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Workpackage Leader: I.N.L.G. van Schagen

Pedestrian and Pedal Cyclist Route Choice Criteria

P.K. Westerdijk

DRIVE Project V1031

An Intelligent Traffic System for Vulnerable Road Users

PEDESTRIAN AND PEDAL CYCLIST ROUTE CHOICE CRITERIA

P.K. Westerdijk

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Workpackage 1

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Schagen, I.N.L.G. van, Rothengatter, J.A. (1989) Problems for vulnerable road users in the Netherlands. Final report for workpackage 1 of DRIVE project V1031: An intelligent traffic system for vulnerable road users. WP 300, Institute for Transport Studies, University of Leeds.

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Workpackage 2

Tight, M.R., Carsten, O.M.J. (1989) Problems for vulnerable road users in Great Britain, The Netherlands and Sweden. Final report for workpackage 2 of DRIVE project V1031: An intelligent traffic system for vulnerable road users. WP 291, Institute for Transport Studies, University of Leeds.

Workpackage 3

Hopkinson, P.G., Carsten, O.M.J., Tight, M.R. (1989) Review of literature on pedestrian and cyclist route choice criteria. Final report for workpackage 3 of DRIVE project V1031: An intelligent traffic system for vulnerable road users. WP 290, Institute for Transport Studies, University of Leeds.

SUMMARY

A Multi Attribute Utility Model was used to reveal more information on pedestrian and pedal cyclist route choice behaviour. The main objective for this experiment was to ascertain the relative importance of and the interrelation between several attributes that were mentioned as important route choice criteria. Another objective was to reveal the difference between three countries, Great Britain, Sweden and the Netherlands. Other objectives were to reveal the differences between men and women and between younger and older vulnerable road users.

Subjects were asked to select four routes from a map, for a frequently made trip. Subjects were familiar with the routes and were able to assign preferences to the routes. Preferences were assigned to the routes (global preference) and to each route for just a single attribute. The weight elicitation technique used was a modified indifference method.

The differences in importance of the attributes between the countries were small. Attributes that get high weights are thought to be important attributes in the route choice behaviour of a subject. Important attributes were rated high in all the countries and unimportant attributes were always rated low. Differences for gender and age were found to be marginal.

Distance and pleasantness were found to be important attributes for pedestrians. These attributes are also the minimal set that produce high correlation coefficients between the aggregated values for the routes and the global preferences. For pedal cyclists the attributes that formed the minimal set and the attributes that are rated important are distance, pleasantness and traffic safety. This minimal set correlated with the global preference at .70 for pedestrians and .71 for pedal cyclists. Distance as a single attribute could not produce these correlation coefficients.

The attribute weights are related to ranges in the objective world. This means that other attributes can be rescaled to distance. This revealed that for pedestrians on average a distance of more than 160 meters can be played off against one point on a pleasantness scale (a 7-point scale). For pedal cyclists on average a distance of 200 meters can be played off against one point on the pleasantness scale or a distance of 250 meters can be played off against one point on a scale for traffic safety.

An important conclusion from the experiment is the fact that pleasantness can be played off against distance. Subjects are prepared to walk or cycle further to have a more pleasant route. This means that the use of safer routes can be encouraged, even if they are longer, by making the safer routes more pleasant.

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1 INTRODUCTION

This project is intended to increase the mobility and to decrease the unsafety of vulnerable road users. Vulnerable road users are pedestrians and pedal cyclists. Previous reports have examined the existing safety and mobility problems of vulnerable road users in three countries, Great Britain, Sweden and the Netherlands (Tight, Carsten and Sherborne, 1989; Ekman and Draskòczy, 1989; Van Schagen and Rothengatter, 1989; Tight and Carsten, 1989). Although there is a lot of information on safety problems for vulnerable road users in the three countries, there is very little information on mobility problems. One of the aims of the project is to designate a model of traffic flows in which vulnerable road users are treated as an integral part of the traffic system.

A number of models that simulate traffic are known nowadays. These models are able to calculate motorized traffic flows. The output of these models is the number of cars that use certain parts of a network, the congestion at junctions and delays for vehicles. A good traffic model can help town planning engineers predict the consequences of certain changes in the network. A disadvantage of all existing models is that they are designated to simulate motorized traffic only. In most of the existing models vulnerable road users are not incorporated or vulnerable road users are only incorporated in respect of the delay they cause to vehicles.

It is intended to produce a model of urban traffic that incorporates the mobility problems, needs and desires of pedestrians and pedal cyclists. This model should be able to predict traffic flows and the use of possible routes by all kinds of road users. The model should also be able to predict the reactions of road users to intended changes in the network. In order to model the travel behaviour of vulnerable road users, it is necessary to know what their desired routes are. In order to know which routes are the desired routes, it is necessary to have a behavioural model of the route choice of vulnerable road users. For a behavioural model it is necessary to know the criteria that are used by vulnerable road users in the selection of routes. When the criteria that are used by vulnerable road users are known this also has implications for quite a lot of safety engineering. By making a safe route more preferable, its use would be encouraged.

The literature review in Workpackage 3 of this project (Hopkinson, Carsten and Tight, 1989) revealed the existing body of knowledge on vulnerable road user route choice criteria. A number of important shortcomings in most of the existing work on route choice criteria were revealed. A number of attributes that could be of importance in the route choice behaviour were mentioned:

–Distance
–Time
–Effort
–Number of road crossings (for pedestrians)
–Number of junctions (for pedal cyclists)
–Number of traffic lights

–Pleasantness
–Attractions
–Traffic safety
–Personal safety
–Quality of the road surface/pavement
–Protection from the weather
–Crowdedness
–Gradient

Some of these attributes seem to be more important then others. Distance/time/effort for example have been shown to be very important attributes. The given attributes however only form a list of important attributes, no relations are given. What is missing in all the existing literature is the overall framework. For the attributes no references are given for differences between several groups of road users. It is not possible to cover route choice behaviour of various kinds of pedestrians and pedal cyclists undertaking various kinds of trips in various conditions, on the basis of the existing literature. The exact interrelationships between all the attributes have not been explored either.

In this experiment on pedestrian and pedal cyclist route choice criteria an overall framework for the attributes will be given. This framework will be based on Multi Attribute Utility Theory (MAUT). The interrelationship between the attributes will be investigated and differences between countries, age groups and sexes will be examined. It will be investigated which attributes are important in pedestrian and pedal cyclist route choice behaviour and which attributes are less important. When more than one attribute is important in pedestrian and pedal cyclist route choice behaviour, it will also be investigated in which way these attributes can be played off against each other. This should all be known to make a traffic model and to encourage more pedestrians and pedal cyclists to use safer routes.

This report is intended to provide information on pedestrian and pedal cyclist route choice criteria. In section 2 of this report the basis for the overall framework will be identified. The process of route choice as a decision problem will be explained and the usability of MAUT will be discussed. Section 3 describes the method that is used in the experiment on route choice criteria. The results of the experiment are shown in section 4. Finally section 5 provides some conclusions and recommendations for modelling pedestrian and pedal cyclist route choice behaviour.

