CYCLISTS' TRAVEL BEHAVIOUR, FROM THEORY TO REALITY

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ABSTRACT

A lot of cities are experiencing an increase of cycling in their daily urban trips. This produce benefits for all citizens and many decision-makers are designing policies to improve bike use. However, this is not possible without a cycling demand management policy, which should be based on the scientific knowledge of cyclist behaviour key factors.

In the scientific literature we can find many references about factors affecting bicycle use. They are oriented either to show qualitative analysis, where bike factors assessment are made; or they present discrete choice models where bike factors are evaluated in order to the final user choice. Both research lines provide important information on cyclist behaviour knowledge. However they are not enough to explain all the explanatory factors to use bikes. Some factors influencing cycling use are of psycho-social type and they are not included in the econometrics models normally used.

This paper presents a research done to improve cycling demand forecast. For this research we have made an internet based survey in the Madrid University Campus, where a public bike system is expected to be implemented. In this survey we have collected more than 3,000 responses, including objective and subjective factors for the trip to the University. Based of the outputs of the survey several models have been adjusted for forecasting cycling demand. We have used social science techniques like covariance structural equation modelling. These techniques are based on the use of latent variables and they consider the relationships among them.

The results emphasize the importance of experience for using bicycle for daily mobility. The explanatory factors have been ranked in four groups: convenience, pro-bike factors, physical limitations and external limitations. Among these groups, external limitations and convenience are the most relevant, explaining 85% of cyclist travel behaviour. There are also important interactions between pro-bike factors and convenience ones that have to be taken into account because pro-bike factor have an influence of almost 57% of the convenience factors. These results allow explaining the key factors to develop a sound cycling policy.

INTRODUCTION

The aim of this research was to improve understanding of the factors associated with increased bicycle use. On one hand, the study aimed to take an in-depth look at the role played by the subjective importance that users place on these factors, and on the other hand, to understand how these factors inter-relate, what the connections between them are and their influence on final behaviour. This information is useful for gaining a better understanding of user behaviour towards riding a bicycle and to determine the appropriate lines of action to be taken by policies to encourage bicycle use.

The method used in this research involved studying scientific literature to determine the most important factors concerning bicycle use. Subsequent to this, focus groups were set up that made it possible to identify which of those factors were decisive in the context of this study. A survey was developed in order to establish the relationships between the factors and the users' subjective evaluations. The results of this survey were processed using structural equation models. By conducting an exploratory factor analysis of these models, it was possible to determine the relationships between the indicators and to detect four latent variables that unite them. Causal factor analysis enabled observation of the relationship between these factors and bicycle use to, lastly, determine and compare a model showing the latent variables identified against final behaviour and the structure of these relationships.

FACTORS INFLUENCING BICYCLE USE

The available literature contains a lot of information relating to factors affecting bicycle use. In amongst the various studies performed are those that deal with the problem from a qualitative perspective, analysing the effects of factors by conducting evaluative surveys on cyclists, and there are those that perform a more quantitative analysis by linking the factors to final bicycle use. This study aims to combine both perspectives.
The factors influencing bicycle use can be grouped, following Rietveld's proposal (Rietveld & Daniel, 2004), into individual features, socio-cultural factors, factors associated with the bicycle as a mode of transport and factors that are a consequence of other modes of transport. This classification was the preferred basis for constructing a classification system related to the manner in which said factors are perceived. In this respect, there can be different types of factors: individual features, objective factors, which include individual, environmental and structural factors, and subjective and evaluative factors.

1. *Individual Features* are related to the socio-demographic characteristics of the users. Factors such as age or level of income provide different results in different studies (Sener et al., 2009,Baltes, 1996,Dill, 2004,Moudon et al., 2005,Dill & Voros, 2007,Pucher & Buehler, 2008,Petritsch et al., 2008). Other factors such as size of dwelling, availability of a car or bicycle do appear to have some direct relation to bicycle use (Ortúzar et al., 2000,Taylor & Mahmassani, 1996,Xing et al., 2008,Pinjari et al., 2008) and further factors such as gender seem to be related more to cycling

culture than to bicycle use (Moudon et al., 2005,Akar & Clifton, 2009,Emond et al., 2009).

