# ASSESSING THE PEDESTRIAN EXPERIENCE IN PUBLIC SPACES

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## ABSTRACT

The assessment of the pedestrian experience in public spaces is increasingly becoming an essential constituent of urban street design. This paper first presents a new methodology for evaluating pedestrian environments through on-street surveys, building upon well-established comprehensive pedestrian audit tools, such as PERS and PEDS. The methodology is applied on the South Kensington area of London, in light of recent redevelopments seeing the conversion of the previous car-oriented layout to a more pedestrian-friendly one. The results suggest that the new design is generally perceived positively by pedestrians, but point out that there may be room for improvement in terms of pedestrian comfort. The results are then further analysed statistically in order to draw generic conclusions and investigate the effects of different aspects of the pedestrian environment on each other with respect to the pedestrian experience. By fitting a series of ordered logistic regression models, a number of interdependences are identified and interpreted.

## 1 INTRODUCTION

Traditionally, street design and traffic engineering have been driven by the concept of segregation of pedestrians and vehicles. As such, the priority has been to allow for quicker access and movement of the vehicular traffic by limiting conflicts and human-dependent decisions and by designing streets according to the desire lines of vehicle drivers. As opposed to that, the desire paths of pedestrians have often been neglected, with structures such as pedestrian subways, bridges, guardrails and walls restricting their movement with the objective of protecting them and preventing their involvement in road accidents. The concept of segregation is set out most lucidly in Buchanan's "Traffic in Towns" report (1) which served as a street design manual in the UK for many decades.

In recent years, however, there has been a trend away from traffic segregation, driven by developments in architecture and urban planning. Segregation has been deemed by some detrimental for urban environments due to its perception as resulting in "the domination of vehicular traffic and associated noise and air pollution alongside street clutter and ugly surroundings" (2). Instead, street design and traffic engineering have seen a shift in focus from vehicles to pedestrians as a means of creating a better environment, mainly through the introduction of single surfaces and the removal of features such as street furniture, signage, delineation and kerbs. Notable examples include the Complete Streets initiative in the USA (3) and the shared space concept in the UK (4).

In light of the increasing importance of catering for pedestrians in urban street design and traffic engineering, the review and assessment of the pedestrian environment is becoming an essential constituent of any new scheme or redevelopment, alongside the conventional assessment of the traffic efficiency, before and after implementation. This is generally carried out using either well-established comprehensive pedestrian audit tools (such as PERS in the UK or PEDS in North America) addressed to small numbers of experts and investigating individual aspects of a design (e.g. the provision of adequate pedestrian crossing facilities), or through shorter purpose-developed general surveys targeting larger numbers of respondents from the general public and thus aiming at broader but statistically significant results.

The present study has two goals: 1) to develop a pedestrian evaluation methodology of the latter category for use in on-street surveys and to apply it to a specific area in order to draw conclusions on the pedestrian environment; and 2) to investigate the effects of different aspects of the pedestrian environment on each other with respect to the pedestrian experience. In particular the second goal aims at investigating the previously unexplored topic of the interrelationships between the factors constituting the pedestrian experience (perception), with the prospect of being used in predictive models in future, in cases with limited data availability or with constraints in the data collection (e.g. survey time).

The study focuses on London's South Kensington area, which has recently been redeveloped as part of the Exhibition Road project. The project comprises, among others, the implementation of a single shared surface as a replacement of a conventional dual carriageway, the unravelling of a pedestrian-unfriendly one-way system, and the provision of more pedestrian facilities (Figure 1). The work described has been carried out as part of a traffic monitoring programme of the Exhibition Road project. Other activities conducted within the framework of the monitoring programme include traffic conflicts analyses (5), behavioural studies (6), and generic shared space perception surveys (7,8).

**FIGURE 1** South Kensington before and after the redevelopment

The paper is structured as follows: Section 2 sets out the background of the study, which includes a review of existing pedestrian evaluation methods. Section 3 describes the survey design methodology and reports on the results obtained. Section 4 then goes on to investigate the interrelationships between the individual aspects of the pedestrian environment and to present the corresponding statistical analysis through a series of regression models. Finally, Section 5 concludes the paper and identifies areas of future research.

## 2 BACKGROUND

A variety of methods have been developed with the aim of assessing the street environment from the pedestrians' point of view in order to be able to address their needs. These methods usually involve the conduct of surveys with pedestrians, covering aspects such as the accessibility of the area, the availability of the required street furniture, the availability of the required services, the aesthetic appearance and the cleanliness of the space. Such an approach is adopted, for example, in a study by Jones et al (2), who analyse a street space in London by asking users about their levels of satisfaction when using the space. However, since external environments are subject to users who have different tastes and needs, what is important for one user may be less important for another, thus making it a necessity to find a common standard for the comparison.

Previous research has attempted to address the topic of pedestrian environment assessment by identifying the key influencing factors and developing appropriate tools. While attempts have been made to evaluate pedestrian facilities objectively, it has been highlighted in the literature that many of the factors involved are subjective in nature, and as such studies have adopted various approaches (9).

Examples include: a method presented by Sarkar (10), which defines a level of service measure for pedestrian movement based on safety, security, comfort and convenience, continuity, system coherence, and attractiveness; a study by Pikora et al (11), evaluating the quality of walking as a function of four criteria (functional, safety, aesthetic and destinations); and the works of Emery et al (12) and Day et al (13), which assess features such as the condition of pavements and sidewalks, safety, lighting, aesthetics, and public transport facilities. Further methods and tools are presented and appraised in a study by Vernez-Moudon and Lee (14).

An important contribution to the field has been made by Clifton et al (15) through the development of the "Pedestrian Environment Data Scan" (PEDS) tool, which is currently one of the most widely-used tools in the USA. Focussing on individual streets rather than districts or areas, PEDS consists of a single review sheet containing three sections. The first section aims at defining the street to be reviewed, which is down to the discretion of the reviewer but is typically the pavement segment between two junctions; the second section allows for a small number of subjective scores to be given (assessing attractiveness and perceived safety); and the third section, which is the main part of the form, requires quantitative scores input to four sets of questions covering the categories of environment, pedestrian facility, road attributes and walking/cycling environment. In total 40 questions are included, and to ensure the integrity of the respondents, a two-day training is required prior to using the tool.

