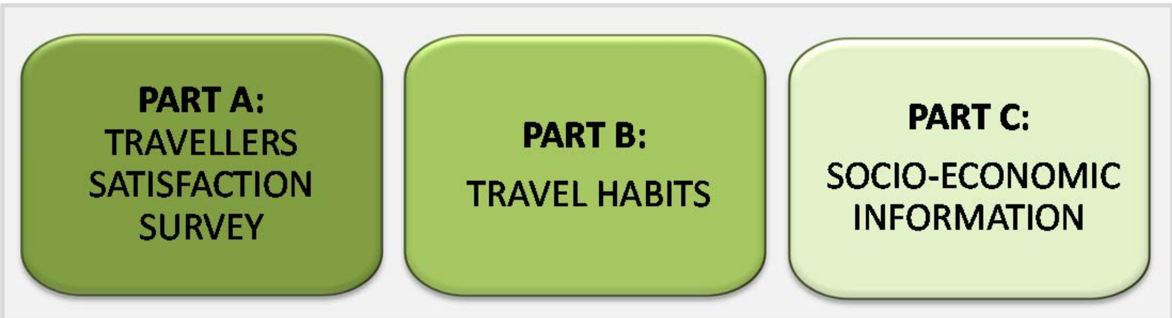

Figure 1 – Parts of the traveller satisfaction survey

Part A: Traveller satisfaction survey

This part of the survey aimed to understand travellers' views of, preferences for and satisfaction with different elements of the interchange. It contained 37 items related to various aspects of the interchange grouped into eight categories: travel information; wayfinding information; time and movement; access; comfort and convenience; image and attractiveness; safety and security; and emergency situations (see Table 1). Each respondent was asked to rate their satisfaction with each item on the Likert scale from 1 (strongly dissatisfied) to 5 (strongly satisfied). One additional question regarding the overall satisfaction with the interchange was included (see Table 2).

Main categories	Items
1. Travel information	1. Availability and clarity of travel information at the interchange 2. Availability of travel information before your trip 3. Accuracy and reliability of travel information displays 4. Ticket purchasing (ticket offices, automated ticket machines, etc.)
2. Wayfinding information	5. Signposting of different facilities and services (shops, toilets, etc.) 6. Signposting for transfers between transport modes 7. Information and assistance provided by staff
3. Time & Movement	8. Transfer distances between different transport modes 9. Coordination between different operators or transport services 10. Use of your time at the interchange 11. Distance between the facilities and services (shops, toilets, etc.) 12. Number of elevators, escalators and moving walkways 13. Ease of movement inside the interchange due to the number of people
4. Access	14. Ease of access to the interchange
5. Comfort & Convenience	15. General cleanliness of the interchange 16. Temperature, shelter from rain and wind, ventilation, air conditioning 17. General noise level in the interchange 18. Air quality and pollution 19. Number and variety of shops 20. Number and variety of cafés and restaurants 21. Availability of cash machines 22. Availability of seating 23. Availability of telephone signals and Wi-Fi 24. Comfort due to presence of information screens
6. Image & Attractiveness	25. The area surrounding the interchange 26. The internal design of the interchange 27. The external design of the interchange
7. Safety & Security	28. Safety getting on and off transport 29. Safety inside the interchange

	30. Feeling secure in the transfer and waiting areas (during the day) 31. Feeling secure in the transfer and waiting areas (evening/night) 32. Feeling secure in the area surrounding the interchange 33. Lighting
8. Emergency situations	34. Information to improve your sense of security 35. Signposting of emergency exits 36. Use of escalators in the event of fire 37. Location of exits in the event of an emergency

Table 1 – List of survey items divided into eight categories.

Finally, the last question of Part A aimed to identify which aspects of the interchange are most important to travellers. To this end, users were asked to choose the three most important attributes of the interchange from the following list (Table 2):

	Select the 3 most important aspects
Availability and quality of information	
Waiting areas	
Safety and security	
Services (toilets, ticketing, luggage check, etc.)	
Shops and cafés	
Transfers between transport modes	
Access to the interchange	
Other (specify)	

Table 2 – Identification of the most important aspects of the interchange.