2. *Objective factors* can be evaluated directly without any interaction with the user. These factors can be divided into those that affect us in a personal manner and those that affect us in a collective manner and are related to the environment, and structural factors related to the conditions of town planning that are favourable towards bicycles.

    a. Journey duration is extremely important when choosing a mode of transport although it is not as much of a decisive factor for cyclists (Hunt & Abraham, 2007,Eash, 1999,Hopkinson & Wardman, 1996,Burbidge & Goulias, 2009). In addition to journey duration, the flexibility offered by bicycle use must also be considered with regard to timetables and frequencies that reduce the penalty of waiting times for public transport or, as regards cars, time spent parking (Akar & Clifton, 2009). Distance and time are closely linked. Bicycles are an efficient mode of transport over certain distances (Petritsch et al., 2008,Hunt & Abraham, 2007), in which they are found to be highly competitive with all kinds of motorised transport, without distance being a definitive explanatory variable (Hyodo et al., 2000,Allen-Munley et al., 2004). Travel reason is a key factor according to the results of this research, which confirm the results obtained by other authors (Heinen et al., 2009,Wardman et al., 2007,Thomas et al., 2009). When conducting a study about bicycles, it is necessary to distinguish forced mobility from mobility for sports or recreational and leisure pursuits, as the behaviour and decisions made by cyclists differ completely depending on the purpose of their bicycle journeys (Monzón et al., 2009).

    b. *Environmental factors* include weather conditions that can affect bicycle use, above all when these are isolated conditions that are not related to sustained weather conditions, which the user eventually adapts to (Dill & Voros, 2007,Aultman-Hall, 2009,Nankervis, 1999,Shiva Nagendra & Khare, 2003). Another aspect determined by the environment is the topographical factor, which has a clear influence on bicycle use, which is not to say that towns with adverse typography do not have a high modal rate in favour of bicycles (Sener et al., 2009,Cervero & Duncan, 2003,Parki et al., 2008,Stinson & Bhat, 2003,Sener et al., 2008). In addition to the orography of the city, the form of such and the design of its spaces can directly affect bicycle use (Sener et al., 2009,Zahran et al., 2008,Kemperman & Timmermans, 2009,McCahil & Garrick, 2008).

    c. Another set of factors that have always been highlighted are those *relating to a city's adaptation* to bicycle use. The existence of a bicycle network encourages bicycle use (Moudon et al., 2005,Akar & Clifton, 2009,Hunt & Abraham, 2007) although its importance decreases depending on the users' cycling experience (Taylor & Mahmassani, 1996,Hunt & Abraham, 2007,Monzón et al., 2009,McCahil & Garrick, 2008). It is worth highlighting that a network alone is insufficient, it must also be well designed (McClintock & Cleary, 1996,Cour Lund, 2009,Carré, 1999,Alves, 2006,Barnes & Krizek, 2005,Faghri & Egyáíziová, 1999). Aside from the network itself, additional facilities on site, such as parking areas or showers and so on, are important (Sener et al., 2009,Taylor & Mahmassani, 1996,Hunt & Abraham, 2007).

3. *Subjective factors* relate to perceptions that users may have about factors and matters associated with bicycles. The dangerous aspect of using a bicycle is not an objective factor as we can measure the relationship between certain elements such as car traffic, or speed, and accident rates (Molino & Emo, 2009,Carter et al., 2007,Natarajan & Demetsky, 2009,Noland & Quddus, 2004,Danya et al., 2009). Perception of risk is a subjective matter and does not always correlate to the actual risk. However, the fact that the user perceives risks, whether real or not, is a determining factor in relation to bicycle use (Rietveld & Daniel, 2004,Pucher & Buehler, 2008,Hopkinson & Wardman, 1996,Sener et al., 2008,Noland & Kunreuther, 1995).