Equivalently to PEDS, the "Pedestrian Environment Review System" (PERS) has been developed in the UK by the Transport Research Laboratory (TRL) (16). Implementing a three-tier system, where each level offers a more detailed assessment of the previous level (Tier 1: Public space -> Tier 2: Route -> Tier 3: Link, Crossing), PERS is based on the completion of a series of separate independent review forms. A wide range of parameters are covered by the review framework, relating to different aspects of urban design features, such as safety, legibility of space, user conflicts, and walking surface quality. Respondents are required to assign scores between -3 and +3 to each of the parameters, which can be subsequently weighted according to their importance (17) in the pedestrians' perceived utility. Overlaying the results from PERS on a map enables their visualisation, which offers a quick insight into the street space under analysis.

While PEDS and PERS are fairly comprehensive analysis tools for pedestrian environments and offer standardised methods of measuring pedestrian views, they are mainly intended for comprehensive interviews with experts. In fact, the completion of the numerous review forms in the case of PERS and the previous training required for the respondents of PEDS are both time-consuming procedures and are not suited for the conduct of on-street surveys with pedestrians. What is more, both tools require very detailed information from the respondents about all parameters, which is mostly not noticed by "ordinary" pedestrians. Conversely, a more general assessment of the pedestrian perceptions of a space through a shorter purpose-developed on-street questionnaire is often the preferred approach, as it enables interviewing larger numbers of respondents and thus collecting less-detailed but statistically-significant data.

An example of a study of that category is a 2007 assessment of the pedestrian perceptions at London's Oxford Circus site. For the purposes of the study an on-site questionnaire was designed and implemented with the prospect of identifying the issues relating to movement within and around the space. Surveys were held on two different study days: one during a specially organised pedestrianised day (called Very Important Pedestrians (VIP) day, held on 1 December 2007), on which vehicles were severely limited from passing through the area; and one on a "normal" day, held a week later, so as to compare the results with everyday conditions. The study was commissioned by Transport for London and was carried out by Atkins Intelligent Space (18). The surveys enquired visitors to the area about their perception of public transport services, way-finding into and around the area, the ease of moving around the space and their perceived safety. A demographic dataset describing the respondents was also collated in the process. The study eventually helped clarify important problems relating to the pedestrian environment, in light of the subsequent redevelopment of the space in 2010, and was also coupled with an after-study using a similar questionnaire, which demonstrated improvements in the aspects identified (19).

A similar evaluation is described in the next section, where a new questionnaire has been developed and tested on the South Kensington site.

## 3 SURVEY DESIGN AND RESULTS

In order to evaluate the pedestrian experience in the South Kensington area following the redevelopments within the framework of the Exhibition Road project, a purpose-developed short on-street questionnaire was developed and was applied on a large sample of respondents. The study area is briefly described first, followed by the questionnaire development and the discussion of the results.

### 3.1 The study area

South Kensington station is one of the busiest underground stations in London with around 30 million users every year (20), as it is the gateway to Exhibition Road, which is home to a number of London's museums, academic institutions and events venues. Before the redevelopment of the immediate surrounding area, traffic congestion, overcrowding and high numbers of pedestrian-vehicle conflicts were significant problems affecting the pedestrian environment. As part of the Exhibition Road project, the road layout was radically altered, with many of the previous one-way roads becoming two-way and with additional pedestrian crossings being introduced. The phasing of traffic signals has also been improved, and large open pedestrian spaces have been provided to the North and South of the station. These spaces have been designed to provide a more attractive and comfortable environment for pedestrians to interact and relax, rather than a busy traffic intersection where pedestrians would rush through.

The study area analysed here is shown in Figure 2, and consists of the immediately adjacent space of South Kensington station, including five pedestrian crossings and two pedestrian spaces surrounding the station entrance.

