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Q-PLOS, developing an alternative walking index. A method based on urban design quality

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ABSTRACT

The Level of Service (LOS) is a measure to evaluate the degree of accommodation of different transport modes in a given infrastructure (road, railway, street, etc.). While the last decades have seen a growing interest regarding the use of level of service for managing and planning private and public transport infrastructures, shortcomings appear when it is used in the context of pedestrian mobility (i.e. the complexity of pedestrian mobility in terms of behaviour and the consideration of urban design factors associated with pedestrianisation). This paper aims to gain insight into the abovementioned issues by developing an alternative walking index, the Quality of Pedestrian Level of Service (Q-PLOS) method. This novel method is based on the quality of urban design for pedestrian and its relationship with walking needs. The city of Granada (Spain) provided the empirical focus. The paper found that the Q-PLOS was a more accurate measurement of pedestrian mobility characteristics. This was based on the relevance of specific factors linked to urban design together with public preferences about them. Finally, the obtained high-detailed outputs provide a platform to increment the effectiveness of level of service specifically for pedestrians that want to access to a public transport stop.

Introduction

Level of Service (LOS) is a measure to evaluate the degree of bicycle and pedestrian accommodation in a roadway environment (Dixon, 1996) or transport station (TRB, 2003). It was mainly developed as part of an initiative from USA to make cities more liveable and reinforce multimodality. One of the first analyses of LOS used pedestrian density to evaluate capacity and space requirements in roadways (Fruin, 1971). Later, other research was carried out using different indicators to evaluate LOS, such as the combination of pavement width and pedestrian density (Mōri & Tsukaguchi, 1987). The results of this indicator were presented on an easily understood scale, leading to its widespread use in planning and decision-making, as reflected by its constant appearance in reference manuals (TRB, 1985, 2000).

Despite advances in LOS measurements, their use has been far greater in the field of non-pedestrian mobility, including bicycling. This gap is due to the complexity in evaluating pedestrian mobility (Landis, Vattikuti, Ottenberg, McLeod, & Guttenplan, 2001), which causes one of the most common problems in this type of measure (Asadi-Shekari, Moeinaddini, & Zaly Shah, 2013). Specifically, one of the most important issues is related to knowing the minimum number of indicators needed to accurately estimate pedestrian satisfaction or perceived level of service. In the past, attempts to improve the P-LOS measure have been based on the addition of new indicators on safety as a walking need. For example, Landis et al. (2001) noticed that the traditional LOS measures could be improved by adding indicators on lateral separation, type of vehicle or traffic volume and speed. Similarly, others such as Baltes and Chu (2002) and Petritsch et al. (2005) have designed a P-LOS measure focusing on pedestrian safety at crossings, including some additional factors, such as signals or medians. Furthermore, there was an improvement in P-LOS measures based on other walking needs: pedestrian comfort, taking account of indicators like air pollution and noise levels (Sarkar, 2003).

Nevertheless, these advances focus on partial aspects, while a more integrated approach incorporating more walking needs is still required (Asadi-Shekari et al., 2013). Academic literature indicates that the research on walking needs has been based on factors such accessibility, safety, comfort, and attractiveness (Alfonzo, 2005; Asadi-Shekari et al., 2013; Pozueta, 2009; Weinstein, Schlossberg, & Irvin, 2008). Furthermore, Alfonzo (2005) demonstrates a hierarchy of walking needs where accessibility is the first

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level followed by safety, comfort and attractiveness. Within this framework, the quality of pedestrian environments is based on the inhabitants' degree of satisfaction with walking needs as a whole. If walking needs are satisfied, pedestrians will tend to display positive behaviour towards walking, which can improve the pedestrian level of service regarding public transport stops, thus increasing their pedestrian accessibility and use (Olszewski & Wibowo, 2005).

In this context, we need to use indicators characterised by their usability and relevance for all factors describing the quality of urban design and creating positive behaviour in the public's desire to walk (Ewing & Handy, 2009). The consideration of urban design factors (related to the improvement of the third D of 3D's) together with the other two D's (density and diversity) (Lee, Yi, & Hong, 2013) allows us to achieve better quality standards in accessibility to transportation. To address this objective, mixed methods merging qualitative and quantitative analysis must be implemented and, in most of cases, there are no reference values for these level of service measures (Dixon, 1996).