Our study focussed on this last type of factor. The study aimed to understand the perception of subjective factors and their internal organization. This knowledge is useful to gain more information about cyclists' evaluations and how such can be used to anticipate their behaviour or to improve cycling policies.

METHOD

Case study presentation

Madrid is a city located in the centre of Spain with a population of 3,213,792 inhabitants, and a density of 5,300 inhabitants per square kilometre. *Ciudad Universitaria* is a campus spanning a surface area of 5.5 square kilometres, which are distributed amongst three public universities, over 30 halls of residence, institutional buildings, research institutes, three sports centres and a botanical garden. Ciudad Universitaria comprises a total of 144 centres, of which more than half belong to Universidad Complutense de Madrid, and which represent an associated population of 112,871 people.

Ciudad Universitaria is a historic university campus dating from 1927. It was the first campus in Europe to be constructed in the American style, a model that then extended throughout the rest of the continent. At present, this campus is shared by several universities and is one of the city's points of reference. However, despite its importance in terms of town planning, it is threatened by mobility based on an increasingly intensive use of cars and an inadequate organisation of its spaces. In this regard, universities are considering different solutions to recover the value of the campus and its use as a space for coexistence and the transfer of knowledge.

One of the solutions for improving the campus is to introduce the bicycle as another mode of transport. Bicycles can travel across routes not covered by public transport and improve the offer of non-polluting modes of transport. In addition, it fulfils the idea of rehabilitating communal spaces. At present, bicycles are a marginal mode of transport both on the university campus as well as in Madrid itself.

The UNIBICI system is a proposed system of bicycle hire for use in Ciudad Universitaria. It aims to complement the transport network already operating in Ciudad Universitaria by connecting its main nodal points with the end destinations. This consequently extends the number of public transport modes available and also offers a new and ideal mode of transport that resolves internal mobility. The system proposed is a fourth generation, completely automatic, public bicycle system.

Prior to the implementation of the system, the UNIBICI study on the potential demand that the bicycle hire system could have in the Ciudad Universitaria university campus was performed. When analysing the demand, it was very important to understand the mechanisms by which bicycle users chose this mode of transport. In order to do this, a detailed analysis was carried out to identify the main barriers that stopped users riding bicycles and to establish the main factors that promoted bicycle use. An extensive survey was conducted on campus users to obtain more information relating to the aforementioned matters and others related to mobility and the acceptance of the new service.

As regards modes of transport used to access Ciudad Universitaria, 42% travel by metro, 26% by car, 16% by bus, 12% by foot and 4% ride their own bike. 78% of the journeys mentioned include a final stage which is made by foot. Combining this data with the fact that 12% make the journey exclusively by foot, it can be concluded that travel by foot is the protagonist for mobility around campus, as it is involved in 90% of all journeys made.

Ciudad Universitaria's environmental conditions can be considered favourable for bicycles: Mediterranean climate, relatively flat and high quality landscape with some isolated slopes. However, there is a high flow of traffic, both passing through as well as arriving at Ciudad Universitaria, which makes riding a bicycle unpleasant.

Survey development

The data required for the study was obtained by conducting an online survey. In order to design the survey, some focus groups were established including people who use bicycles in Ciudad Universitaria. These focus groups served to detect significant variables and to find out about the true requirements of the potential bicycle users on campus. Using this information, a questionnaire was prepared, which was tested by conducting a face to face pilot survey on 233 users at different locations within Ciudad Universitaria. Lastly, the definitive questionnaire was prepared which included four fundamental sections: socio-demographic information, mobility, bicycle use combined with the subjective evaluation of different factors and willingness to use the future UNIBICI system in various scenarios.

The final survey was conducted online from April to July 2008. To contact the target population, an e-mail was sent to the accounts provided by the different universities on campus. As a reward, and to encourage participation in the survey, approximately 1,000 reflective bands were given away and there was a prize draw for ten foldable bicycles. The final sample gathered comprised 3,048 people. The statistical error was 1.78%, for a 95% confidence interval. We obtained a 22% rejection rate calculated based on the number of people surveyed who did not complete the questionnaire.