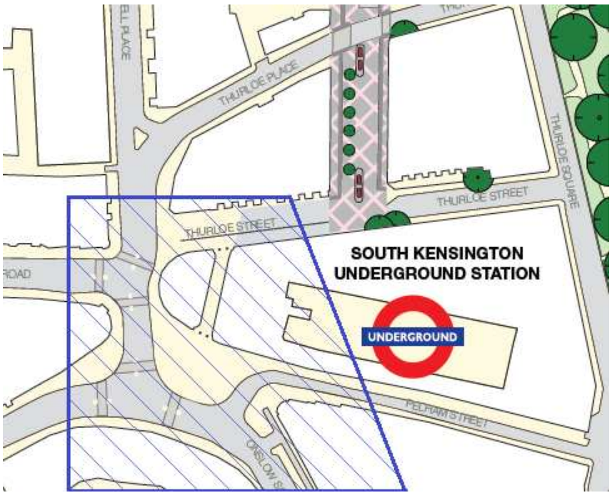
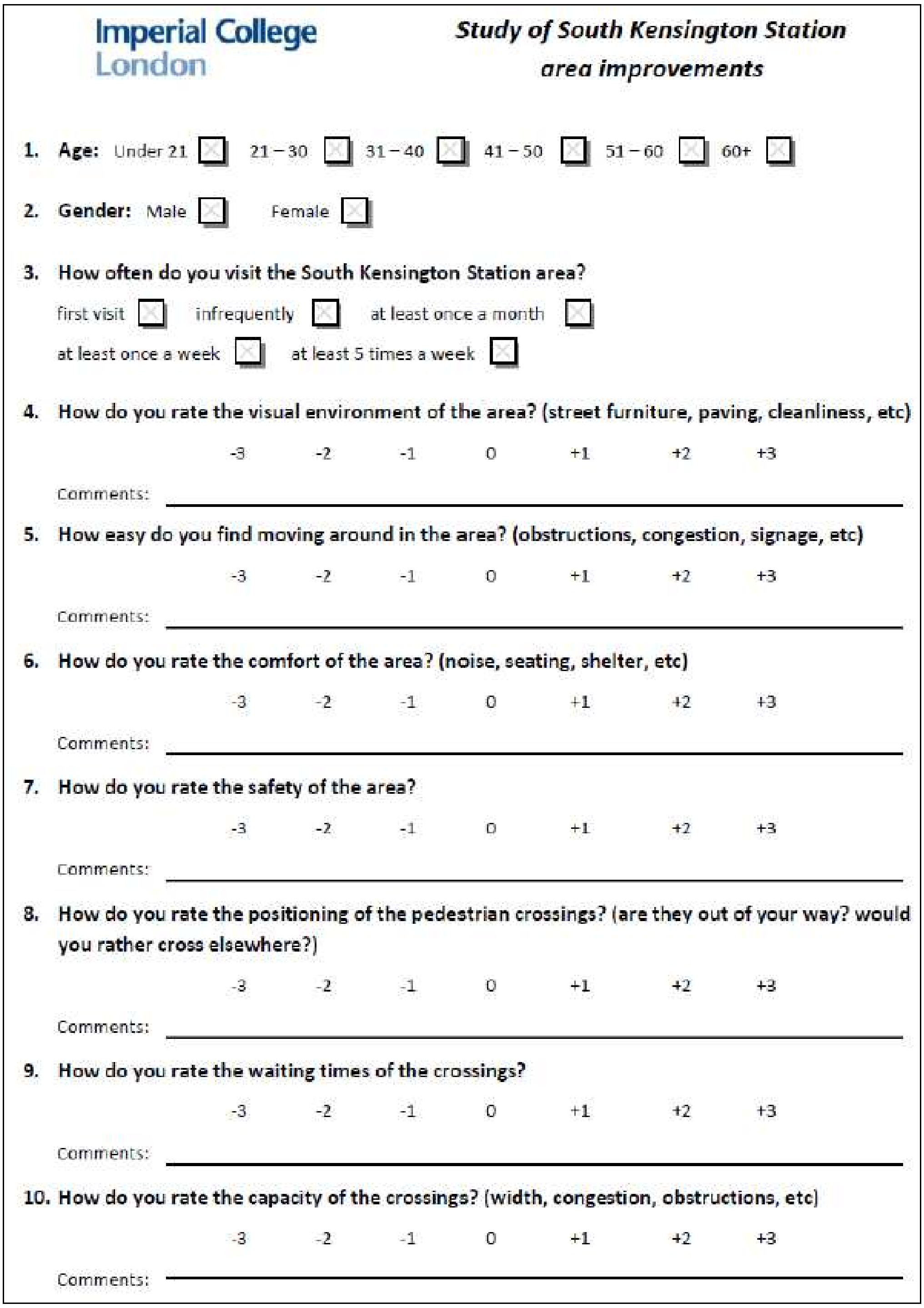



**FIGURE 2** Study area

### 3.2 Questionnaire development

The design of the questionnaire used in the on-street survey was an important task, as careful thought needed to go into the selection of the attributes examined and the formulation of the questions. As the number of questions directly influences the amount of information gained but also the time taken to complete the questionnaire, a trade-off between brevity and level of detail was required. Naturally, respondents may become restless and frustrated with an overlong questionnaire, while too few questions would limit the amount of information that could be obtained. Looking at previous on-street questionnaires, it was decided in this study that 10 questions were required.



Imperial College London

***Study of South Kensington Station area improvements***

**1. Age:** Under 21 ☐ 21 – 30 ☐ 31 – 40 ☐ 41 – 50 ☐ 51 – 60 ☐ 60+ ☐

**2. Gender:** Male ☐ Female ☐

**3. How often do you visit the South Kensington Station area?**

first visit ☐ infrequently ☐ at least once a month ☐

at least once a week ☐ at least 5 times a week ☐

**4. How do you rate the visual environment of the area? (street furniture, paving, cleanliness, etc)**

-3 -2 -1 0 +1 +2 +3

Comments: ______

**5. How easy do you find moving around in the area? (obstructions, congestion, signage, etc)**

-3 -2 -1 0 +1 +2 +3

Comments: ______

**6. How do you rate the comfort of the area? (noise, seating, shelter, etc)**

-3 -2 -1 0 +1 +2 +3

Comments: ______

**7. How do you rate the safety of the area?**

-3 -2 -1 0 +1 +2 +3

Comments: ______

**8. How do you rate the positioning of the pedestrian crossings? (are they out of your way? would you rather cross elsewhere?)**

-3 -2 -1 0 +1 +2 +3

Comments: ______

**9. How do you rate the waiting times of the crossings?**

-3 -2 -1 0 +1 +2 +3

Comments: ______

**10. How do you rate the capacity of the crossings? (width, congestion, obstructions, etc)**

-3 -2 -1 0 +1 +2 +3

Comments: ______

**FIGURE 3** Questionnaire

The first three questions reviewed the respondent's age, gender and frequency of visit to the area, in order to collect some demographical data of the sample so as to allow for the examination of any possible correlation between demographics and pedestrian perceptions. The remaining questions were then formulated in a way that would allow for the most useful conclusions to be drawn, and given the nature of the area, it was decided that focus would be given to the assessment of the pedestrian crossings and the public spaces, following the structure of the PERS software. An important feature that was also added was the provision of space for the recording of additional comments that respondents would state. This would enable subsequent qualitative analysis so as to investigate the causes behind specific ratings.

The concept of the PERS software was also followed in the rating scale implemented, as respondents were asked to give a rating between -3 and +3 to each of the attributes examined, with -3 implying "very bad", 0 implying "neutral" and +3 implying "excellent". Indeed, it was deemed useful that respondents were able to give negative/neutral/positive ratings to aspects towards which they felt negative/indifferent/positive, as such a rating scale resulted in better clarity of the questions and hence more confident and honest answers.