3 ROUTE CHOICE AND DECISION ANALYSIS

If we want to get a better insight into the route choice behaviour of pedestrians and pedal cyclists, we need to find out what road users know about the possible alternatives, which route characteristics (attributes) are important in their route choice behaviour and which characteristics are taken into consideration by road users. When we know these characteristics we have to know how road users weight them to choose one of the possible alternative routes. It is assumed that route choice is determined by a number of attributes of routes and that the routes that are chosen by road users are the results of a decision problem that the road users have to solve. The road users have to decide how they travel from their origin to their destination.

Normally every road user can choose one of a great number of possible routes. Not all of these routes are equally good. Some of the routes can be rejected because one or more attributes do not satisfy the needs of the road users at first sight. If one or more attributes does not satisfy the needs of the road user at first sight, these routes are rejected immediately. Other routes can be rejected at first sight because certain attributes are clearly inferior to the same attributes on other possible routes (Elimination By Aspects).

When a small number of routes (2–5) remain as possible alternatives, these remaining routes are evaluated carefully. The process that is assumed for this evaluation is a process of compensation. Attributes of a route that have low levels can be compensated for by attributes of the same route that have high(er) levels. An appropriate methodology for estimation of the importance of multiple attributes is MAUT (Multi Attribute Utility Theory). The assessment of alternatives, in this case routes, is simplified by expressing the overall value of an alternative as a decomposed function of the separate outcome attributes (Fischer, 1979).

In MAUT the scores of alternatives are divided into the separate scores for the different attributes. When the attributes are not equally important, the attributes can get different weighting factors. The weighting factors are assumed to express the importance of the attributes. These separate scores for the different attributes are summed later on to get an overall value for the alternative. It is assumed that the alternative with the highest summed value is the most preferred alternative. This alternative has the highest subjective utility to the decision-maker. When a decision problem is composed of multiple attributes, the decision-maker is easily overloaded by the amount of information to process. Due to cognitive limitations most decision-makers will not be able to handle alternatives with too many (important) attributes. A separation of attributes is performed to simplify the decision process. The amount of information that has to be processed by the decision-maker is now relatively low. The decision-maker now has to construct evaluations for single attributes. Trade-offs among attributes are quantified as importance weights.

Two groups of MAUT procedures can be distinguished, numerical rating techniques and indifference techniques. Numerical rating techniques give an indication of the importance of the attributes. These techniques are easy to handle for subjects but the theoretical basis is weak. In indifference techniques it is assumed that weights are rescaling parameters that are necessary to match the units of one attribute with the units of another attribute. The theoretical basis for indifference techniques is good but the technique can be difficult for subjects.

With the aid of a computer program that is based on MAUT, the relative importance of attributes has been determined. Existing MAU techniques were used as the basis of the development of a computer program, specifically directed at the reasons for route preferences. This program was developed by Van Winsum (1990).

5 METHOD

6.1 SUBJECTS

Subjects were asked to volunteer for the experiment using announcements in local newspapers and posters in public buildings. In Sweden the subjects were chosen from a subject database. The subjects were invited to the institute (Great Britain and the Netherlands), visited at an old people's centre (Great Britain) or visited at home (Sweden). The total number of subjects that volunteered is 284 (50 subjects in Great Britain, 121 in Sweden and 113 in the Netherlands). In Great Britain there were only pedestrians, in Sweden and the Netherlands there were pedestrians and pedal cyclists. About half of the subjects were male. Subjects were distributed into three age categories (20–39 years old, 40–59 years and 60 years and older). The exact distribution per country, travel mode, sex and age group is given in Tables 1 to 5.

Table 1: The distribution of pedestrians in Great Britain (N=50)

	20–39	40–59	60+
Male	7	7	9
Female	7	10	10

Table 2: The distribution of pedestrians in Sweden (N=61)

	20–39	40–59	60+
Male	10	10	10
Female	10	10	11

Table 3: The distribution of pedestrians in the Netherlands (N=53)

	20–39	40–59	60+
Male	10	5	10
Female	10	7	11

Table 4: The distribution of pedal cyclists in Sweden (N=60)

	20–39	40–59	60+
Male	9	11	10

Female	11	9	10

Table 5: The distribution of pedal cyclists in the Netherlands (N=60)

	20–39	40–59	60+
Male	10	10	10
Female	10	9	11

In Great Britain the subjects did the experiment twice: once for a good weather condition and once for a bad weather condition. The ordering of the weather conditions was alternated.

The distribution for trip motive is given in Table 6, where a distinction is made between trips for school/work and social/recreational trips.

Table 6: Subjects by trip motive and country (percentages)

	school/work	social/recreational
Pedestrians		
Great Britain	28%	72%
Sweden	29%	71%
The Netherlands	11%	89%
Pedal Cyclist		
Sweden	48%	52%
The Netherlands	41%	59%

In all countries the percentage of subjects that have work or school as a trip motive is low for pedestrians. For pedal cyclists the percentages of subjects that have school/work as a trip motive is about equal to the percentages in the group that has a trip motive that is social or recreational.

6.3 ALTERNATIVES

The set of alternatives that was used in this study consisted of four routes. These routes had to be clear to the subjects and had to be presented in such a way in that comparisons between the routes could be made. Subjects had to be familiar enough with the routes to be able to make valid assessments of the values of each alternative on a value attribute scale. When subjects generated their own choice set, consisting of routes they were familiar with, these requirements were satisfied.

6.5 ATTRIBUTES

The set of attributes was derived from the review of literature on pedestrian and pedal cyclist route choice criteria (Hopkinson, Carsten and Tight, 1989). The decision model used here requires the attributes to be independent. The additive aggregation rule to aggregate utility values for the routes only applies when the separate values for the attributes are totally independent. The set of attributes that is derived from the literature review was not completely independent. The set of attributes was restructured in such a way that Additive Difference Independence was maintained, so the model can be structured in a simple way (Von Winterfeldt and Edwards, 1986). The value of one attribute does not change as a consequence of a change in value of another attribute. This is necessary to elicit reliable weights and to prevent implicit weighting in the value measurement phase.

The new set of attributes for pedestrians consisted of eight attributes. The exact definitions of the attributes are given in Appendix A. The attributes were:

–Distance
–Number of crossings with special pedestrian lights
–Number of crossings without special pedestrian lights
–Pleasantness
–Attractions
–Quality of the pavement
–Traffic safety
–Gradient

For pedal cyclists the set of attributes was almost the same as it is for pedestrians.

