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**11th December 2007**



**Diana, M. (2008) Making the “primary utility of travel” concept operational: a measurement model for the assessment of the intrinsic utility of reported trips, *Transportation Research Part A*, vol. 42(3), pp. 455-474.**

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## ABSTRACT

A growing body of research is casting light on the intrinsic utility of the traveling activity, something that seems not identifiable with the utility of performing activities at different locations. As a complement to previous speculative and empirical researches on this topic, the present study proposes a measurement model for the intrinsic, or primary utility of travel. A new definition of primary utility is proposed, keeping into account the users of different transportation modes, beyond car drivers. The model is then estimated on a dataset coming from a mixed behavioral and mobility survey, focusing on weekday trips of less than 50 kilometers. Exploratory factor and item analyses define the set of structural equations used in a subsequent hierarchical confirmatory factor analysis. The rationale of this mixed approach is to adequately capture the complexity of the primary utility concept. The proposed model is found to fit the data satisfactorily well. The analysis of the resulting primary utility scores of the reported trips puts into evidence that intrinsic benefits from the traveling activity are not an exclusivity of car drivers and that they can be detected in work-related as well recreational trips.

## KEYWORDS

Travel behavior; Primary utility; Measurement model; Hierarchical factor analysis

## 1. INTRODUCTION

Current transport planning theory and practice is predominantly based on the assumption that the benefits of traveling are uniquely given by the possibility of performing activities at different locations. As a consequence, the fact of making a trip is something that intrinsically has nothing valuable. People behaviors and choices are then modeled assuming that they trade higher mobility levels with higher utilities derived from the related activity patterns.

This view, at least seen as an absolute, started being challenged by some recent scholarly works, that are pointing at the possible existence of a utility component that is inherent the traveling activity. However research in this area is still seminal and at an early development stage. As such, it is mainly focused in developing sound theoretical arguments and exploratory attitudinal models (e.g. Hupkes, 1982; Marchetti, 1994; Mokhtarian and Salomon, 2001; Handy et al., 2005; Ory and Mokhtarian, 2005). Other studies analyze phenomena that cannot easily be explained if we exclude that traveling itself could be pleasurable, such as the existence of travelers with zero value of time (Richardson, 2003) or the fact that few people would like to have a very short commute time (Redmond and Mokhtarian, 2001). More generally, it has also been pointed out that the study of such "intrinsic utility of trips" could shed some light on the debate concerning the existence of travel time budgets (Zahavi and Talvitie, 1980; Zahavi and Ryan, 1980; Kirby, 1981; Supernak, 1982; Schafer and Victor, 2000; Mokhtarian and Chen, 2004; Joly, 2005, 2006). A related issue is also the study of the determinants of the subjective assessment of the amount of consumed travel (Collantes and Mokhtarian, 2007) and of the desire to alter one's own mobility levels (Choo et al., 2005), that are respectively called subjective mobility and relative desired mobility.

Our objective is to follow and to expand this line of research, looking whether it is possible to embed this new "intrinsic utility" concept in a transport modeling process. Mokhtarian and Salomon (2001) refer to this new idea with the expression "the positive utility of travel", to stress that its existence is in contradiction with the standard microeconomics assumption of travel as a disutility to be minimized. However the distinction between "intrinsic" and "derived" utility is more grounded on theoretical considerations than on different mathematical signs, since the derived utility itself is also positive, mathematically speaking. Given the quantitative study that we develop in this article, we adopt the original expressions "primary utility" or "intrinsic utility" as they were used in the pioneering study of Hupkes (1982), in order to avoid potential confusions. The term “primary” is here used in the sense of “first in order of time or development” (primitive), or “not derivable” (direct, firsthand), according to the online Webster dictionary, and not according the other possible meaning of “most important”. The relative importance of the primary and derived trip utility components is in fact something that still needs to be quantitatively assessed (and one of the aims of this study is to contribute to reach this goal) and not an assumption.

We are interested in assessing the explanatory power of this new concept as compared to the standard determinants usually being considered in current transport engineering practice, such as trip purposes or attributes of different transport modes. This can be done once we set up a method to measure the trip utility that keeps into account the primary utility component. The aim of this paper is then to present a methodology for defining a measurement model for the primary utility of a trip. Diana (2005a) has analyzed the relationship between the primary utility of travel and driving frequency with a structural equation modeling approach. However that analytical definition of primary utility relies on the presence of driving-related physical disabilities and behavioral self-limitations of respondents, and it is not easily generalisable as such.