76% of people accessing the campus on a daily basis are students, the remainder are employees. The number of people surveyed who were in employment was 57%, and 70% of people surveyed had higher education qualifications. Consequently, it is possible to conclude that the target population of the study does not eminently comprise students who are attending university for the first time but rather there are also a high number of employees and people who combine employment with study. However, the sample could be somewhat biased as a result of using the most of the trips to an educational institution. It could be interesting to chose a more diverse sample in the future for a more useful results.
The survey found that 74% of those surveyed stated that they would be willing to use the UNIBICI system and half of those said they would do so on a regular basis.

Psycho-social variables of bicycle use

It can be gathered from different experiences of modelling bicycle demand that there is an evident necessity to assess not only factors that can be observed but also factors related to cyclists' emotions, feelings and personal perceptions. The fact that the classic factors, which determine transport user behaviour, play a less important role as regards bicycles may indicate that these other kinds of factors gain importance in the correct characterisation of cyclist behaviour (Pinjari et al., 2008,Eash, 1999, Burbidge & Goulias, 2009,Schossberg & Brehm, 2009). Following Ben-Akiva's metaphor, it could be said that the part of the *black box* of behaviour that the models do not cover is very significant in terms of the bicycle, and attention must be paid to it (Barnes & Krizek, 2005,Ben-Akiva et al., 1999,Ben-Akiva et al., 2002,Golob, 2001,Golob, 2003).
The first stage of this analysis involved a detailed study of all of the psycho-social factors that could influence bicycle use. Factors related to bicycle use can be classified in terms of whether they are perceived as a barrier or as an incentive to bicycle use. In order to do this, existing literature was analysed and an in-depth analysis was performed as regards the context of the project based on the focus groups and the pilot survey:

- Factors that promote bicycle use:
    - Efficiency: avoids traffic problems such as traffic jams, easy to park, enables door to door transport and is competitive with other modes of transport over certain distances.
    - Flexibility: no time or frequency restrictions.
    - Economical: no fuel expenses, the purchase and maintenance of the bicycle is economical.
    - Ecological: does not emit pollutants or greenhouse gases, hardly makes any noise and takes up little space.
    - Healthy: it is an active mode of transport that encourages people to exercise.
    - Fun: some users take pleasure in riding a bicycle.
- Factors that inhibit bicycle use:
    - Distance: distances to be travelled that are too long
    - Danger: perception of risk in relation to accidents or falls
    - Orography: mountainous or hilly landscape
    - Fitness: poor physical condition

- Climate: weather limitations such as rain, wind, low or high temperatures, etc.
- Vandalism: fear of the bicycle being stolen
- Facilities: need for complementary facilities that provide areas for personal hygiene, a bicycle parking area at the destination point, a place to keep the bicycle at home, etc.
- Comfort: not as comfortable as other modes of transport

The existence of cycling infrastructures has not been included as a factor because although it is believed to play a subjective role that would fit in with this analysis, it is believed that this component falls under the perception of risk factor.

Tables 1 and 2 show the evaluation of the factors gained from the survey conducted as part of the UNIBICI study. The importance given to the factors that promote use is, in general, greater that that given to those that inhibit its use. The factors considered most important are efficiency and the ecological aspect. The most noteworthy amongst the barriers to bicycle use are the importance given to the need for complementary facilities and perceived dangers.

Table 1: Importance of the factors that promote cycling (1 to 6 scale).