–Distance
–Number of junctions with traffic lights
–Number of junctions without traffic lights
–Pleasantness
–Attractions
–Quality of the road surface
–Traffic safety
–Gradient

Time and effort were left out of the set because it was assumed that they are implicitly present in distance, number of crossings/junctions and gradient. Time is related to distance plus some extra time due to waiting times for crossings/junctions. The attributes used in the experiment should be as independent as possible. In the Netherlands the attribute gradient was left out of the set since almost no places with a slope in the road can be found there. Personal safety and protection from the weather were left out of the set because these are attributes that do not always apply for a route. Personal safety is partly dependent on time of the day. When the weather is nice the attribute protection from the weather would be irrelevant. Although protection from the weather was left out of the attribute set, it was studied in the experiment in Great Britain. In Great Britain the subjects did the experiment twice. In one of the sessions they were asked to think up routes for a trip in good weather conditions. In the other session the subjects were asked to think up routes for a trip in bad weather conditions. In most cases the origin and destination were the same for both weather conditions, but the routes could have been different. The ordering of the sessions was varied.

6.7 THE CRITERION VARIABLE

The global preference is used as a criterion variable. This global preference should be explained by the decision process and so it is a good variable to evaluate the correctness of the estimated weights. The global preference as used in this experiment is the same as the holistic preference assessment in numerous other studies. This holistic preference assessment can be used as a criterion for the correctness of the linear model (convergent validity) (Fischer, 1979). The global preference was represented on a bar ranging from 0 (worst) to 100 (best). A subject was asked to select the best route first. This best route was set at value 100. Then the subject was asked to select the worst route. This route was set at value 0. The remaining routes were placed in between the best and the worst route. The relative distance between two alternatives on the bar, reflects the magnitude of preference of one alternative to another alternative. All alternatives were scored from 0 to 100, according to the preferences of a subject.

6.9 RATING METHOD FOR THE ALTERNATIVES PER ATTRIBUTE

Direct rating was used to measure the values for the alternatives per attribute. This is the most widely used numerical estimation technique. For every attribute the routes were set on a bar ranging from 0 to 100. First the route that was best on a certain attribute was selected. This best route was set at the value 100 at the bar. Second the route that was worst on the same attribute was selected and set at the other extreme "0" of the bar. The remaining routes were rated in between these two extremes. This rating of the alternatives per attribute was done for every attribute. The rating of the alternatives per attribute was done irrespective of ratings of alternatives for the other attributes. For every attribute, all alternatives were scored again from 0 to 100, according to the preferences of a subject.

6.11 ESTIMATION OF WEIGHTS

The procedure used for the estimation of weights was a modified indifference technique. This procedure was developed to make the indifference estimation as easy as possible. Subjects had to indicate how much the global preference of a route would increase if one attribute of that route improved to a higher level. On the screen two bars were drawn. The upper bar represented the global preference a subject had given before, the lower bar represented the values of a specific attribute. The subject was then asked how much a route improved when that specific attribute improved to the best level of that attribute. The improvement in global preference could be entered by means of the arrow keys on the keyboard. The improvement was represented on the screen by an arrow on the upper bar (the global preference bar). The routes were scaled on the screen in such a way that the target route on the upper bar was directly above the same target route on the lower bar. For every route that did not have the best level for a single attribute this question was put again. In principle this question was put three times for every attributes (with four routes there can be three routes that are not the best on a certain attribute). So, for the estimation of the weights, a subject had to indicate several times what the score for an alternative became, when a certain improvement was given for this alternative.

It is assumed that the weights represent the importance of the attributes. When an attribute receives a (relative) high weight this means that a subject rates this attribute as an important factor in his route choice. Two methods that produce weight factors, relative weights and beta weights were used in this experiment.

6.13 RELATIVE WEIGHTS

The attribute weights are determined by dividing the increase in global preference by the increase that was awarded to an attribute. The weights of all attributes are now expressed in the same units, the units of global preference. Because of this expression of weights in equal units, the weights are now comparable to each other. The attribute weights are normalized by dividing each weight by the sum of all the weights. These weights now have a rank ordering and a magnitude relative to each other. From now on these weights will be named relative weights.

6.15 BETA WEIGHTS

As has been stated before, there are in principle three measurements for every attribute to reduce measurement errors. This also gives the opportunity to get enough data points for a multiple regression analysis for every individual. The number of cases for a regression analysis on the indifference measurement is, in principle, (the number of attributes) * (the number of alternatives – 1). In this experiment this means 24 data points (for the Netherlands 21 because the attribute gradient was left out). The independent variables for a regression analysis are the values of the attributes on a route. The attribute with the highest level for that route has the value 100. The dependent variable is the global preference of a route if the proposed improvement of an attribute would be incorporated in the value of the route. The values of the dependent variable are the scores at which alternatives are set by the subject in the second part of the experiment. These are the scores the routes would receive if the proposed improvements would really be part of the routes.

The multiple regression analysis was done for every subject. This multiple regression analysis was based on the judgements of the subjects in the modified indifference procedure. The beta weights that are produced by the multiple regression analysis are transformed by dividing each weight by the sum of all beta weights. If a beta weight is negative, all weights are summed with the absolute value of the smallest weight and then transformed to sum to one.

6.17 PROCEDURE

The subjects were briefly told the purpose of the experiment. The experiment took place in the following sequence.

1) At the desk in front of the subject there was a large map of the city with all streets and street names. Subjects were asked to give the origin and the destination of a regularly made trip. This trip should be within the range of the map. The trip should be chosen so that it was long enough to make a variety of different routes possible. Now the subject was asked to give a frequently used route. This route was drawn by the experimenter or by the subject on a small map. After this the subject was asked to give another route and this new route was drawn on the small map in a different colour. Up to four routes were given by a subject. Not all routes were used equally frequent. Each route had its own colour and in the remainder of the experiment the routes were identified by their colour.

After this the computer session started. The subject and the experimenter were seated in front of a personal computer. The experimenter had control over the keyboard. The names of the routes (colours) and the attributes were read into the program from a file.

2) The subjects were asked to determine their global preferences on the routes: the best route, the worst route and the other routes in between.

3) The subjects were shown the list of attributes and received a description of the attributes. This was done to make sure that all subjects had the same understanding of the attributes. They determined the values of each route on every attribute.

4) The subjects determined the weights of the attributes by means of the indifference method.

5) The subjects were shown their global preference and they were asked if they wanted to change this global preference at the end of the session.

The computer session ended and all data plus the data for the regression analysis was written to file.

6) Subjects filled in a questionnaire on personal characteristics, general trip characteristics and objective characteristics for all attributes in relation to the given routes. In Sweden the subjects filled in a computer version of the questionnaire. For every attribute subjects had to fill in the objective values for the route that was worst on that attribute and the objective value for the route that was best on that attribute (Appendix B). Attributes were expressed as follows:

–Distance was estimated in kilometres/miles.

–For (special pedestrian) traffic lights respondents were asked to estimate the number.

–For crossings/junctions respondents were asked to estimate the number.

–Pleasantness was expressed on a 7-point scale ranging from very unpleasant to very pleasant.

–Attractions was expressed on a 7-point scale ranging from very few to very many.

–Quality of the road/pavement was expressed on a 7-point scale ranging from very poor to very good.