Beyond the development of a measurement model, alternative methodologies could be explored in order to investigate the influence of the primary utility in transport behavior. Hess et al. (2005) provide an interesting discussion on the consistency of a positive value of travel time as regards behavioural hypotheses and restrictions underpinning current econometric tools. Technically speaking, mixed logit models allow for random taste variations in the population, and then a positive travel time value can occasionally be found. However this is more the sign of a model misspecification from a microeconomic perspective, that could be due for example to the influence of unobserved travel-related attributes, so that the identified construct is not properly the travel time but something different. The problem is that the current state of the art probably does not allow for easily defining and embedding such primary utility-related attributes in random utility models. Further results are shown by Larson and Lew (2005), who propose a different methodology in the evaluation of trips with a recreation destination, based on a utility-theoretic inverse demand system. In view of the above, we believe that more directly focusing on the issue of the measurement of the primary utility could give an added value at this stage, defining a tool that could be later employed to better capture this idea in transport planning models.

The research perspective usually being adopted when dealing with the primary utility concept is focused on the role that it can have in inflating travel demand. Many of the above mentioned researches seem also to implicitly or explicitly privilege the point of view of car users in elaborating the concept and conducting related empirical work. Much of the discussion reported in Mokhtarian and Salomon (2001) is about cars, although the authors acknowledge that the primary utility is not an exclusivity of this mode. Collantes and Mokhtarian (2007) and Choo et al. (2005) study the determinants of subjective and relative desired mobility of short-distance car trips. On the other hand, the dataset used in these latter analyses is related to mobility patterns where car use is pervasive: the reported mean weekly mileage by public transport is about 9% out of the global weekly mileage for short-distance trips (19.77 out of 220.54 miles, according Choo et al., 2001, p. 60). Therefore it is likely that the related findings largely reflect the point of view of car users whenever the analysis is not categorized by transport mode, that is the approach followed in Redmond and Mokhtarian (2001) for example. Of course, this point of view is a natural and consequent choice in an experimental context where the car is the predominant mode, and moreover most of the findings of these studies are likely to be valid also for the other transport modes as well.

In the following we try to adopt a different perspective concerning the two above points, and for this we introduce the different experimental setting later described. Our efforts will hence be aimed at investigating what happens to users of different transport modes, including transit, as was done by Ory and Mokhtarian (2005) when studying the related issue of the travel liking determinants. On the other hand, beyond the generic desire to move through an open space that can influence the demand generation, it is important to assess the impact that the primary utility has on mode choice and modes use behaviors. This “multimodal perspective” could be very important from the European point of view, where the car plays a prominent role in general terms but the market shares of the other modes are still relevant in many transportation market segments, and where modal diversion strategies were considered of capital importance both in the definition of the research agendas and concerning policy recommendations at the turn of the century (European Commission, 2001 and 2002) but their implementation has been rather disappointing until now (European Commission, 2006).

We believe that the best way to attain our goal is to study the primary utility not only considering general attitudes and behaviors, but in relation with the trips that persons actually have made. In statistical terms, we could say that our observation unit will not be the individual, as for most of the above reviewed researches in the same area, but the single trip that he/she performs, as it is customary in current modeling practices. Hopefully this approach will lead to a more disaggregate and punctual analysis of the concept under investigation. In the next section we will discuss the implications of this new perspective in the definition of the study object, i.e. the trip utility construct, whereas section 3 is devoted to the description of the case study that has been considered for the measurement model development, including a short presentation of the survey instrument that has been used. Section 4 describes the exploratory factor analysis framework that has been used to preliminary define a measurement model that is coherent with the definition and correctly interprets the correlation patterns of the dataset. Section 5 shows how the model can be refined through item analysis, whereas section 6 presents the model estimation results through a hierarchical confirmatory factor analysis. The model is then tested by computing the primary utility scores for the trips included in the dataset. The concluding section offers some reflections on the reported work and describes further research developments that should be useful to refine the results.

## 2. DEFINITION OF THE “TRIP UTILITY” CONSTRUCT

### 2.1. Modeling framework

The first step for the construction of a measurement model is to develop a theoretical definition of the concept under investigation. As we stated in the introduction, the primary utility of a trip is the utility that people intrinsically have when they perform the activity of traveling, independently on what they do at different locations.