The complete questionnaire is shown in Figure 3. Prior to the conduct of the actual survey the questionnaire was piloted in the field to identify potential shortcomings and need for improvements, particularly with respect to the interview length and the formulation of the questions (e.g. the existence of ambiguous statements, leading to the confusion of the respondents). 30 responses were collected in the pilot test and it was found that the time to complete the questionnaire was less than two minutes, and no signs of restlessness or frustration were shown by any of the respondents. Also, the respondents seemed to understand the questions fairly well and gave confident responses, in line with what was expected. It was hence decided that no modifications to the survey were required.

### 3.3 Survey results

Surveys were carried out in several two-hour periods between January and June 2011, and the total number of responses obtained was 202. Looking at the demographics, there were 97 male respondents (48%) and 105 female ones (52%), resulting in a fairly well-balanced sample in terms of gender. Considering age, the following distribution was obtained: 4 respondents were under 21 years old (2%); 55 were 21-30 (27%); 46 were 31-40 (23%); 42 were 41-50 (21%); 35 were 51-60 (17%); and 20 were over 60 (10%). As such, the sample was well-balanced in terms of age, with the exception of the under 21 category, whose small number of responses could give statistically insignificant results in the analysis if considered on its own. With respect to the frequency of visit to the area, the following distribution was obtained: 25 respondents stated that it was their first visit to the area (12%); 48 said that they were infrequent visitors, i.e. less than once a month (24%); 51 visited the area at least once a month (25%); 50 visited the area at least once a week (25%); and 28 were daily visitors to the site, visiting it at least 5 times per week (14%). Consequently, a well-balanced sample was achieved.

The average score for each of the questions of the survey across the whole sample of respondents is shown in Figure 4a. As an overall conclusion about the area, the respondents rated most examined pedestrian experience aspects positively, with the exception of comfort. In particular the visual environment and the perceived safety were rated strongly positive, with the average ratings being above 1; comfort, on the other hand, scored clearly lower than the other aspects, with a rating of zero, indicating that the respondents were indifferent towards it. When looking at some of the respondents' comments, it seems that the lack of seating and the high levels of noise were the explanations behind that score.

Considering the results of the survey in conjunction with the demographics of the sample, i.e. the demographical categories' distributions of the responses to each question, interesting inferences can be drawn. Namely, it can be seen in Figure 4b that responses from males and females were similar, suggesting that gender did not affect the response to each of the questions, and that men and women perceived the public space in a similar way. On the other hand, looking at the responses of the different age groups in Figure 4c, it can be seen that ratings seem to decrease with increasing age in most questions, such that older pedestrians appeared to be more critical towards public space perception parameters. Finally, as concerns the frequency of visit, results suggest that this did not affect public space perception in general (Figure 4d). However, a notable finding is that people who visited the area at least five times per week seemed to have rated safety slightly higher than others, whilst rating ease of movement, positioning of crossings and waiting times of crossings slightly lower. This might suggest that increased familiarity with the area resulted in noticing more negative aspects.

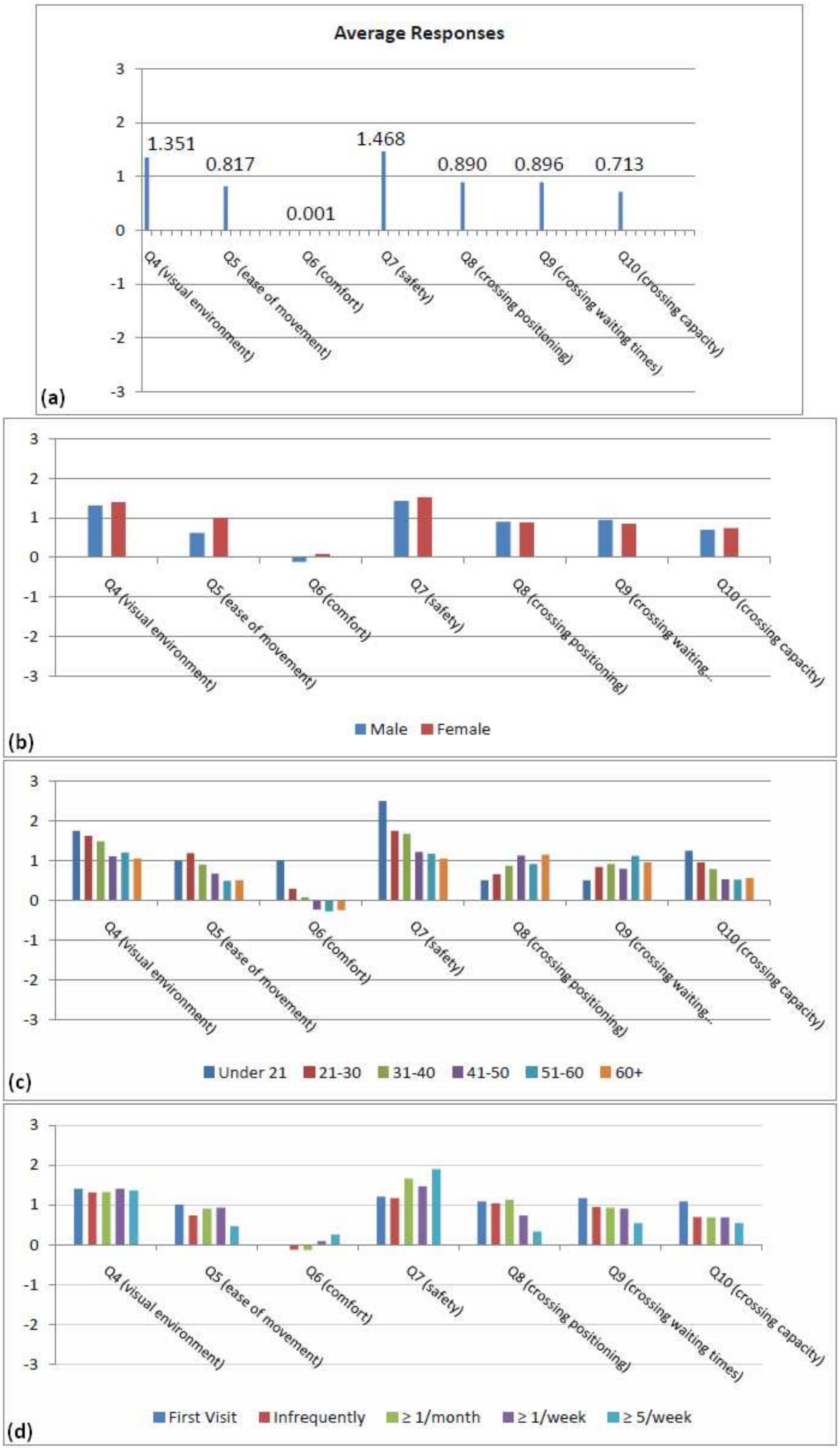



**FIGURE 4** Average response ratings to each question

The effects of the demographics on the perceptions of pedestrians, as well as the interrelationships of the parameters making up pedestrian perceptions, are investigated in more detail by means of statistical analysis in the next section.