–Traffic safety was expressed on a 7-point scale ranging from very unsafe to very safe.

–Gradient was expressed on a 7-point scale ranging from very pleasant to very unpleasant.

Total session time ranged from 30 to 60 minutes. The subjects received a payment for participating in the experiment.

7 RESULTS

8.1 FAMILIARITY WITH THE AREA

The subjects were generally familiar with the area in which the routes were situated. On average they scored 6.2 on a 7-point scale in which 1 means very unfamiliar and 7 means very familiar. This is important because the subjects have to give estimations of values of routes in the area. When subjects are not familiar with an area it is difficult to assess routes in the area. The mean scores per country and the percentages of responses for the response categories are given in Tables 7 and 8.

Table 7: Mean score for familiarity with the area

Great Britain	6.4
Sweden	6.2
The Netherlands	5.9

Table 8:Percentages of responses for the familiarity with the roads in the area, on a 7-point scale (1=very unfamiliar, 7=very familiar)

scale point	1	2	3	4	5	6	7
pedestrians	-	1	3	5	13	19	59
pedal cyclists	-	1	1	14	10	21	53

In all three countries the subject were familiar with the network in which the trips were made. Most of the subjects claimed to be very familiar with the area. On average the trips that were used in the experiment were made by the subjects 3.1 times a week. Pedestrians made the trips on average 3.0 times a week and pedal cyclists made their trip on average 3.4 times a week. From this it can be concluded that subjects were able to give valid estimations of the attributes for the routes.

8.3 THE NUMBER OF ATTRIBUTES

When the subjects were not able to indicate any difference between routes for an attribute, this attribute was left out of the analysis. In those cases the subjects were not able to indicate which route was best on an attribute and which route was worst on an attribute because there were no differences in that set of (alternative) routes. The number of attributes that was left out during a session was not the same in all countries and not the same for all attributes. In Tables 9a and 9b the number of times an attribute was left out of the experiment is given by country and by type of road user.

Table 9a:The number of times an attribute was left out of an experimental session by country and by attribute (pedestrians)

	GB (N=100)	S (N=61)	NL (N=60)
Distance	24	2	0
Crossing with lights	48	18	6
Crossings without lights	58	15	0
Pleasantness	34	1	0
Attractions	25	7	0
Quality of the road surface	37	29	2
Traffic safety	24	5	0
Gradient	46	34	–

Table 9b:The number of times an attribute was left out of an experimental session by country and by attribute (pedal cyclists)

	S (N=60)	NL (N=60)	
Distance	4	1	
Junctions with lights	5		0
Junctions without lights	15		0
Pleasantness	5		0
Attractions	13		0
Quality of the road surface	23		1
Traffic safety	1		0
Gradient	20	–	

As can be seen very few attributes were left out of the experiment in the Netherlands. In the Netherlands the subjects only deleted attributes when there was no difference between all the routes on this attribute. In Sweden and Great Britain, attributes were sometimes left out of the experiment when the subjects thought differences between the routes on this attribute to be unimportant.

Subjects also had the opportunity to add attributes. If the subjects were convinced that an important attribute was left out of the list, this attribute could be added. The experimenter first tried to incorporate the characteristics of the new attribute into one or more of the existing attributes. Only a small number of subjects wanted to incorporate one or more attributes. These extra attributes were too few to do a proper analysis.

8.5 GLOBAL PREFERENCES AND THE AGGREGATED VALUES

In the experiment the subjects had the opportunity to give a global preference once again at the end of the experiment. It was assumed that subjects might change their minds after having thought over all the attributes of the routes and having evaluated the attributes more carefully. Only 42 out of 334 subjects did change their global preference at the end of the experiment. These changes were mostly only small changes in preference. As a result we will use the first global preference as a criterion value.

In the experiment, the routes were given values ranging from 0 (worst) to 100 (best). In addition, for each attribute all routes were given values ranging from 0 to 100. All the attribute values were summed to an aggregated value for a route. This value is an aggregated value for equal weights, because all attributes are equally important. The attributes all have the same weighting factor (a factor of 1).

A_1 is the total value for route r,
which is defined as $A = \Sigma$ (1 * value(r, x))
where value (r, x) is the value for route r on attribute x.

During the experiment the attributes were given relative weights. These relative weights were determined by the program during the indifference procedure. Multiplying for every route every attribute value with the relative attribute weight and summing these weighted attribute values will produce aggregated relative values for every route. When an attribute was left out of an experimental session by a subject, this attribute was given the relative weight of 0.

A_2 is the aggregated relative value for route r,
which is defined as Σ (weight(x) * value(r, x))
where weight(x) is the weight factor that is determined for attribute x.

Beta weights, derived after the experiment by means of a multiple regression analysis, can be used to produce aggregated beta values for the routes. These beta weights were not derived for the British data. In Great Britain the number of attributes that were left out of the experiment was too great to do a proper multiple regression on the remainder and derive the beta weights.

A_3 is the aggregated beta value for route r,
which is defined as Σ (beta weight(x) * value(r, x)).

We now have three methods of aggregating values for all routes. The quality of a method can be tested by comparing the results of a method with a criterion variable. As was argued before the global preference is a good criterion variable. For all subjects the aggregated values will be compared to the global preference given by a subject at the start. Routes that are said to be good alternatives (scoring high) should be given high aggregated values by the other methods. For every subject the global preference was correlated with the different methods of aggregating values. These correlation coefficients were averaged by country. It is important to notice that if equal weights do well, all weights will have a high change of doing well. If equal weights do well all aggregated values will correlate highly with the global preference because of the correlational structure of the methods. Only if equal weights do poorly we will be able to distinguish good methods from less good methods and the good methods will by definition do better than the equal weights method.

Table 10: Average correlation coefficients between aggregate values for routes and the global preference (averages determined with Fisher Z-transformations)

	equal	relative	beta
Pedestrians			
Great Britain	.84	.75	—
Sweden	.77	.79	.97
The Netherlands	.80	.84	.95
Pedal cyclists			
Sweden	.77	.80	.98
The Netherlands	.82	.86	.96

As can be seen, equal aggregated values and relative aggregated values correlate about the same with the global preference. The average correlation coefficients for equal weights and relative weights are about the same and these correlation coefficients are high. While the correlation coefficients for equal weights are high, it is not clear if the aggregated values on the basis of relative weights produce high correlation coefficients or if these correlation coefficients are high because the correlation coefficients for equal weights are high already. It is possible that the quality of the relative weights depends partly on the correlational structure of the data. The beta aggregated values have much higher correlation coefficients with the global preference than the other two methods. The correlation between aggregated values based on beta weights and the global preference is high. So if a route is much preferred by a subject, the aggregated value for that route, based on the beta weights, will be high too. The beta weights seem to produce more valid aggregated values then relative weights do. There are only small differences between the three countries and the two travel modes.