On the basis of the above reviewed past research results, we postulate that the primary utility concept encompasses different aspects that need to be separately assessed. Two components that have been identified are the utility of the activities conducted while traveling and the utility of traveling as an activity. In the present study we consider as “activities conducted while traveling” only those “complementary” activities that could also take place without traveling, such as reading, thinking or enjoying a scenery. It is however possible to think to other “inherent” activities that cannot be performed without the travel activity, such as driving a car or navigating with a map, that can also be a source of utility. However these latter cases would rather go under the other heading "utility of traveling as an activity" in our framework. The survey that will be introduced when describing our case study (see section 3) has been designed according to this bipartition, even if the utility from the "inherent" activities was not specifically addressed and can be only indirectly assessed through some of the items that will be presented in the next subsection.

In view of the above, we assume that these two facets of the primary utility are unrelated. For example, one can think about a trip on a crowded and uncomfortable commuter train during which a person has the opportunity of reviewing some important material for an imminent meeting. However, the same reviewing activity could be performed in a comfortable coach heading to a congress venue through some exotic land, when the person is fond of trains and an adventure-seeker. In other words, the primary utility has several dimensions and cannot be adequately represented by a unique latent variable or scale.

The above theoretical definition of utility allows us to form measures for our construct through a more operational articulation of the concept under investigation. Considerable preliminary work has been done at this stage to have a set of "good" measures, including some trial and error iterations. However in the following we will only describe the outcome of this process, diachronically presenting the items definitions, the data collection and the subsequent statistical analyses, for the sake of briefness and clarity. The considered measures are assumed to be represented by ordinal variables, built on semantic scales, such as "Agree", ..., "Disagree"; "Wonderful", ..., "Horrible" or "Much more", ..., "Much less".

### 2.2. Primary utility measures

We stated in the preceding section that past research work has already considered two independent components of primary utility: the utility of the "complementary" activities performed while traveling and the utility of traveling as an activity. The former component was measured for the specific trip under investigation as follows. A multiple-choice question asked first to list which of the following activities had been performed: reading, studying, working, using a cell phone, using a laptop, talking, listening to music or a radio, thinking or being alone, sleeping, making physical exercise, looking at the scenery or at shop-windows, eating or drinking, other activities (to be specified). Immediately after, the respondent was asked to rate the importance he/she attached to the activities he/she had listed. Hence, the measure we consider is the subjective assessment of the importance of the reported activities through the ordinal variable IMPORT_ACTIV. This unique variable is perhaps a too synthetic indicator to adequately capture the importance of the “complementary” travel activities. However we think that the design of the questionnaire, recalling first a reasonably broad range of possible activities, asking for their selection and then requiring to rate their importance, can provide a reasonable measure of the construct for the trip under consideration.

On the contrary, we presume that the utility of traveling as an activity is something more complex to measure. Hence, we assume that it needs to be articulated in the following dimensions in order to be adequately represented:

- The presence of implicit trip motivations, that cannot be traced back to the pattern of activities at different locations;
- The subjective evaluation of trip-related feelings;
- The desired trip length;
- The performances of the transportation mode(s) when making the trip, as well its general intensity of use.

The first three aspects of this list have already been identified in previous research (e.g. Mokhtarian and Salomon, 2001) in terms of more general attitudes of the respondent towards the activity of traveling. As we said, our analysis is instead at the single trip level, but the same concepts do not loose their validity in this more disaggregated context. Besides, we expect more precise answers when we inquire about a particular trip, rather than about a general attitude, so that the measurement error is likely to be reduced. On the other hand, constraining our analysis to a single trip might be too limiting for the “desired trip length” dimension, that could also be influenced by the general trip patterns of the individual, the time budget mentioned in the introduction, the intensity of use of the different modes etc. Future work could improve this point, but at this exploratory stage we preferred to define the primary utility exclusively on the basis of elements that are related with the trip under investigation. The fourth and last dimension has been added to adequately keep into account the influence of the use of a particular transportation mode on the primary utility, according to what has been discussed in the introduction. Different aspects related to the evaluation of transport means performances have been the object of intensive research (see for example the studies of Nicolaidis, 1975; Prashker, 1979 and Koppelman and Pas, 1980, that investigate specific aspects that were useful to improve former mode choice models, or the more recent studies of Steg, 2005; Crocket and Hounsell, 2005; Guiver, 2007 and Stradling et al., 2007).

The intrinsic meaning of these four dimensions suggests the opportunity of building ad-hoc measurement scales, rather than using a single variable as for the assessment of the importance of the activities performed during the trip. Many different items have thus been generated through comparisons with the above mentioned research works and through panel discussions with experts.