# 4 ANALYSIS AND MODELLING

The statistical analysis of the results is carried out by fitting a series of regression models to the data, each time taking a different attribute as the dependent variable.

## 4.1 Analysis methodology

As most variables/attributes had categorical outcomes ordered from low to high (-3 to +3), ordered logistic regression is used. Ordered logit models take the form $Y^* = X \cdot \beta + \varepsilon$, where $Y^*$ is the unobserved dependent variable, X is the vector of independent variables, $\beta$ is the vector of regression coefficients to be estimated, and $\varepsilon$ is a random disturbance term following a logistic distribution. The observed ordinal variable Y is a function of $Y^*$, which has various category thresholds. For example,

$$Y_i = 1 \text{ if } Y_i^* < \mu_1$$
$$Y_i = 2 \text{ if } \mu_1 \leq Y_i^* \leq \mu_2$$
$$Y_i = 3 \text{ if } Y_i^* > \mu_3$$

The ordered logit technique uses the observations on Y to determine the parameter vector $\beta$ and the threshold values $\mu_1$, $\mu_2$, and $\mu_3$ so as to be able to subsequently estimate $Y^*$ and predict Y for specific configurations of X.

In order to ensure that enough responses have been given to each response category of each attribute so that statistically significant coefficients can be obtained, responses to the perception-related questions (4 to 10) are aggregated into three categories: "negative" (-3 to -1), "neutral" (0) and "positive" (+1 to +3). As concerns the demographic attributes, the age and frequency of visit parameters are grouped into three categories: "under 30", "31-50" and "over 51", and "rarely" (less than once a month), "intermittently" (once a month) and "regularly" (at least once a week), respectively. No further grouping has been done to the responses to the gender question, as this is binary. As such, the parameters used in the statistical analysis, with their respective categories, are:

- the seven perception-related parameters, i.e. visual environment (VisEnv), ease of moving around (MovAround), comfort (Comf), safety (Saf), crossing positioning (CrossPos), crossing waiting time (WaitTime), and crossing capacity (CrossCap), each one having three categories (1=negative, 2=neutral, 3=positive);
- and the three demographic parameters, namely respondent's age (Age, 1=under 30, 2=30-50, 3=over 50), respondent's gender (Gen, 1=male, 2=female) and frequency of visit (Freq, 1=rarely, 2=intermittently, 3=regularly).

Regression is carried out by taking each one of the seven perception-related attributes as the dependent variable and fitting a model with the remaining perception-related and the three demographic parameters as independent variables. No models are fit with the demographic attributes as dependent variables, as these may be considered constant and can thus only be analysed as causes and not as consequences.

It should be noted that while the attributes are used as ordinal variables in the left hand side of each model, it has been decided that only binary variables (zero-one) be used as independent variables in the right hand side to ensure better readability of the effects. Namely, if ordinal variables were included in the right hand side, then the effect of an independent variable on the dependent one would not only be expressed by the coefficient, but would also depend on the value of the independent variable itself (such that a value of "2" would mean that the effect would be doubled). Zero-one variables on the other hand ensure that the effect only depends on the value of the coefficient, as the effect is be zero if the variable is zero, and is equal to the coefficient is the variable is one.

In order to meet this condition, each ordinal variable is replaced by a series of binary ones in the right hand side of each model, depending on the number of categories of the corresponding attribute. Considering the fact that the number of variables coming into a model for each attribute should be n-1, where n is the number of categories of the attribute, two variables are introduced for each perception-related parameter, another two each for “Age” and for “Freq”, and another one for “Gen”. With respect to the notation, the postfixes (_2, _3) denote the cases where the respective attributes take the value indicated (e.g. the _VisEnv_2 zero-one variable denotes the VisEnv=2 category). The attributes considered and the respective variables used in the models are listed in Table 1.

**TABLE 1** Attributes and variables

| **Attribute** | **Ordinal var.** | **Categories** | **Binary independent var.** |
|---|---|---|---|
| Visual environment | VisEnv | 1=negative<br>2=neutral<br>3=positive | _VisEnv_2<br>_VisEnv_3 |
| Ease of moving around | MovAround | 1=negative<br>2=neutral<br>3=positive | _MovAround_2<br>_MovAround_3 |
| Comfort | Comf | 1=negative<br>2=neutral<br>3=positive | _Comf_2<br>_Comf_3 |
| Safety | Saf | 1=negative<br>2=neutral<br>3=positive | _Saf_2<br>_Saf_3 |
| Crossing positioning | CrossPos | 1=negative<br>2=neutral<br>3=positive | _CrossPos_2<br>_CrossPos_3 |
| Crossing waiting time | WaitTime | 1=negative<br>2=neutral<br>3=positive | _WaitTime_2<br>_WaitTime_3 |
| Crossing capacity | CrossCap | 1=negative<br>2=neutral<br>3=positive | _CrossCap_2<br>_CrossCap_3 |
| Respondent’s age | Age | 1=under 30<br>2=30-50<br>3=over 50 | _Age_2<br>_Age_3 |
| Respondent’s gender | Gen | 1=male<br>2=female | _Gen_2 |
| Frequency of visit | Freq | 1=rarely<br>2=intermittently<br>3=regularly | _Freq_2<br>_Freq_3 |