	Efficiency	*Flexibility*	*Economical*	*Ecological*	*Healthy*	*Fun*
mean	5.08	4.87	4.77	5.15	4.89	4.13
median	5.00	5.00	5.00	5.00	5.00	4.00
mode	5.00	5.00	5.00	6.00	5.00	4.00
standard deviation	0.95	1.07	1.20	1.04	0.97	1.29

Table 2: Importance of factors that inhibit the cycling (1 to 6 scale)

	Distance	*Danger*	*Orography*	*Fitness*	*Climate*	*Vandalism*	*Facilities*	*Comfort*
mean	3.61	4.09	3.42	2.46	3.63	3.32	4.43	3.18
median	4.00	4.00	4.00	2.00	4.00	3.00	5.00	3.00
mode	6.00	6.00	4.00	1.00	4.00	4.00	6.00	3.00
standard deviation	1.81	1.65	1.54	1.43	1.43	1.58	1.50	1.55

The ultimate objective is to understand the importance that the user places on these factors, how they inter-relate and what relationship they have with the user's end behaviour. When working with psycho-social information about the users, their subjective evaluations and attitudes towards specific situations, we distance ourselves from the field of the objective variables known to the modeller, and consequently from the field in which the theory of discreet choice models is a powerful tool (Golob, 2001,Pendleton & Shonkwiler, 2001,Fujii & Gärling, 2003,Vredin Johansson et al., 2005,Vredin Johansson et al., 2006). As a result, structural equation modelling was used. This technique enabled an analysis of how our indicators are grouped, how they interrelate and the existence of latent variables underlying their structure (Golob, 2003).

RESULTS

The Covariance Structure Analyses incorporate variables that cannot be directly observed, which are known as latent variables, and these can only be measured through other variables or indicators that can be observed directly. These models differ from the discrete choice models due to their capacity to work with latent variables and because they reveal a causal relationship and not only descriptive measurements of association or correlation between variables (Goldberguer & Duncan, 1973).

In our study, an exploratory factor analysis was firstly performed in order to observe the manner in which the variables group together and to detect possible existing latent variables. To confirm these results, a confirmatory factor analysis *(Jöreskog, 1969)* was performed, relating the resulting grouping of indicators and the latent variables detected to the hypothesis of their contribution towards the explanation of behaviour. Lastly, the structural model presented was formulated by using the results obtained.

Identification of latent variables

Exploratory factor analysis (Spearman, 1904,Bollen, 1989) allows us to determine which indicators contribute towards the measurement of each of the latent variables included in the model. It is also useful for eliminating those indicators that do not contribute anything towards the estimation of the latent variables, and therefore retains in the model those that are most relevant.

After subsequent work on the indicators, involving verifying the linearity and normality of the variables, several models were estimated using the maximum probability method, taking into account the existence of an indefinite number of latent variables as a hypothesis.

When considering the set of responses, it was confirmed that there was no structure in the indicators. This is due to the fact that the responses from those who do not use a bicycle contributed to a dispersion of the indicators. After filtering out responses from those people who had no cycling experience, either because they did not have a bicycle, did not know how to ride one, or were uninterested in cycling, a clear structure was found in the factors. This indicates that there is a significant difference in attitudes towards the bicycle between those who sometimes use a bicycle and those who never do (see Table 3). Consequently, this shows a substantial distance between the idea of riding a bicycle, which produces a diversity of expectations; and the reality of those that do ride a bicycle, whose perceptions do respond to a verifiable common system. For example, users that frequently ride a bicycle place greater importance on factors such as efficiency, flexibility or the fun aspect and minimise the importance of factors such as perceived risk. Differences according to type of use can also be verified as users that ride a bicycle for sports pursuits give greater importance to negative factors such as the need for complementary facilities or fear of the bicycle being stolen, in comparison to people who use a bicycle as their usual mode of transport.

Table 3: differences between the importance given to different factors depending on the frequency of use or type of cycling (1 to 6 scale).

Frequency of use			
	Never	Occasional	Habitual
Efficiency	5.0	5.1	5.5
Flexibility	4.8	4.9	5.3
Danger	4.2	4.1	3.7
Fun	3.9	4.3	4.9
Type of use			
	Commuter	Leisure	Sport
Vandalism	3.4	3.3	3.6
Facilities	4.3	4.5	4.7

Lastly, the best adjustments were achieved for the consideration of four latent variables. The grouping of indicators into latent variables was consistent with associations of ideas between factors, which made it possible to grant validity to the structure and define the meaning of the latent variables found.