Part B: Travel habits

Part B gathered information about users' travel habits, including trip purpose, the selected transport mode (from the origin to the interchange and from the interchange to the destination), time (to/from/inside the interchange), the type of ticket used and how they used their time inside the interchange.

Part C: Socio-economic characteristics

This section of the survey collected socio-economic information about the users, including gender, age, employment status, household size and net household income.

5.2 Implementation of the traveller satisfaction survey

Traditional methods, such as face-to-face interviews, were not considered appropriate for the implementation of this survey. Urban transport interchanges are nodes in the public transport network where users transfer rapidly from one mode of transport to another and would be unlikely to participate in a 20-minute questionnaire that would interrupt their journeys unnecessarily. Therefore, a new approach was used to improve data collection rates and reflect the realities of urban interchanges. This approach combines the best of new technologies (online surveys) with traditional survey techniques (a face-to-face distribution process).

The survey was carried out using SurveyMonkey, an online software platform for conducting surveys. Entry in a prize draw for an iPad 2 was offered for participating in the survey. The survey procedure was as follows. First, a card marked with a number (*Survey Number*) was handed out to travellers (see an example card in Figure 3); this included a brief description of the survey objectives, a link to the survey website and information on the prize draw in order to capture the users' attention. The *Survey Number* provided each respondent with an individual access code to the online survey which was accessible on computers, smartphones and tablets.

Figure 2 – Card handed out at the Moncloa transport interchange, Madrid, Spain.

Each person who received a card was asked a few questions. The answers were recorded by the interviewers on a control sheet containing the following information: survey number, date, time, location in the interchange, gender, and age and other observations (carrying luggage, pushchair, etc.).

Finally, each completed survey recorded by the SurveyMonkey tool was exported to a database. Using the individual survey numbers, it was possible to control for duplication of responses and incomplete surveys.

This new approach allowed the survey team to reach a rather high response rate in a short period of time, therefore increasing the sample size. In addition, the data processing was simplified by avoiding the need to transfer responses from paper to computer, which can result in discrepancies due to input errors or illegible responses.

6. RESULTS

The traveller satisfaction survey aimed to capture users' perceptions and needs in order to identify which attributes of urban transport interchanges are of greatest importance to them and to outline policy recommendations for the management and operation of such interchanges. A descriptive analysis of the collected data along with the importance ratings assigned to the main factors are presented in Section 6.1. The results obtained from the CART analysis and the IPA are detailed in Section 6.2.

6.1 Survey implementation and overview of results

The survey was carried out in the Moncloa transport interchange according to the procedure described above (Section 5.2). Cards were handed out mainly in the three different bus islands by a group of four interviewers on five working days and one weekend in May 2013. The response rate was 23.2%: 4,000 cards were distributed during this period and 928 completed surveys were recorded on SurveyMonkey. In the end, there were a total of 865 valid surveys.

Most of the respondents were habitual users – accounting for 75% of the sample – and their main trip purposes were work (48.6%) and education (34.5%). The percentage of female users (54.1%) was greater than the percentage of male users (45.9%) and the age ranges of the respondents were 18-25 (42.5%), 26-40 (26%) and 40-65 (27.9%), as can be seen in Figure 4. The fraction of the respondents in the lowest net household income bracket was 43% and the proportion in the highest bracket was 22.7%.