### 4.2 Modelling results

The STATA 10 statistical software package is used to perform the series of regressions and estimate the coefficients of the resulting ordered logit models. The results are shown in Table 2, where in each of the sub-tables the dependent ordinal variable is shown at the top-left cell. It should be noted that the tables of the two regressions using the VisEnv and Saf attributes as the dependent variables have not been included in Table 2, as the models did not converge. The two attributes have not been included in the other models as independent variables either, as they have either resulted in non-convergence, or in statistically insignificant models as whole. The reason behind this is that almost all respondents gave positive ratings to both visual environment and safety (hence the higher average ratings shown in

Figure 4a) regardless of their responses to the other questions, thus making an estimation of their interrelationships with the other attributes impossible. While from a purely statistical perspective this implies that visual environment and safety have no effect on the other attributes, this conclusion cannot be accepted from a logical perspective, as several interrelationships can be identified in practice (e.g. crossing capacity and safety, safety and age, visual environment and comfort, etc). The occurrence in question has thus been attributed to potential lack of clarity in the questions' formulation, or to the absence of benchmarks as to what constitutes a pleasant and safe environment, which can be established through comparison with a different site.

Looking at the other five models in Table 2, it can be seen that they are statistically significant as whole, as the null hypothesis for each model that all its coefficients are equal to zero is rejected at the 5% level in all models (Prob<chi2 smaller than 0.05). For the interpretation, the values of the coefficients (Coef. column) and their statistical significance to the 5% level through their p-values (P>|z| column) are examined.

**TABLE 2** Ordered logistic regression models

(a)

Ordered logistic regression — Number of obs = 202; LR chi2(13) = 70.14; Prob > chi2 = 0.0000; Pseudo R2 = 0.1952

Log likelihood = -144.61498

| MovAround | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _Comf_2 | 1.249796 | .4153594 | 3.01 | 0.003 | .435707 | 2.063886 |
| _Comf_3 | 2.03011 | .4639469 | 4.38 | 0.000 | 1.120791 | 2.939429 |
| _CrossPos_2 | 1.795007 | .6092461 | 2.95 | 0.003 | .6009071 | 2.989108 |
| _CrossPos_3 | 2.065914 | .5748088 | 3.59 | 0.000 | .9393097 | 3.192519 |
| _WaitTime_2 | -.4637023 | .8038814 | -0.58 | 0.564 | -2.039281 | 1.111876 |
| _WaitTime_3 | .0637535 | .7910835 | 0.08 | 0.936 | -1.486742 | 1.614249 |
| _CrossCap_2 | -.1401532 | .5212457 | -0.27 | 0.788 | -1.161776 | .8814697 |
| _CrossCap_3 | .4390324 | .5146418 | 0.85 | 0.394 | -.569647 | 1.447712 |
| _Age_2 | -1.013645 | .4731191 | -2.14 | 0.032 | -1.940941 | -.0863483 |
| _Age_3 | -1.270391 | .5493713 | -2.31 | 0.021 | -2.347139 | -.193643 |
| _Gen_2 | .4088403 | .3291786 | 1.24 | 0.214 | -.2363379 | 1.054018 |
| _Freq_2 | .4815159 | .4458645 | 1.08 | 0.280 | -.3923625 | 1.355394 |
| _Freq_3 | -.5226736 | .4202032 | -1.24 | 0.214 | -1.346257 | .3009096 |
| /cut1 | -.1268073 | .8104771 | | | -1.715313 | 1.461699 |
| /cut2 | 1.532585 | .8221726 | | | -.0788434 | 3.144014 |

(b)

Ordered logistic regression — Number of obs = 202; LR chi2(13) = 58.15; Prob > chi2 = 0.0000; Pseudo R2 = 0.1316

Log likelihood = -191.77096

| Comf | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _MovAround_2 | 1.338678 | .5628555 | 2.38 | 0.017 | .2355013 | 2.441854 |
| _MovAround_3 | 2.284736 | .5344686 | 4.27 | 0.000 | 1.237197 | 3.332275 |
| _CrossPos_2 | .1107058 | .577844 | 0.19 | 0.848 | -1.021848 | 1.243259 |
| _CrossPos_3 | .0031667 | .5391777 | 0.01 | 0.995 | -1.053602 | 1.059936 |
| _WaitTime_2 | -.4521513 | .7937637 | -0.57 | 0.569 | -2.0079 | 1.103597 |
| _WaitTime_3 | -.1338138 | .7836143 | -0.17 | 0.864 | -1.66967 | 1.402042 |
| _CrossCap_2 | .7374347 | .5303857 | 1.39 | 0.164 | -.3021022 | 1.776972 |
| _CrossCap_3 | 1.157451 | .4858179 | 2.38 | 0.017 | .2052652 | 2.109636 |
| _Age_2 | -.579616 | .3491055 | -1.66 | 0.097 | -1.26385 | .1046181 |
| _Age_3 | -.6192661 | .4184308 | -1.48 | 0.139 | -1.439375 | .2008432 |
| _Gen_2 | .3131166 | .2833993 | 1.10 | 0.269 | -.2423357 | .8685689 |
| _Freq_2 | -.3101735 | .3707309 | -0.84 | 0.403 | -1.036793 | .4164458 |
| _Freq_3 | .4552166 | .3502757 | 1.30 | 0.194 | -.2313111 | 1.141744 |
| /cut1 | 1.715227 | .9096525 | | | -.0676593 | 3.498113 |
| /cut2 | 3.23071 | .9301734 | | | 1.407603 | 5.053816 |

**TABLE 2** (continued)

(c)

Ordered logistic regression

| | |
|---|---|
| Number of obs | 202 |
| LR chi2(13) | 41.32 |
| Prob > chi2 | 0.0001 |
| Pseudo R2 | 0.1276 |