8.7 ATTRIBUTE WEIGHTS

8.8.1 Different weather conditions in Great Britain

In Great Britain the subjects had to go through the session twice. They had to do a session in which the trip was made in a good weather condition and they had to do a session in which the trip was made in a bad weather condition. This was done because it was thought that the importance of attributes would not be the same for different weather conditions. The subjects also filled in a questionnaire twice. Not all subjects made the same trip twice, sometimes the they choose different trips for the good and the bad weather condition. Table 11 shows the relative weights of the attributes for the two weather conditions.

Table 11: Magnitude of the relative weights in Great Britain for good and bad weather

Attribute	good weather	bad weather
Distance	.14	.23
Crossings with pedestrian lights	.05	.05
Crossings without lights	.04	.04
Pleasantness	.24	.07
Attractions	.23	.16
Quality of the road pavement	.07	.16
Traffic safety	.10	.14
Gradient	.05	.12

A conclusion from the foregoing table is the fact that attribute weights do differ depending on weather conditions. Analysis of variance will control for differences in group means. The degrees of freedom for the variable and the total set are given for the F-value together with the level of significance. Significant differences for the relative attribute weights at different weather conditions are found for distance ($F(1,99)=5.38$, $p < .03$), pleasantness ($F(1,99)=29.57$, $p < .001$), quality of the pavement ($F(1,99)=6.42$, $p < .02$) and gradient ($F(1,99)=5.03$, $p < .03$). During bad weather, subjects find distance, quality of the pavement and gradient more important attributes than during good weather. Route choice during bad weather conditions is based more on these attributes than during good weather conditions. Pleasantness is more important during good weather conditions.

From the results on different weather conditions it can be concluded that during bad weather conditions, other attributes will not be played off against distance easily. If we want pedestrians to use safe routes during bad weather conditions, these routes should be short and the quality of the pavement should be high. To make pedestrians use safe routes during good weather conditions, the pleasantness of that route should be high. Pleasantness can be played off more easily against distance during good weather conditions.

Although there seem to be differences between good and bad weather conditions, we prefer to use the average weights of good and bad weather in the remaining part of these report. The average weights are better comparable to the Swedish and Dutch results. In Sweden and the Netherlands no special recommendations were made in respect to weather conditions; an overall weather type was assumed. At the moment we are interested in general differences between countries and not in differences for specific situations.

8.8.3 Pedestrians

The study was designed to find out if there were differences between the three countries and differences between men, women and different age groups. In the literature review of Workpackage 3 of this project it was argued that there could be great differences in the importance of one or more route choice criteria. We will first look at difference in importance of attributes for pedestrians. The relative weights and beta weights for pedestrians are shown in Tables 12 and 13.

Table 12:The relative weights of the attributes for pedestrians in the Netherlands, Sweden and Great Britain

	NL	S	GB
Distance	.24	.23	.19
Crossing with pedestrian lights	.04	.08	.05
Crossings without lights	.05	.09	.04
Pleasantness	.28	.21	.16
Attractions	.15	.16	.20
Quality of the pavement	.13	.07	.12
Traffic safety	.10	.13	.11
Gradient	—	.04	.09

When we look at the relative weights we see differences between the three countries for crossings with special pedestrian lights ($F(2,211)=3.30$, $p < .04$) and for crossings without special pedestrian lights ($F(2,211)=6.57$, $p < 01$). Both attributes are found more important by the subjects in Sweden than in the two other countries. Other differences are pleasantness ($F(2,211)=11.28$, $p < .001$) and gradient ($F(1,158)=4.91$, $p < .03$).

The relative weight of distance was found to vary by gender and by the age categories across countries. Male subjects have higher relative weights for distance than female subjects ($F(1,213)=6.11$, $p < .02$). Younger subjects have, on average higher relative weights for distance than older subjects ($F(2,213)=4.72$, $p < .02$). Distance is a more important factor in the route choice of younger subjects who tend to take the shortest routes. Differences between other attributes on several routes should be high to compensate the greater distance of route, that has other attributes that are preferred more. Older subjects are more likely to take a route that is a little bit longer, when other attributes for that route are better than the same attributes for the shortest route. For the other attribute weights no differences by group were found.

Almost no differences in attribute weights were found by trip motive between countries. The only difference by trip motive is for number of attractions ($F(1,211)=3.97$, $p < .05$). Subjects that make their trip for recreational or social reasons think number of attractions to be more important than subjects that have work or school as trip motive. So when a trip is made for recreational or social reasons, a subject will be more willing to take a route that has many attractions, even when that route has other attributes that are less good, compared to the other routes.

Although there seems to be some differences in the ratio of the attributes between the three countries, what is more important is the fact that those attributes that are thought to be important by subjects in one country are thought to be important by subjects in the other countries too. Distance, pleasantness and attractions are the three most important attributes in the Netherlands, Sweden and Great Britain. The rank of these attributes is not the same in all three countries.

For the Netherlands and for Sweden we also have beta weights for pedestrians. These beta weights result in aggregated values that correlate better with the global preference than do aggregated values from relative weights. As was argued before beta weights are less sensitive to measurement errors and irrationalities. Table 13 gives the beta weights for pedestrians.

Table 13: The beta weights of the attributes for pedestrians in the Netherlands and Sweden

	NL	S
Distance	.28	.25
Crossing with pedestrian lights	.07	.10
Crossings without lights	.09	.10
Pleasantness	.23	.19
Attractions	.12	.16
Quality of the pavement	.12	.15
Traffic safety	.11	.15
Gradient	—	.14

The correspondence between the beta weights for the Netherlands and Sweden seems to be very high. The only difference that is found between the two countries is for traffic safety ($F(1,106)=4.55$, $p < .04$). Subjects in Sweden think traffic safety to be a more important factor than subjects in the Netherlands.

A small difference ($F(1,84)=4.59$, $p < .04$) was found across country, between the beta weights for male and female subjects for the attribute number of crossings without special pedestrian lights. Female subjects tend to give higher weights to this attribute, they prefer to have fewer crossings without pedestrian lights on their routes.

Distance and pleasantness seem to be the attributes that are clearly more important than the other attributes. Trip motive does not seem to be important in pedestrian route choice criteria. No differences at all were found for different trip motives by country (Sweden and the Netherlands) for beta weights.

When we have two types of weights that end up with different correlation coefficients with a criterion variable, we are interested in the reasons for this differences. Is it only a difference in the magnitude of the weights or are there differences in the sequence of importance of the weights? The average relative weights for pedestrians can be compared to the average beta weights for pedestrians in Table 14.

Table 14:The relative weights and the beta weights of the attributes for pedestrians (Sweden + the Netherlands)

	relative	beta
Distance	.24	.26
Crossing with pedestrian lights	.06	.08
Crossings without lights	.07	.09
Pleasantness	.25	.20
Attractions	.16	.13

Quality of the pavement	.10	.13
Traffic safety	.12	.13

From the foregoing table it can be seen that the differences between the two types of weights is only a difference in magnitude of the weights. The sequence of the attribute weights is about the same for both types of attribute weights. For pleasantness there is a difference. The magnitude of pleasantness seems to be greater for relative weights then the magnitude of pleasantness for beta weights. The main conclusion however is that attributes that have high values for relative weights, also have high values for beta weights. Attributes that have low values for relative weights, also have low values for beta weights.