The latent variables identified and their indicators were as follows:

- CONVENIENCE: measures the practical nature of the bicycle as a mode of transport for users. This latent variable is related to efficiency and flexibility.
- PRO-BIKE: set of characteristics and factors intrinsic to the bicycle which make it an attractive mode of transport. Its indicators are the fact that it is economical, fun, healthy and ecological.
- EXTERNAL RESTRICTIONS: importance of factors that restrict bicycle use and that are not under the users' control. This variable is related to the aspect of danger, vandalism and available facilities.
- PHYSICAL RESTRICTIONS: measures the impedance to use of the bicycle as it is not motorised. This variable is related to the physical fitness of the user and to orography.

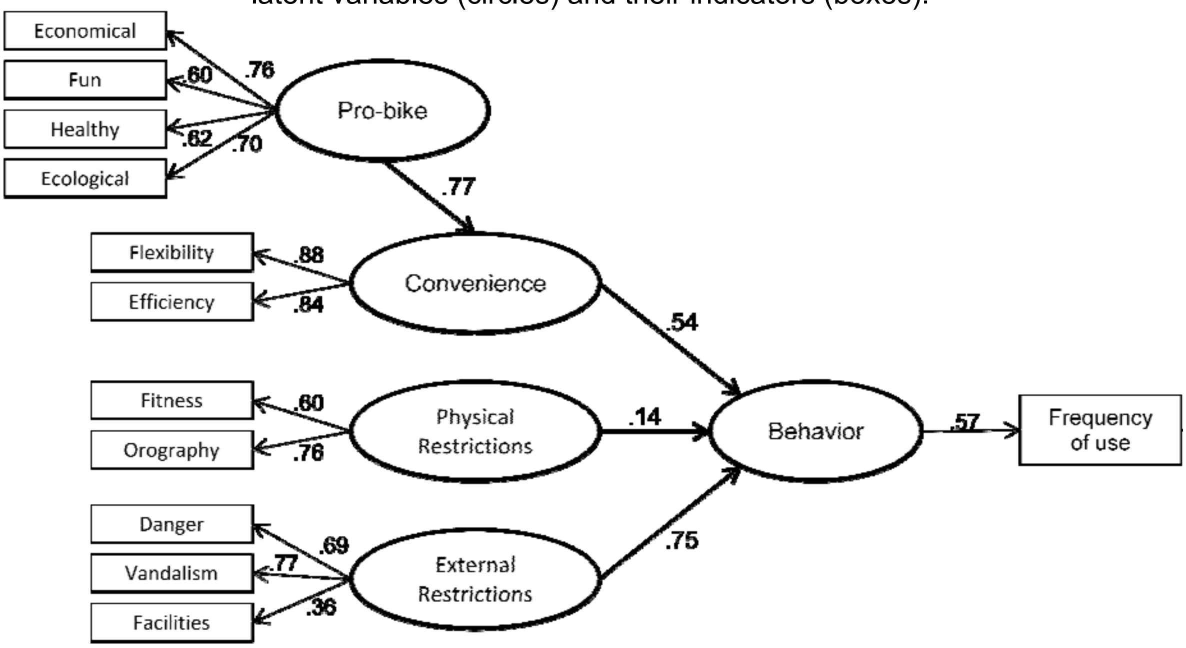
During this process of identification of latent variables and association with indicators, several of these were rejected due to not adding explanatory strength to the structure of the factors studied, specifically: distance, climate and comfort.

Model of relationship between latent variables and cycling behaviour

Once the latent variables had been investigated and their coherence with the indicators that reflect their structure had been verified, a Confirmatory Factor Analysis *(Jöreskog, 1969)* was carried out that helped to corroborate the results obtained until this point. This type of analysis provides us with an optimum and meaningful model in which we can assess the latent variables based on the indicators measured in the surveys and by relating them to the end variable observed: user behaviour. In the resulting final model, the latent variables are inter-related, making it therefore possible to ascertain the influence of some over others.