Log likelihood = -141.24843

| CrossPos | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _MovAround_2 | .0690453 | .5223259 | 0.13 | 0.895 | -.9546947 | 1.092785 |
| _MovAround_3 | 1.187012 | .5198409 | 2.28 | 0.022 | .1681427 | 2.205882 |
| _Comf_2 | -.4973046 | .425519 | -1.17 | 0.243 | -1.331307 | .3366973 |
| _Comf_3 | .0286856 | .4671069 | 0.06 | 0.951 | -.8868271 | .9441983 |
| _WaitTime_2 | 1.575098 | .7554797 | 2.08 | 0.037 | .0943854 | 3.055811 |
| _WaitTime_3 | 2.108894 | .7431241 | 2.84 | 0.005 | .6523974 | 3.56539 |
| _CrossCap_2 | .2004185 | .5579143 | 0.36 | 0.719 | -.8930734 | 1.29391 |
| _CrossCap_3 | -.1375428 | .5342588 | -0.26 | 0.797 | -1.184671 | .9095851 |
| _Age_2 | .7152615 | .4002679 | 1.79 | 0.074 | -.0692492 | 1.499772 |
| _Age_3 | .444675 | .4978483 | 0.89 | 0.372 | -.5310897 | 1.42044 |
| _Gen_2 | -.080589 | .338662 | -0.24 | 0.812 | -.7443543 | .5831762 |
| _Freq_2 | -.0896156 | .4653678 | -0.19 | 0.847 | -1.00172 | .8224886 |
| _Freq_3 | -1.07301 | .4072423 | -2.63 | 0.008 | -1.87119 | -.2748296 |
| /cut1 | -.319948 | .7919441 | | | -1.87213 | 1.232234 |
| /cut2 | 1.506265 | .8077501 | | | -.0768956 | 3.089427 |

(d)

Ordered logistic regression

| | |
|---|---|
| Number of obs | 202 |
| LR chi2(13) | 52.74 |
| Prob > chi2 | 0.0000 |
| Pseudo R2 | 0.1686 |

Log likelihood = -130.08093

| WaitTime | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _MovAround_2 | -.0431655 | .5349036 | -0.08 | 0.936 | -1.091557 | 1.005226 |
| _MovAround_3 | .4344871 | .537156 | 0.81 | 0.419 | -.6183193 | 1.487294 |
| _Comf_2 | .456753 | .4485614 | 1.02 | 0.309 | -.4224111 | 1.335917 |
| _Comf_3 | .1335155 | .4470725 | 0.30 | 0.765 | -.7427306 | 1.009761 |
| _CrossPos_2 | .5080314 | .6296382 | 0.81 | 0.420 | -.7260368 | 1.7421 |
| _CrossPos_3 | 1.33566 | .5987142 | 2.23 | 0.026 | .1622018 | 2.509118 |
| _CrossCap_2 | .1729429 | .4814151 | 0.36 | 0.719 | -.7706134 | 1.116499 |
| _CrossCap_3 | 1.998022 | .4864742 | 4.11 | 0.000 | 1.04455 | 2.951494 |
| _Age_2 | .3880264 | .4234662 | 0.92 | 0.360 | -.4419522 | 1.218005 |
| _Age_3 | 1.34842 | .5272417 | 2.56 | 0.011 | .3150455 | 2.381795 |
| _Gen_2 | -.3013085 | .3441275 | -0.88 | 0.381 | -.975786 | .3731691 |
| _Freq_2 | -.258104 | .4239173 | -0.61 | 0.543 | -1.088967 | .5727586 |
| _Freq_3 | .2362618 | .4328494 | 0.55 | 0.585 | -.6121075 | 1.084631 |
| /cut1 | -.3757227 | .7801506 | | | -1.90479 | 1.153344 |
| /cut2 | 2.248294 | .8072543 | | | .6661049 | 3.830484 |

(e)

Ordered logistic regression

| | |
|---|---|
| Number of obs | 202 |
| LR chi2(13) | 62.04 |
| Prob > chi2 | 0.0000 |
| Pseudo R2 | 0.1674 |

Log likelihood = -154.24334

| CrossCap | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| _MovAround_2 | .3051491 | .4901582 | 0.62 | 0.534 | -.6555433 | 1.265842 |
| _MovAround_3 | .6235698 | .5004164 | 1.25 | 0.213 | -.3572283 | 1.604368 |
| _Comf_2 | .7990072 | .4148936 | 1.93 | 0.054 | -.0141693 | 1.612184 |
| _Comf_3 | .9886653 | .4403051 | 2.25 | 0.025 | .1256832 | 1.851647 |
| _CrossPos_2 | .2361271 | .654404 | 0.36 | 0.718 | -1.046481 | 1.518735 |
| _CrossPos_3 | -.0631554 | .6099978 | -0.10 | 0.918 | -1.258729 | 1.132418 |
| _WaitTime_2 | 2.340458 | .7571467 | 3.09 | 0.002 | .8564781 | 3.824438 |
| _WaitTime_3 | 3.399866 | .7450346 | 4.56 | 0.000 | 1.939625 | 4.860107 |
| _Age_2 | -.5829074 | .4438523 | -1.31 | 0.189 | -1.452842 | .2870271 |
| _Age_3 | -1.340833 | .5024737 | -2.67 | 0.008 | -2.325663 | -.3560025 |
| _Gen_2 | .1118427 | .3249769 | 0.34 | 0.731 | -.5251003 | .7487857 |
| _Freq_2 | -.2523768 | .4118915 | -0.61 | 0.540 | -1.059669 | .5549156 |
| _Freq_3 | -.6968797 | .4055348 | -1.72 | 0.086 | -1.491713 | .097954 |
| /cut1 | .7740028 | .8600934 | | | -.9117492 | 2.459755 |
| /cut2 | 2.466093 | .8831564 | | | .7351382 | 4.197048 |

Table 2a shows the resulting model with the ease of moving around attribute (MoveAround) as the dependent variable. As can be seen, the coefficients of the variables _Comf_2, _Comf_3, _CrossPos_2, _CrossPos_3, _Age_2 and _Age_3 are found to be statistically significant (<0.05) and are all positive. With respect to the first four, this implies that the attributes of comfort and positioning of crossings have positive effects on the ease of moving around the area, such that pedestrians who rate the comfort and the positioning of crossings in a street space positively are also likely to find it easy to move around. It is additionally noteworthy that the effects increase with higher ratings of both attributes, and that while the effect of the crossings positioning is higher than that of the comfort in neutral ratings, it is roughly equal in the case where both attributes are rated positively. On the other hand, the negative coefficients of _Age_2 and _Age_3 indicate an inverse relationship between age and the ease of moving around. In fact, it seems that the ease of moving around is likely to be looked at less favourably by older people, as already suggested by the histogram of Figure 4c.