It is concluded that for pedestrians the attributes distance and pleasantness are the attributes having the highest weights. This indicates that these attributes are more important attributes in pedestrian route choice behaviour than the other attributes. Distance/time and pleasantness were similarly found to be motives that were mentioned most often by pedestrians during on-street interviews (Van Schagen 1990).

8.8.5 Pedal cyclists

As has been done for pedestrians we will also compare the types of weights for pedal cyclists. In Table 15 we compare the relative attribute weights for the Netherlands and for Sweden.

Table 15:The relative weights of the attributes for pedal cyclists in the Netherlands and Sweden

	NL	S
Distance	.21	.19
Junctions with traffic lights	.10	.09
Junctions without lights	.10	.10
Pleasantness	.17	.17
Attractions	.15	.11
Quality of the road surface	.14	.09
Traffic safety	.14	.19
Gradient	—	.07

There only is a difference for the attribute traffic safety ($F(1,118)=5.88$, $p < .02$). Subjects in Sweden think traffic safety to be a more important factor than the subjects in the Netherlands. No significant differences are found for attractions and for quality of the road surface because of the high variance between subjects for these attributes.

No differences for the attribute weights were found between male and female subjects and no differences were found between the age groups either. Similarly for different trip motives no differences were found between school/work and recreational/social for the relative attribute weights.

Table 16:The beta weights of the attributes for pedal cyclists in the Netherlands and Sweden

	NL	S
Distance	.24	.23
Junctions with traffic lights	.12	.11
Junctions without lights	.10	.12
Pleasantness	.17	.17
Attractions	.12	.12
Quality of the road surface	.12	.13
Traffic safety	.14	.19
Gradient	—	.13

The beta weights are compared for the Netherlands and Sweden in Table 16. Here too, as with the beta weights for pedestrians, there is only a difference for the attribute traffic safety ($F(1,117)=8.40$, $p < .01$): traffic safety is rated higher in Sweden.

For pleasantness a difference was found between male and female subjects ($F(1,95)=10.71$, $p < .01$). Male subjects have higher beta weights for pleasantness than female subjects. No difference were found for the age categories.

Almost no differences in attribute weights were found in beta weights by trip motive across the two countries. The only difference by trip motive is for distance ($F(1,113)=4.31$, $p < .05$). Subjects that have work or school as a trip motive think distance to be more important than subjects that make their trip for recreational or social reasons. When pedal cyclists make a trip for recreational or social reasons the attribute distance can be compensated for by other attributes more easily than when the trip is made for work or school.

Table 17:The relative weights and the beta weights of the attributes for pedal cyclists (the Netherlands + Sweden)

	relative	beta
Distance	.20	.23
Junctions with traffic lights	.09	.11
Junctions without lights	.10	.11
Pleasantness	.17	.17
Attractions	.13	.12
Quality of the road surface	.11	.12
Traffic safety	.16	.16

The magnitudes of the relative weights and the beta weights are almost the same (Table 17). There is only a very small difference between the magnitudes for distance.

Magnitude for the beta weight of distance is slightly higher than the magnitude of the relative weight.

It is concluded that for pedal cyclist the attributes distance, pleasantness and traffic safety are the attributes having the highest weights. This indicates that these attributes are more important attributes in pedal cyclists route choice than the other attributes. Distance, pleasantness and attractions were also found to be motives that were mentioned most often by pedal cyclists during on-street interviews (Van Schagen 1990).

8.9 SIMPLE ATTRIBUTES AND GLOBAL PREFERENCES

Attributes that are important will contribute strongly to the global preference. Important attributes therefore have to correlate high with the global preferences. Important attributes should have positive values for routes that are preferred, otherwise it will almost be impossible for that route to be preferred. This does not mean however that attributes that correlate highly with the global preference, are automatically important attributes. Unimportant attributes can also correlate high with the global preference.

For every attribute the correlation with the global preference was determined. This was done for pedestrians and for pedal cyclists.

Table 18:Correlation coefficients for every attribute with the global preference

	pedestrians (UK + S + NL)	pedal cyclists (S + NL)
Distance	.56	.58
Junctions/crossing with lights	.24	.36
Junctions/crossings without lights	.19	.28
Pleasantness	.41	.49
Attractions	.28	.27
Quality of the road surface	.17	.20
Traffic safety	.24	.38
Gradient	.02	.12

The attributes that were found to be important do have higher correlations with the global preference. Routes that have high values for the important attributes are also more often rated higher on the global preferences. It should be noted that none of the correlation coefficients is high meaning that the importance of the attributes varies quite a lot among the subjects.

8.11 PREDICTING ROUTE CHOICE

As was found in the foregoing part, the magnitudes of the weights are comparable to each other across country. Attributes that are thought to be important in one country are also thought to be important in the other countries. This means that we can create average attribute weights over these three countries.

When subjects were asked during the experiment to make trade-offs between attributes, they were able to do this. These trade-offs are valid. This does not mean however that subjects use the same attributes and that they make the same trade-offs in real life. It is likely that subjects do not take all the attributes into consideration when they have to evaluate the set of possible routes in daily life and that the preference for routes can be explained by a smaller subset of attributes.

If we want to incorporate the attribute weights into a model that can predict pedestrian and pedal cyclists route choice behaviour, it will be best to have the smallest subset of attribute weights with the highest predictive power.

The set of attributes that has a high predictive power is the set that is necessary to explain the global preference. It is assumed that the attributes with the highest magnitude in weight should at least be part of the set. The predictive power of any set of attributes is always determined by correlating the newly aggregated values (from the small set of attribute weights) with the global preferences. This is also done for distance only. Distance is said to be a very important attribute and perhaps has a high predictive power on its own.

When we look at the routes that have the highest global preference for pedestrians, 65 percent of these routes are also the routes that are shortest in distance. This means that 35 percent of the routes that are shortest are not routes that are preferred most by the subjects. Of the best routes for pedal cyclists, 62 percent of these routes are also the routes that are shortest in distance. These percentages are higher than those that are found for routes of car drivers (Van Winsum, 1990). This measure only compares routes that are preferred overall with routes that are best for distance.

A good model should not only predict the best route, it should be able to predict routes that are chosen often and those that are chosen rarely. The correlation coefficient between estimated values for routes (the aggregated values for the routes) and the global preference values for the same routes is used as a measure here. If we only use distance as a predictor, the correlation coefficient between the values for distance and the global preferences is .56 for pedestrians. The weights used here are the beta weights that are almost the same as the relative weights (If all attribute weights are used the correlation coefficient becomes .67). When we use the two most important attribute weights, distance and pleasantness, the correlation coefficient is improved to .70. When more attributes are added to the set the correlation with the global preference does not improve any further. Distance and pleasantness seem to be enough to predict pedestrian route choice behaviour adequately.