At this stage of the modelling process, all of the causal relationships to be compared against the latent variables must be considered. In the method proposed herein, a simplified causal relationship between the latent variables identified and the frequency of use of the bicycle by the user was chosen. Frequency of use of the bicycle was directly asked to respondents in the survey in a six-tip question: never, once a month, several times a month, once a week, several times a week or daily. Other more complex relationships may be possible, and this represents a basis for future research and for an improvement in modelling cycling behaviour.
In the method detailed to identify causality, a new latent variable is used: behaviour. The creation of this latent variable responds to the need to consider the error between that measured directly, frequency of bicycle use, and user behaviour. Our measurement is an indicator of behaviour but it does not encompass everything that behaviour implies. Using this construction, it can be gathered that a percentage of behaviour, 68%, is understood by measuring the frequency of bicycle use (Table 4).

Figure 1: *Path diagram* of the proposed model to explain the use of bicycle as a function of latent variables (circles) and their indicators (boxes).



β: saturation rates for each relationship

We assessed the goodness of fit of the model using the chi-square test, the root-mean-square-error of approximation (RMSEA), the comparative fit index (CFI) and the adjusted goodness-of-fit index (AGFI). The indexes were computed using the program LISREL 8.80.
The value of chi-square is 379.88 with p-value < 0.01. Besides, RMSEA=0.0743 that is less than 0.08 and within 90% Confidence Interval for RMSEA (0.0675;0.0814), CFI=0.955 , GFI=0.971 and AGFI=0.953 are greater than 0.090. On the basis of these criteria, the model fits the data well and we can conclude that the model meets our expectations insofar as concerns its statistical adequacy.

The structure of the model shows five latent variables (figure 1): convenience, pro-bike, external restrictions, physical restrictions and behaviour. Indicators of the pro-bike latent variable include the fact that riding a bicycle is economical, fun, healthy and ecological. As regards the convenience variable, efficiency and flexibility are worth mentioning, as well as the pro-bike variable which explains 57% of its variance. The indicators of external restrictions include the aspect of danger, vandalism, facilities and climate. Indicators of physical restrictions include the physical condition of the user and orography. Lastly, convenience, external restrictions and physical restrictions explain 85% of the behaviour measured based on frequency of use.

The degree of the explanatory effect on behaviour is greater for external restrictions (β=0.75) than for convenience (β=0.54) and physical restrictions, the effect of which is less relevant (β=0.14) (See Figuere 1).

As can be seen from table 4, depending on the coefficients of determination and the relationships of the structural model, it can be concluded that 57% of the variance of the economical indicator of the bicycle, 49% of its ecological aspect, 38% of its healthy aspect and 36% of the fun aspect are explained by the pro-bike latent variable. In addition, 71% of the variance in the efficiency indicator and 77% of the flexibility indicator are explained by the convenience variable; 15% by the necessity for facilities, 48% by danger, and 60% by vandalism explain the external restrictions variable; and lastly, 36% of physical fitness and 59% of orography explain the physical restrictions variable.

Table 4: indicators determination coefficients used in the model

Indicator	R^2
Efficiency	.714
Flexibility	.771
Economical	.574
Ecological	.486
Healthy	.380
Fun	.363
Facilities	.152
Danger	.480
Vandalism	.598
Forma	.355
Orography	.584
Frequency of use	.686

The structure presented herein shows that the positive indicators associated with the bicycle can be split into two latent variables: convenience and pro-bike. One is linked to indicators directly related to the bicycle's ability to compete with other modes of transport within the transport system, the convenience factor; and the other to indicators intrinsic to the bicycle which are included in the pro-bike variable. The importance placed on these latter indicators by the user does not have a direct influence on the behaviour of the user, rather it complements the importance that the user gives to the idea of the convenience of a bicycle, which does directly influence the user's behaviour. In other words, the user values the practical aspects of the bicycle as a mode of transport in his/her decision even though other positive aspects are also valued and improve the opinion of the former.