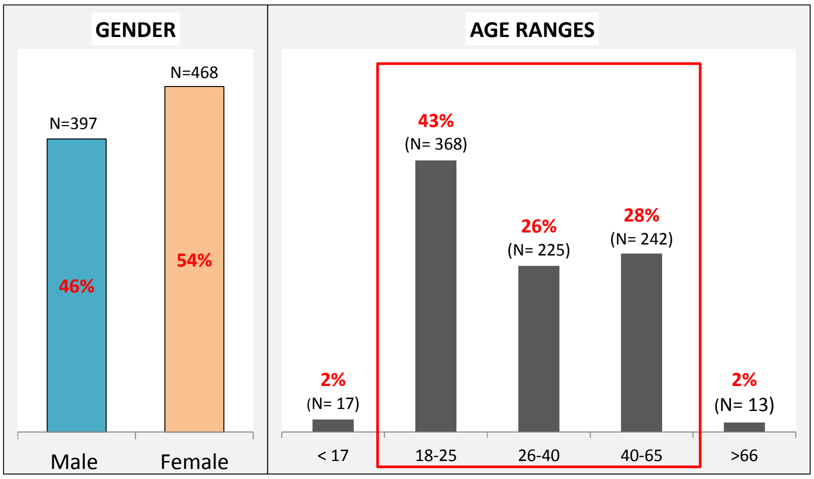

Figure 4 – Characterisation of the sample by gender and age.

The results of Part B provided information regarding users' travel habits. The respondents reported spending most of their time inside the interchange queuing and transferring from one transport mode to another. On average, 41% of users spent between 5 and 15 minutes queuing and transferring per journey while another 42% reported spending more than 15 minutes in these activities. Queuing times were reported to be between 5 and 15 minutes (41%) while transfer times tended to be less than 5 minutes (92%).

Lastly, the three most important factors identified by users (Table 2) were information, transfers and safety and security (see Figure 5).

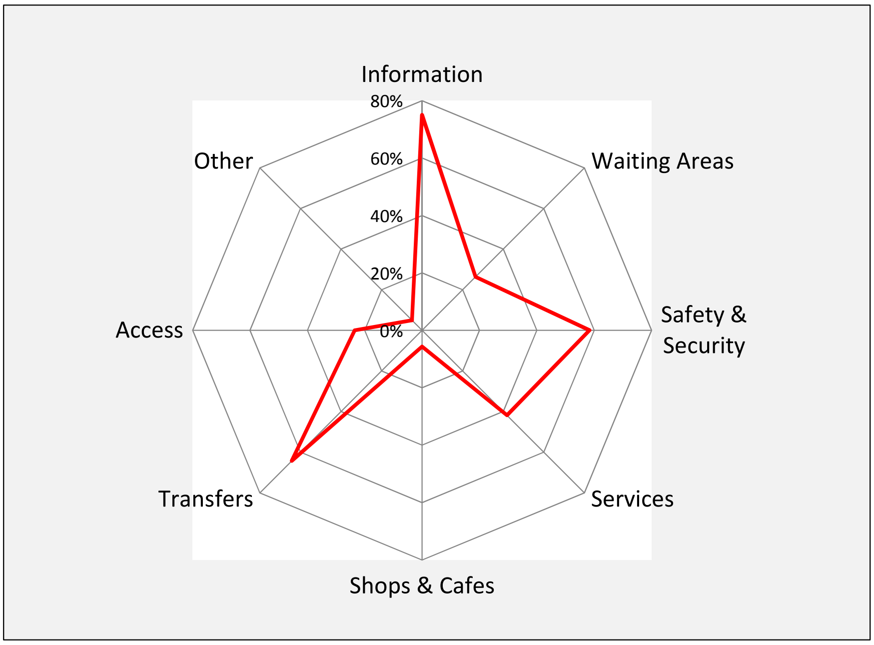

Figure 5 – Importance of factors according to users of the Moncloa interchange.

6.2 User satisfaction ratings: performance assessment

The methodological framework proposed in Section 3 was applied to the sample described above. A CART model was designed using a ten-fold cross-validation of the sample. The accuracy rate was acceptable for the CART model: the tree obtained was 67.4% accurate, higher than in other studies with a similar focus (de Oña et al., 2012).