The correlation coefficient between distance alone and the global preference is .58 for pedal cyclists. Important factors for pedal cyclists were distance, pleasantness and traffic safety. If distance is used together with pleasantness the correlation coefficient improves from .58 to .67. If traffic safety is added to the set too, the correlation coefficient becomes .71 for this set of three attributes. Adding more or other attributes did not improve the correlation between predicted values and global preference any further.

If we intend to use the route choice criteria in a model that can predict pedestrian and pedal cyclist route choice behaviour, it would be an advantage to use only objectively measurable attributes. Objectively measurable attributes that are used in the experiment are distance, number of crossings/junctions with special (pedestrian) lights and number of crossings/junctions without special (pedestrian) lights. When we use these three attributes and look at the correlation of the predicted values with the global preference, the correlation coefficient for pedestrians becomes .58 and the correlation coefficient for pedal cyclists becomes .62. This is almost no improvement over the power of predictions that are based on distance alone.

From the foregoing it can be concluded that we do not have enough objectively measurable attributes to predict pedestrian and pedal cyclist route choice behaviour. To produce a model that can predict the route choice behaviour of pedestrians and pedal cyclists better than a model that is only based on distance, we need to incorporate at least pleasantness. When an attribute is to be used in a model, it should be objectively measurable; this means that we have to objectify pleasantness.

8.13 THE RANGES IN THE OBJECTIVE WORLD

The attribute weights we have until now do not have much meaning. Distance is thought to be more important by the subjects than the number of crossings without special pedestrian lights but the meaning of this is not indicated clearly. This will be clarified in an example. Suppose you have the opportunity to choose between two possible routes. The length of route A is 1000 metres and you have to cross 10 busy roads with special pedestrian lights (waiting times are long at these lights). The length of route B is 1050 meters and there are no roads to cross. Which of the routes would you prefer? From this example it can be seen that something like "distance is the most important attribute" has no meaning without a range indication in the real world.

In the experiment the subjects had to indicate the ranges of the attributes of their routes. Subjects were asked to estimate the length of the best and the worst route (best and worst on the attribute distance). For the other attributes the subjects had to give estimations of objective values too. This is done by the subjects for all attributes. From these estimations we can now transform the other attributes into distance. As a result we will be able express the value of routes in distance alone. This rescaling of attributes is only done for those attributes that are in the smallest sets with a high predictive power. For pedestrians this means pleasantness only. For pedal cyclists the set consists of distance, pleasantness and traffic safety.

The rescaling is done for the averages of all subjects as follows:

(range(x)/W(x))/(range(dist.)/W(dist.))

where W(x) = weight for attribute (x)
dist. = distance

For pedestrians it was found that 1 meter in distance is equal to .006 points on the pleasantness scale. This means 1 point on the pleasantness scale is equal to 167 meters. A pedestrian is prepared to walk on average more than 160 meters extra if a street on the longer route is one point better on a pleasantness scale (a 7-point scale) than the street on the shorter route.

For pedal cyclists 1 meter is equal to .005 points on the pleasantness scale and .0038 points on the scale for traffic safety. A pedal cyclist is prepared to cycle on average an extra 200 meters to have a route that is one point better on a pleasantness scale or to cycle more than 250 meters extra to have a route that is one point better in traffic safety.

9 CONCLUSIONS

A decision analytic experiment has been performed to gather more information on pedestrian and pedal cyclist route choice criteria. To produce a model that can predict pedestrian and pedal cyclists' route choice behaviour, we have to use those attributes that are important to the road user. The interrelation of the attributes should be given and it should be known in which way attributes can be played off against each other. To create an efficient model it is best to use as few attributes as possible.

In the literature review that was performed in Workpackage 3 of this project (Hopkinson, Carsten and Tight, 1989) a number of attributes were mentioned that could be important in pedestrian and pedal cyclist route choice behaviour. It was concluded that no overall framework for these criteria existed. The interrelation between the criteria had not been investigated and it was not known in which way the attributes that are important in the pedestrian and pedal cyclist route choice behaviour, could be played off against each other. No references were made in relation to differences between groups for age and gender.

The method used here to estimate the importance of the attribute weights was the method of indifference weighting. This method revealed two different weight factors for every attribute. The first weight factor is the relative weight which is directly derived from the improvements in global preference. The second weight factor is the beta weight which is derived by means of multiple regression analysis. Beta weights seem to be better predictors for the global preference than the relative weights. Values that are aggregated with the beta weights correlate higher with the criterion variable. The difference between the relative weights and the beta weights however is not very great. Attributes that have high values for relative weights also have high values for beta weights, but beta weights are better for avoiding measurement errors.

From the experiment it was concluded that distance and pleasantness are the most important attributes for pedestrians. Distance, pleasantness and traffic safety are the most important attributes for pedal cyclists. There were only small difference in attribute weights for the three countries, Great Britain, Sweden and the Netherlands. Almost no differences were found in the importance of attribute weights between male and female subjects and between different age groups. Only the importance of the attribute distance was different for the age and gender groups. Younger subjects tended to give higher importance to distance and so did male subjects.

From the British data it was concluded that a number of differences in attribute weights existed between good and bad weather conditions. During bad weather people tend to give more importance to distance, quality of the pavement and gradient than during good weather. During good weather conditions the attributes pleasantness and attractions seem to be more important route choice criteria. The average attribute weights however are comparable to the weights in Sweden and the Netherlands.

An important conclusion from the results is the fact that some attributes can be played off against each other. During bad weather conditions, other attributes can not easily be played off against distance. If we want pedestrians to use safe routes during bad weather conditions, these routes should be short and the quality of the pavement should be high. To make pedestrians use safe routes during good weather conditions, the pleasantness of that route should be high. Pleasantness can be played off more easily against distance during good weather conditions. For average weather conditions it can be stated that the pleasantness of a route can compensate for the greater distance of a route. An important safety implication of this is that the use of safer routes can be encouraged by making the routes more attractive, even if the routes are a little longer. This conclusion could have important implications for quite a lot of safety engineering, e.g. subways, footbridges, etc.

As was argued before, an efficient model has to work with as few attributes as possible. An attempt was made to find the minimal set of attributes that would produce aggregated values that correlate well with the global preference. For pedestrians the minimal set consisted of distance and pleasantness. The correlation coefficient with the criterion variable is .70. A correlation coefficient of .56 was produced when distance was used as the only attribute. For pedal cyclists the minimal set of attributes contained the attributes distance, pleasantness and traffic safety. Where distance produces .58 as a single attribute, this minimal set of three attributes produces a correlation coefficient of .71 with the global preference.