It is possible to calculate the indirect influence the pro-bike variable has over behaviour, by using the importance placed on convenience ($\beta=0.77*0.54=0.41$), and verifying that it is greater than the direct influence of the importance placed on physical restrictions ($\beta=0.14$). Consequently, the importance that the user places on physical restrictions has the least influence on his/her behaviour. This can be explained by the user's capacity to adapt to these restrictions of their own accord.

The restricting external factors are those that have a greater influence on the final decision to ride a bicycle. The fact that users place more importance on factors beyond their control that inhibit them from using the bicycle, than on the intrinsic advantages of a bicycle, shows the demand for actions that improve cycling conditions in the user's environment. This leaves an open door to the influence that cycling policies can have on citizens' evaluation and on their final behaviour.

Lastly, it must be noted that 88% of the final behaviour to use a bicycle is reflected by the importance placed on the evaluation of convenience, physical and external restrictions and, indirectly, pro-bike factors, which indicates that a significant part of the users' final decision can be explained by their evaluation of these factors as well as by observable transport system variables.

DISCUSSION AND CONCLUSIONS

It is evident that there are differences in factors related to bicycle use depending on the importance placed on such factors by users, and that these differences relate directly to user behaviour. On one hand, users differentiate factors that are perceived as barriers from those that are perceived as opportunities resulting from bicycle use. Within the former category, they also differentiate between barriers that are under their control from those that depend on the actions of the Government or the cultural situation. Within the latter category, user behaviour corresponds directly to their evaluation of the indicators that make the bicycle more convenient than other modes of transport, while positive factors that are not directly related to a bicycle's competitive edge in the transport system only reinforce the image of convenience.

The existence of a structure amongst the indicators makes their differentiated handling advisable both in the analysis of demand that is based on such indicators, and when designing policies to encourage bicycle use. In this respect, it is clear that the policies that can achieve the best results are those that are geared towards changing the external restrictions that are not related to the environment or the physical fitness of the user. Barriers such as physical fitness or a mountainous or hilly landscape are not especially important when compared to an improvement in complementary facilities for bicycles, measures that prevent theft, or that create an image of the bicycle as a safe mode of transport.

There is a clear difference between the perceptions of users that have cycling experience, whatever kind it may be, and those that do not ride a bicycle. The diversity of inexperienced users' evaluations is natural as they are based on assessments of something that is unknown to them, and it contrasts with the clear structure shown by experienced users. This leads us to reflect upon the direction that policies geared towards promoting bicycle use in the city should take. It seems logical that an adequate direction to follow should involve measures that allow people to experience cycling in real situations as opposed to creating policies in uncertain directions, the value of which shall vary in time. In this regard, policies such as the construction of a specific type of cycle path, such as the off-road cycle paths, under the justification that they provide the new user with a safe introduction to riding a bicycle, despite their lower degree of efficacy and the greater danger involved than in on-road cycle lanes, do not seem to be the answer. This is due to the fact that the perception of risk is the true factor to be acted upon, and this factor is related more to cycling experience than to the infrastructure itself. It is therefore more convenient to design policies based on the reality of bicycle use and not the theory of it, as the latter does not seem to have a clear analysis structure that can guide adequate policies.

The fact that indicator such as distance and climate are not seen to be shown in the structure could be due to these indicators relating more to the specific journey than general behaviour towards bicycle use. Long-distance journeys or journeys that have to be made in adverse weather conditions shall simply not be made but assessment of such does not have an influence over the user's general attitude towards the possibility of riding a bicycle or not. However, the factors used in the model do have a direct relationship with bicycle use beyond the specific consideration of each journey.

The existence of structures in the importance that the users place on different factors associated with the bicycle indicates that these factors are valued in an organised fashion in the decision made by the user. This evaluation is not directly observable but can be measured through the indicators detailed in this article and translated into latent variables that can be incorporated into the discreet choice models, verifying whether their inclusion improves the explanatory strength of these models. The combination of psycho-social latent variables and observable variables may be a path worth exploring in the modelling of cyclist behaviour.

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