The last aspect we consider is the relationship between the activities performed at destination and the activity of traveling. It is in fact possible that trips having greater primary utility tend to be those in which the activities at destination are less relevant and the derived utility lower, thus being referred to as “undirected trips”. Within our context, it is interesting to point out that it is probably easier to assess the activities that people perform at different locations than the activity of traveling per se. For this, we decided to include in our definition some measure of derived utility, namely the respondent’s assessment of the importance of reaching the trip destination, of the necessity of making the trip and of the relevance of the trip purpose. We consider then these items as inverse measures of an additional component of the primary utility of the trip and we test if such component can be discerned from the correlation patterns among the different variables through the Exploratory Factor Analysis presented in section 4.

To sum up, the items that have been selected and included in the questionnaire for each of the above mentioned dimensions are reported in the following table.

**Table 1**

## 3. CASE STUDY

The selected methodology of analysis requires a targeted dataset that includes information usually collected through standard mobility survey, as well additional variables that correspond to the utility measures that have been defined in the preceding section. A specific survey instrument has then been designed and administered to the staff working at the French National Institute for Transport and Safety Research (INRETS). The complete description of the surveying activity can be found in Diana (2005b); in the following we only recall those points that are most important or insightful for our discussion.

The questionnaire that has been prepared is rather long and complex. This was almost unavoidable, given the exploratory nature of the work here proposed and the above mentioned articulation of the needed dataset. This led us to administer the survey to a sample of people more skilled in transportation matters than the average, such as the staff working at INRETS, so that one can be less concerned with the respondent burden issue, at least to some extent. Another advantage of this choice has been the possibility of organizing a web-based survey, that eased data collection procedures but moreover allowed for an innovative design that explored new possibilities concerning the dataset structure. For example, it has been possible to automatically pose the questions related to the primary utility construct only for a single randomly selected trip that has been made by the respondents shortly before the interview day. We also chose to focus our attention on workday trips of less than 50 kilometers that have been completed for any purpose, the purpose of a trip being defined by the kind of activities that the respondent has performed at the origin and at the destination location. This is because we believe that the primary utility of long distance or weekend trips would deserve a more targeted work. Trying to build a comprehensive measurement model in a single step risks to be a too ambitious goal.

Survey contents are synthetically depicted by the flow chart in figure 1. After a welcome page, the survey starts by asking the frequency of use of several transportation modes in the past 12 months. This can be seen as a measure of the degree of familiarity of the respondent with different modes, that could be interesting to relate to the actual mode choice. Questionnaire part 3 allows for retrieving trip chains for a given day, that is the weekday prior to the interview day. If no trips below 50 kilometers have been made on that day, then the computer asks the same questions for a previous weekday. The successive section asks full details concerning a randomly selected trip among those reported, including the use of different transportation means, like in standard mobility surveys. Part 5 is devoted to the exploration of the attitudes and perceptions of the respondent concerning this specific trip, and contains most of the questions related to the measures that have been introduced in the previous section. Then we find a variant of a classic SP experiments that is not relevant for the present study, whereas the successive part asks for an evaluation of the amount of trips made in the past and the desired amount of trips to be made in the future, both measured on a semantic scale ranging from “Far less” to “Much more”. The survey ends with customary questions on socioeconomic and demographic characteristics of the respondent and of his/her household.

**Figure 1**

This survey instrument has gone through an intensive reviewing process that involved discussions with a panel of experts and small scale pre-tests to evaluate the items. Then it went on the field, and 164 responses have been collected between November and December 2004. Comparing the number of collected responses with the number of active INRETS E-mails, the estimated response rate should be around 30%. However this latter figure cannot be exactly estimated, since it is difficult to efficiently monitor the status temporary positions, and moreover that of trainees and Ph.D. students. Active E-mails could in fact still be assigned to people that are no more in activity at INRETS, since rosters are cleaned once or twice a year.

Preliminary analyses seem to confirm that the survey dataset is well suit for testing our measurement model. The set of measures that has been defined in section 2 has been made operational through the construction of 11-point semantic scales. The number of considered points is high, compared to standard practice in measurement theory, but it is well known that more points can be used when the respondent is familiar with the subject (Chang, 1994). In our framework, workers in a transport research institute had to answer to questions related to a trip they have made, so that such requirement should largely be met. Beyond this, longer scales tend to increase the construct reliability while decreasing the accuracy of the responses (Weathers et al., 2005). This latter effect is due to the increased respondent burden. However we used an innovative questionnaire layout, with cursors that can be dragged on a ruler with the computer mouse and semantic scales identified by smileys or other graphical interfaces that do not match each point in the scale. Hence the respondent should choose a position on the ruler seeing it as a continuum, the computer would then translate this choice into a number. Hopefully this procedure can effectively limit the respondent burden.