Considering the model with the comfort attribute (Comf) as the dependent variable (Table 2b), the variables _MoveAround_2, _MoveAround_3 and _CrossCap_3 have statistically significant coefficients. In the case of the former two (MoveAround), the finding of the first model can be identified as a two-way effect, as it appears that the ease of moving around has an effect on the pedestrian comfort, with positive coefficients increasing with higher ratings. As concerns the other attributes, the positive coefficient of _CrossCap_3 indicates that highly-rated crossing capacity is likely to also lead to a positive perception of comfort.

Taking the positioning of crossings (CrossPos) as the dependent variable (Table 2c), the variables _MoveAround_3, _WaitTime_2, _WaitTime_3 and _Freq_3 have statistically significant coefficients. The positive coefficient of the first variable demonstrates that the positively rated ease of moving around the space is likely to positively affect the rating of the crossings' positioning. The positive coefficients of the next two variables indicate that the waiting time has a similar effect, which in fact becomes stronger with increased positive perception of waiting time (the coefficient of _WaitTime_3 is higher than _WaitTime_2). As such, it appears that pedestrians who find it easy to move to the crossings and do not find that they are waiting too long to cross are also likely to be happy with the positioning of the crossings. On the other hand, the negative coefficient of _Freq_3 suggests that the positioning of the crossings is looked at more critically by regular visitors to the area.

The interrelationship between the positioning of the crossings and the perceived waiting time is further found to be two-way in the model where waiting time (WaitTime) is the dependent variable (Table 2d), as _CrossPos_3 has a positive statistically significant coefficient. Additional effects on the waiting times that can be identified are that of the crossing capacity, given the positive significant coefficient of _CrossCap_3, and that of the older age, given the also positive coefficient of _Age_3. These indicate that pedestrians may perceive waiting at crossings more favourably if crossings appear well-positioned and of sufficient capacity, or if the pedestrians are over 50 years old.

Lastly, interesting conclusions can be drawn from the last model, where the crossing capacity (CrossCap) is the dependent variable (Table 2e), and where the variables _Comf_3, _WaitTime_2, _WaitTime_3 and _Age_3 have statistically significant coefficients. The positive coefficient of _Comf_3 implies that pedestrians who rate comfort positively are likely to look more favourably on crossing capacity, indicating that the interrelationship between the two parameters is two-way. The positive coefficients of the WaitTime variables, in conjunction with the model of Table 2d, show that the interrelationship of the waiting time at crossings and of the perceived capacity of the crossings is also two-way, with higher ratings of the former having a higher effect of the latter. On the other hand, the negative coefficient of _Age_3 suggests that older pedestrians (over 50) perceive the capacity of the crossings less favourably.

In summary, the models suggest that there is interdependence between many of the parameters constituting the pedestrians' perception of public spaces. The different relationships are summarised in Table 3, where the nature of each dependence (positive, negative or none) and its magnitude are indicated.

**TABLE 3** Interdependence of pedestrian perception parameters

| | | Dependent variable | | | | |
|---|---|---|---|---|---|---|
| | | **Ease of movement** | **Comfort** | **Crossing positioning** | **Crossing waiting time** | **Crossing capacity** |
| **Independent variable** | **Ease of movement** | | + + | + | · | · |
| | **Comfort** | + + | | · | · | + |
| | **Crossing positioning** | + + | · | | + | · |
| | **Crossing waiting time** | · | · | + + | | + + + |
| | **Crossing capacity** | · | + | · | + | |
| | **Age** | – | · | · | + | – |
| | **Gender** | · | · | · | · | · |
| | **Frequency of visit** | · | · | – | · | · |

## 5 CONCLUSIONS

In light of the shift in focus in urban street design, this paper examined the topic of the evaluation of the pedestrian experience in public spaces and presented a new method based on a questionnaire for use in on-street surveys, building on comprehensive pedestrian evaluation systems. Collecting data from respondents in London's South Kensington area, which has recently undergone major redevelopment to a more pedestrian-oriented street design, the study found that the new design generally attracted positive comments, but that there is room for improvement in terms of the pedestrian comfort. Then, the study went on to conduct statistical analysis to the data to investigate the interrelationships between the several aspects constituting the pedestrian experience. By performing a series of ordered logistic regressions, it was found that there are strong positive dependences between comfort and ease of movement, between the perceived positioning of the crossings and the ease of movement, and between the perceived waiting time and the capacity of the crossings. Dependences were also identified between the pedestrian's age and the ease of movement and perceived crossing capacities, and between the frequency of visit to an area and the perceived crossing positioning.

The results highlight the need for putting special attention into the different aspects of public space at the design stage, since the way in which pedestrians perceive a particular aspect may be influenced by altering other aspects rather than just the one in question. For example, if designers were interested in improving the waiting times of crossings, they may want to consider improving the capacity of the crossings instead, since this is likely to improve the perception of the waiting times by pedestrians without the need of modifying the signal programmes.

While the study has thrown some light into the topic of assessing the pedestrian experience, research in this direction continues. Further work will primarily concentrate on collecting data from more sites in order to investigate the effects of the visual environment and safety parameters, but also to observe the performance of the new questionnaire in a more generic context. Additionally, through comparative work with comprehensive pedestrian audit systems, such as PEDS and PERS, predictive models will be derived which will allow for more detailed assessment of the pedestrian experience in situations with limited data availability. Finally, the relationship of the pedestrian experience with the behaviour of other road users, such as vehicle drivers and cyclists, will be investigated.

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