Figure 6 shows the CART for the overall database of the traveller satisfaction survey. The root node (Node 0) is split into two child nodes (Node 1 and Node 2), using the variable that maximises the "purity" of the two child nodes, in this case item 34 (Information to improve your sense of security). The majority of the sample (85.5%) is concentrated in this child node (Node 1), which indicates that this factor is a great discriminant of the model. When this item is rated with a score lower than 4 (Node 1), the user feels satisfied (67.6%). Other attributes were used as splitters of the tree, such as item 26 (The internal design of the interchange), item 14 (Ease of access to the interchange) and item 31 (Feeling secure in the transfer and waiting areas (evening/night)). Some items were even selected repeatedly for dividing the sample into two child nodes (e.g. item 34 and item 31), demonstrating their importance in the model.

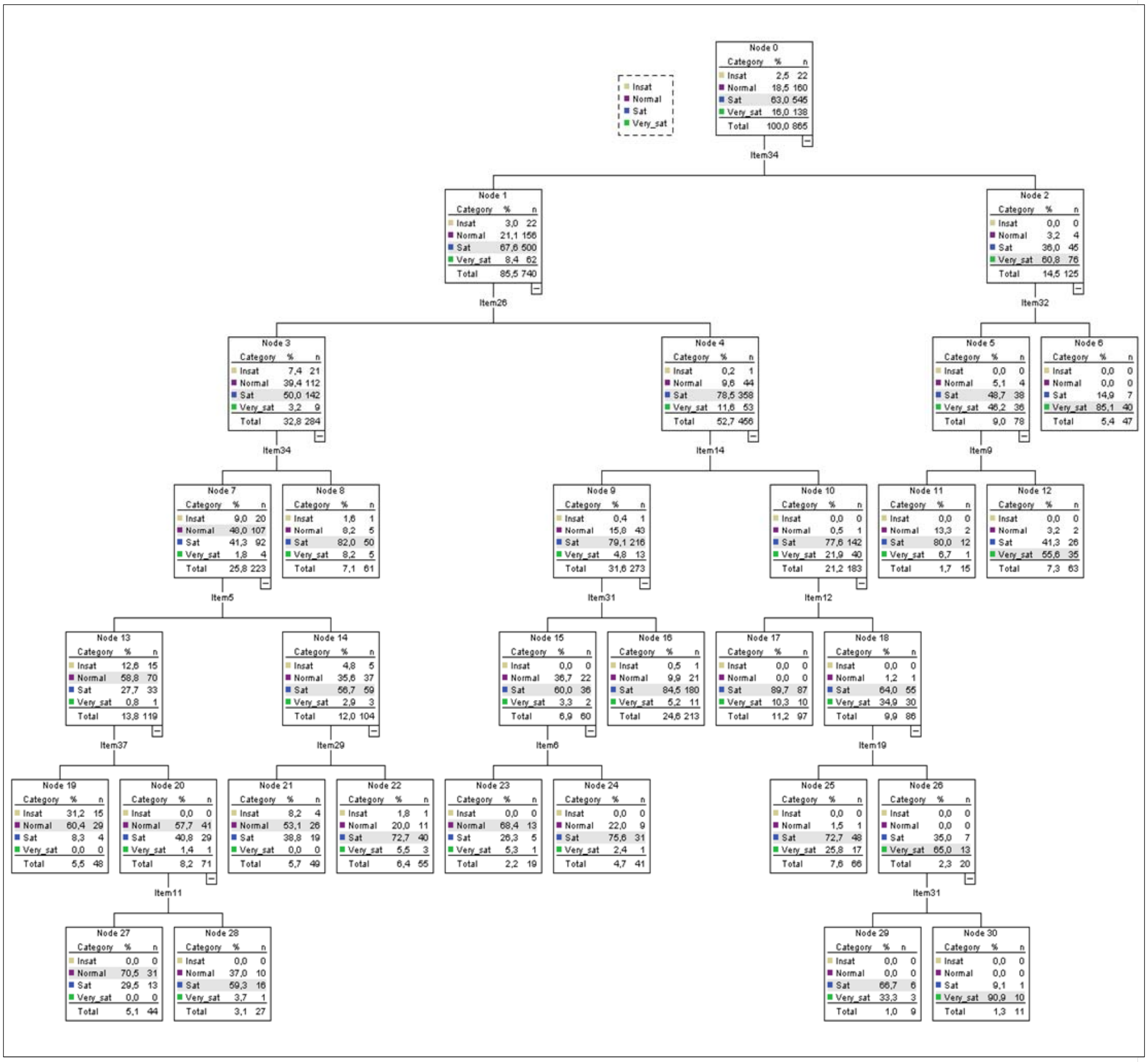

Figure 6 – CART for the Moncloa transport interchange in Madrid, Spain.