The attribute weights are meaningless when they are not related to a range of the attributes in the objective world. You can not state that distance is the most important attribute in route choice behaviour, when no ranges in the objective world are given. In the experiment the subjects gave the ranges for all attributes for the trip. These ranges are related to the attribute weights. This revealed that a pedestrian is prepared to walk on average more than 160 meters extra if a street on the longer route is one point better on a pleasantness scale (a 7-point scale) than the street on the shorter route. A pedal cyclist is prepared to cycle an extra 200 meters to have a route that is one point better on a pleasantness scale and to cycle more than 250 meters extra to have a route that is one point better in traffic safety.

It will be difficult to find objectively measurable values for pleasantness and traffic safety and this will cause problems in using these attributes in a model. However, if we want to make an effective model, pleasantness (and traffic safety) will increase the predictive power of that model. We will have to try to define the pleasantness (and traffic safety) of elements of a network into objectively measurable values. The objectively measurable values we now have (distance, number of crossings/junctions with and without lights) have no more predictive power than distance alone.

The minimal sets to model pedestrian and pedal cyclists route choice behaviour only apply for situations in which the road users are familiar with the network. This network has to be an urban network. Most of the trips that are made in urban networks by foot or by bicycle are made by road users that are familiar with the area. When the road users are not familiar with the network, they will use other criteria in choosing a route because they are unable to give valid estimations for some or all of the attributes.

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APPENDICES

APPENDIX A1
DEFINITIONS OF THE ATTRIBUTES FOR PEDESTRIANS

Distance:

The total distance of a route in kilometres/miles from the origin until the destination.

Crossings with lights:

Total number of crossings on your route at places with special pedestrian lights.

Crossings without lights:

Total number of crossings on your route at places without special pedestrian lights.

Pleasantness:

The pleasantness of a route because there are so many shops, it is pleasantly crowded or there are so many trees and other green.

Gradient:

The (dis)attractiveness because of a slope in the route.

Attractions:

Number of specific points you want to look at on a route.

Quality of the pavement:

The quality of the pavement and the number of obstacles on the route.

Traffic safety:

A subjective feeling of how save you find a route in account of crossing facilities, speed of other traffic, separation of other traffic, survey at dangerous points etc.

APPENDIX A2
DEFINITIONS OF THE ATTRIBUTES FOR PEDAL CYCLISTS

Distance:

The total distance of a route in kilometres/miles from the origin until the destination.

Junctions with traffic lights:

Total number of junctions on a route that are regulated by traffic lights.

Junctions without lights:

Total number of junctions on your route that are not regulated by traffic lights.

Pleasantness:

The pleasantness of a route because there are so many shops, it is pleasantly crowded or there are so many trees and other green.

Gradient:

The (dis)attractiveness because of a slope in the route.

Attractions:

Number of specific points you want to look at on a route.

Quality of the road:

The quality of the surface and the number of obstacles on the route.

Traffic safety:

A subjective feeling of how save you find a route in account of crossing facilities, speed of other traffic, separation of other traffic, survey at dangerous points etc.

APPENDIX B1
PEDESTRIAN QUESTIONNAIRE

N.B. The worst and the best route are always the worst and the best route on that specific attribute (that is not necessary the a priori worst or best).

Subject number .....

Can you please tell me your age? ......years

Gender Male / Female

Which level of education have you completed? ....

What is the main reason for this trip?
Home/work
Social visiting
Recreational
Other

How often do you make this trip? ....times a week

How well do you know the area? very badly |x|x|x|x|x|x|x| very well

How long in distance is the worst route? ..... kilometre/miles

How long in distance is the best route? ..... kilometre/miles

Number of crossings with special pedestrian lights at the worst route? .....

Number of crossings with special pedestrian lights at the best route? .....

Number of times you cross a road at places without traffic lights at the worst route? .....

Number of times you cross a road at places without traffic lights at the best route? .....

How pleasant do you find the worst route?
very unpleasant |x|x|x|x|x|x|x| very pleasant

How pleasant do you find the best route?
very unpleasant |x|x|x|x|x|x|x| very pleasant

In terms of gradient, how do you find the worst route?
very unpleasant |x|x|x|x|x|x|x| very pleasant

In terms of gradient, how do you find the best route?
very unpleasant |x|x|x|x|x|x|x| very pleasant

How many attractions are there on the worst route?
very few |x|x|x|x|x|x|x| very many

How many attractions are there on the best route?
very few |x|x|x|x|x|x|x| very many

What is the quality of the pavement on the worst route?
very poor |x|x|x|x|x|x|x| very good

What is the quality of the pavement on the best route?
very poor |x|x|x|x|x|x|x| very good

How safe do you feel on the worst route?
very unsafe |x|x|x|x|x|x|x| very safe

How safe do you feel on the best route?
very unsafe |x|x|x|x|x|x|x| very safe

-- 3 Extra questions for Leeds (only bad weather condition) --

How much protection you have on the a priori worst route?
very few |x|x|x|x|x|x|x| very much

How much protection you have on the a priori best route?
very few |x|x|x|x|x|x|x| very much

To which of the following would you rate protection from the weather equally important?

- Total distance
- Number of crossings with pedestrian lights
- Number of crossings without lights
- Attractiveness
- Gradient/hilliness
- Attractions
- Quality of the pavement
- Traffic safety

or

- More important than any of the foregoing attributes
- Less important than any of the foregoing attributes

APPENDIX B2
PEDAL CYCLIST QUESTIONNAIRE

N.B. The worst and the best route are always the worst and the best route on that specific attribute (that is not necessary the a priori worst or best).

Subject number .....

Can you please tell me your age? ......years

Gender Male / Female

Which level of education have you completed? ....

What is the main reason for this trip?
- Home/work
- Social visiting
- Recreational
- Other

How often do you make this trip? ....times a week

How well do you know the area? very badly |x|x|x|x|x|x|x| very well

How long in distance is the worst route? ..... kilometre/miles

How long in distance is the best route? ..... kilometre/miles

Number of junctions with traffic lights at the worst route? .....

Number of junctions with traffic lights at the best route? .....

Number of junctions without traffic lights at the worst route? .....

Number of junctions without traffic lights at the best route? .....

How pleasant do you find the worst route?
very unpleasant |x|x|x|x|x|x|x| very pleasant

How pleasant do you find the best route?
very unpleasant |x|x|x|x|x|x|x| very pleasant

In terms of gradient, how do you find the worst route?
very unpleasant |x|x|x|x|x|x|x| very pleasant

In terms of gradient, how do you find the best route?

very unpleasant |x|x|x|x|x|x|x| very pleasant

How many attractions are there on the worst route?
very few |x|x|x|x|x|x|x| very many

How many attractions are there on the best route?
very few |x|x|x|x|x|x|x| very many

What is the quality of the surface on the worst route?
very poor |x|x|x|x|x|x|x| very good

What is the quality of the surface on the best route?
very poor |x|x|x|x|x|x|x| very good

How safe do you feel on the worst route?
very unsafe |x|x|x|x|x|x|x| very safe

How safe do you feel on the best route?
very unsafe |x|x|x|x|x|x|x| very safe