As Asadi-Shekari et al. (2013) point out, the existing PLOS methodologies may be of three types: regression methods, simulation or point system methods. All these PLOS type methods have their advantages and disadvantages. On the one hand, regression and simulation methods have as main advantages that weight and strength of indicators are not passed on personal decisions. Nevertheless these methods (e.g. Landis et al. (2001), Muraleetharan, Adachi, Hagiwara, and Kagaya (2005), Petritsch et al. (2006)) present some disadvantages such as high complexity and time-consuming, making difficult to incorporate in a decision making process. On the other hand, point system methods (e.g. Gallin (2001), Sarkar (2003)) are easy to follow and integrate in a decision making process but the weights are selected more arbitrarily. In this sense Q-PLOS method tries to get the advantages of each type of methods in order to response to the existing LOS shortcomings such as lack of methods that provide safe, secure, comfortable and convenient walking, as well the difficult to link this methods in a easily and low time-consuming way to the decision making process (Asadi-Shekari et al., 2013).

In this paper, we propose a method of contemplating urban design factors in P-LOS under the name of "Quality of Pedestrian Level of Service" (Q-PLOS). The method aims to provide a better integration of walking components compared to traditional LOS measures, based on a white-box model that allows transport planners to fit it in with the characteristics of local mobility environments. To address this, we selected highly relevant indicators of urban design qualities that may provide a consistent measure to be used by transport planners when designing pedestrian environments based on quality criteria within the framework of a transport infrastructure.

Thus, the proposed method for P-LOS measure tries to evaluate the quality of urban design in order to increase pedestrian accessibility to public transport stops, making access routes more convenient and easier for pedestrians (Fig. 1). In addition, the indicator results can be aggregated to provide a global value of quality for pedestrian mobility based on the weights obtained from surveys on inhabitants (Adkins, Dill, Luhr, & Neal, 2012; Cerin, Macfarlane, Ko, & Chan, 2007) or panels of experts (Ewing & Handy, 2009; Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003) which aims to reduce the disadvantages of arbitrariness that accompanies the point system methods.

The paper has three sections. Firstly, we present the research method in three stages: (i) selection of pedestrian factors and associated indicators; (ii) definition of quality thresholds; and (iii) aggregation of quality values. Next, we aim to show how the measure could be applied using the city of Granada as a study area, where a new light rail line is being built. This light rail project enables us to test whether quality of urban design has been taken into account as a key issue in increasing accessibility to light rail stops and, therefore, their use, which should be one of the objectives of this type of projects. Finally, we discuss the results obtained and the usefulness of the Q-PLOS measure in urban transport planning in order to achieve improved multimodal cities where walking and cycling can play a predominant role.

Research method

Q-PLOS is a measure based on a method designed with regard to three key issues. First, it evaluates pedestrian environments through the use of urban design indicators related to walking needs. Second, the measure must let the easy comparison between different case studies through the definition of quality thresholds. Third, the output is simultaneously presented as an aggregated result and as separated factors. This would make its potential use in the decision-making process.

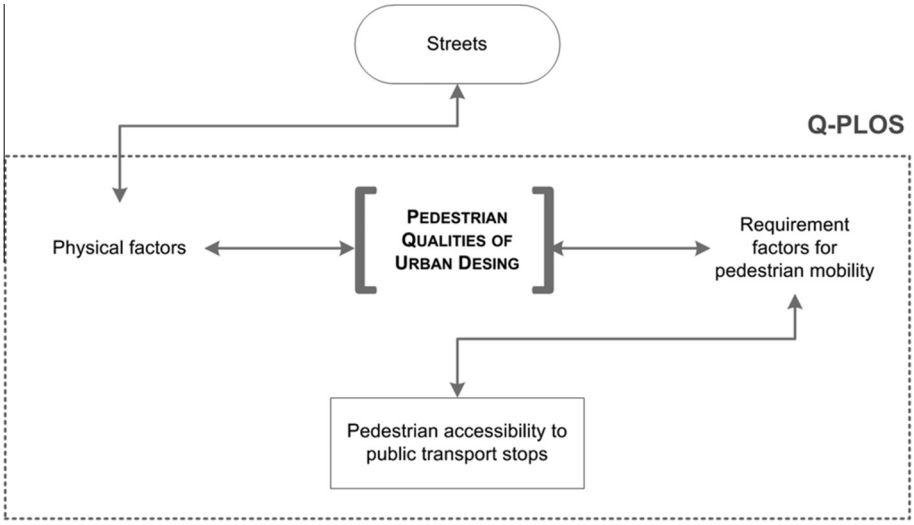

Fig. 1. Method to evaluate the quality of pedestrian level of service of public transport stops.