Table 3 shows the normalised importance of the independent variables of the seven most important variables identified by the survey respondents. It can be observed that the factors of most importance to travellers are those related to emergency situations, comfort and convenience, and safety inside the interchange.

Independent variables		Importance	Normalised
Item 24	Comfort due to presence of information screens	0.107	100.0%
Item 34	Information to improve your sense of security	0.102	95.0%
Item 37	Location of exits in the event of an emergency	0.079	74.0%
Item 36	Use of escalators in the event of fire	0.071	66.4%
Item 19	Number and variety of shops	0.062	58.2%
Item 35	Signposting of emergency exits	0.062	58.0%
Item 29	Safety inside the interchange	0.060	56.2%

Table 3 – Derived importance based on users' perception of quality.

Finally, Figure 7 presents the proposed IPA for the Moncloa transport interchange. The axes of the quadrant chart correspond to the average value of the importance ratings (vertical axis) and the satisfaction ratings (horizontal axis). A red line establishes a performance threshold: attributes with ratings below this threshold should be improved immediately without further evaluation. In this study, three factors did not meet the basic performance standards: items 21, 22 and 23, related to the availability of cash machines, seats, telephone signals and Wi-Fi inside the interchange. These can be categorised as the major weaknesses of the interchange.

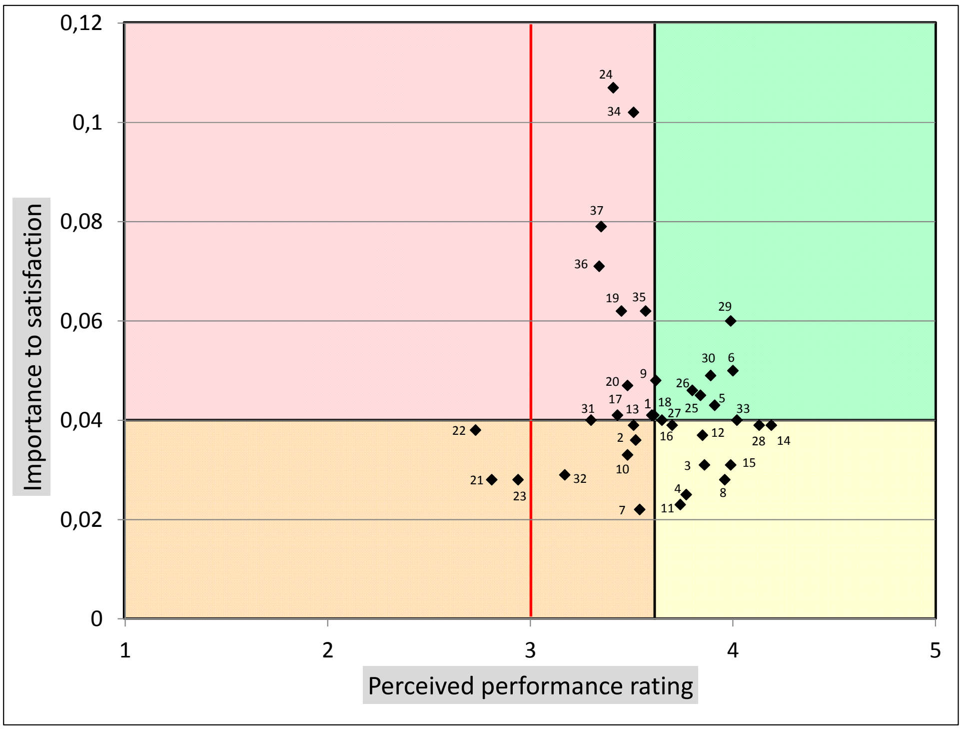

Figure 7 – Importance-performance analysis for the Moncloa transport interchange.

The IPA quadrant chart is separated into four different sections. Items 5, 6, 25, 26, 29 and 30 are within the upper right-hand, “Keep up the good work” section (green). These attributes are considered to be of high importance to users and they also ranked high in terms of performance, indicating that they are the greatest strengths of the interchange. These elements are related to the signposting of different facilities and transport services, the internal design of the interchange and the surrounding area, and safety and security. The upper left-hand section (red) contains the attributes that need improvement, as these are of high importance but are perceived to be of low quality. Items 24 and 34 (Comfort due to presence of information screens and Information to improve your sense of security) are the factors that should be improved with the greatest urgency because of their high importance and relatively low performance. Additionally, items 37, 36, 35, and 19 are attributes which interchange managers should work to improve in order to increase user satisfaction. These items are associated with emergency situations and safety inside the interchange. In contrast, the bottom right-hand section (yellow) represents areas of “Possible overkill” in the interchange, attributes that do not have a strong influence on users’ evaluations but nevertheless are perceived to be of high quality. Items 28 and 14 (Safety getting on and off transport and Ease of access to the interchange) fall into this category, although their importance almost brings them within the limits of the green quadrant; they can therefore also be considered as strengths of the interchange, as they received the highest overall satisfaction ratings. The performance and quality of the other aspects can also be considered to be positive attributes of the interchange, as their ratings were close to the average thresholds for both importance and satisfaction.

7. CONCLUSIONS AND RECOMMENDATIONS

There are few opportunities for direct journeys when choosing to use public transport; most trips require a transfer at one point or another at a stop or interchange. Urban transport interchanges, therefore, play a key role in public transport networks in cities, facilitating transfers between routes and different public transportation modes (Vuchic, 2005). However, evaluation methods have rarely been adapted for measuring users’ needs or their perception of the quality of urban transport interchanges in the operational phase. This study proposes a methodological framework to identify the aspects that are most important to travellers in order to recommend strategies for new and upgraded urban transport interchanges.

The proposed methodological framework allows interchange managers to formulate adequate strategic decisions to improve their operations, overcome barriers and enhance the attractiveness of public transport. Additionally, the graphical analysis provides information with which to establish the priority of interventions, allowing the most urgent needs to be addressed first.

The results demonstrate that the three most important factors identified by users of the Moncloa interchange are information, transfers and safety and security (Figure 5). Furthermore, the importance-performance analysis shows that the specific elements that are most important to travellers are associated with comfort inside the interchange due to the presence of information screens (item 24), shops and cafés (item 19) and all aspects related to emergency situations (items 34, 35, 36 and 37). However, these all received low performance ratings despite being of high importance; these attributes therefore need urgent improvement. In contrast, the attributes related to the signposting of different facilities and transport services (items 5 and 6), the internal design of the interchange and the surrounding area (items 25 and 26) and safety and security (items 29 and 30) were identified as the greatest strengths of the interchange.

An interchange is a facility which enables passengers to transfer from one route to another or to change from one mode to another. In this respect, interchanges should act as hubs in urban areas, designed in a way that attracts people to the facility from the outside in order to connect them to the transport modes available there. The core function of an interchange is to enable efficient transfers between routes and modes within the interchange, bearing in mind that passengers may need to exit the system or be obliged to wait for their connections. Larger interchanges are increasingly incorporating a variety of retail and commercial opportunities for travellers, allowing passengers to use their time between connections for shopping, eating or meeting people. This also creates opportunities for more attractive business models and encourages the participation of the private sector. The design of the interchange, however, should always be focussed on transport transfers – otherwise the facility is just a shopping centre with good transport access. Those responsible for interchanges must therefore focus their attention on the aspects of the travel experience that are most important to passengers and use the tools available to them – such as the evaluation method proposed here – to prioritise and address users' needs.

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