Few observations are missing from the dataset, the number of people that did not respond to one of the items used in the following analysis being always less than 12. Another important aspect is to have a good representativeness concerning the use of different transport modes, so that the resulting model is not too prone to a dominant mode such as car drivers. Concerning this issue, we point out that each of the 164 respondents gave details on a selected trip between two activities locations. A trip can be made of several different legs if different transport modes have been used (i.e. bicycle and then a transit system). Hence we have in our dataset 234 different legs, whose modal share is shown in figure 2. It can be seen that there is a certain balance among different modes, that can be useful concerning the applicability of our results to different contexts. On the other hand, building a measurement model that is too centred on the views of car drivers could lead to biases for a significant portion of the reported trips.

**Figure 2**

## 4. EXPLORATORY FACTOR ANALYSIS

The first step for the construction of the measurement model has been the running of an exploratory factor analysis. The purpose is to gain a preliminary insight on the extent to which correlation patterns among variables are compatible with the hypothesized structure of the measurement model. In other words, we are interested in looking whether the distilled factors "look more or less like" the dimensions of the construct that have been postulated in section 2, as they are listed in table 1. On the basis of the discussion there reported, beyond such general assessment we would like to check the following two critical points: (1) whether the single variable related to the importance of the activities performed during the trip is an independent dimension, and (2) if the utility coming from the activities performed at the locations visited during the trip is represented by a self-standing factor with positive coefficients, after having reversed the scales of the corresponding items.

The limitations of an exploratory factor analysis are well known. On one hand, the rules to fix the number of factors to extract are always arbitrary to some extent. Churchill (1979) for example points out that there is a tendency to overestimate the number of dimensions, compared to those that can be theoretically identified. Furthermore, the factors that are individuated will never directly correspond to the constructs as they are listed in table 1, since the former are usually defined as a weighted sum of all the variables. In conclusion, exploratory factor analysis alone cannot bring enough evidence to support a measurement model in our context, nevertheless it rests a useful tool at the preliminary stages of the research.

A Spearman rank-order correlation matrix has been considered as the appropriate input for the factor analysis, since the considered variables are all ordinal. The principal component model has then been employed, performing also a varimax rotation of the solution in order to ease the interpretation of the results. Principal component analysis seemed to us the most appropriate technique, since we would like to account for the maximum variance of the data with the minimum number of factors. Common factor analysis could lead to better results in terms of characterization of the dimensions of the primary utility construct. However it is well known that common factor analysis, unlike the principal component model, makes some hypothesis on the structure of the covariance matrix that could lead to computational problems when the number of observation is not so big compared to the number of variables, as in our case. On the other hand, we used an orthogonal rotation method such as varimax that can give us factors that are uncorrelated, and this is a nice characteristic for example if the construct has to be used for subsequent statistical dependence analysis techniques such as regression or structural equation modeling. The price to pay is a decreased flexibility in identifying dimensions that are likely to be at least partly correlated, such as those constituting the primary utility construct.

A model run involving all the 46 variables that are listed in table 1 gave poor results, showing an unacceptable value of the Kaiser's overall measure of sampling adequacy (MSA) of .36, whereas its generally recommended minimum threshold is .70. We excluded then the four variables that had the lowest MSA, namely SECURITY, CRIME, TRIP_NECESSITY and CHEAPER, and we run again the analysis. The new overall MSA value was .76 and no variable among the 42 left showed an MSA lower than .50, so that this reduced set of variables can be considered appropriate for factor analysis.

The number of factors to be retained has been fixed initially considering some commonplace rules of thumb, and then looking at the interpretability of the results in terms of the construct dimensions that were assumed in section 2. More in details, nine factors initially had eigenvalues greater than 1 and were thus candidate for being selected, whereas the scree plot inspection did not evidence a clear cut-off value. This number of factors is greater than the number of dimensions identified in section 2, and then we run other analyses retaining 8 and 7 factors respectively. It turned out that the 8-factors solution is the most informative and is then presented here (table 2). These eight factors globally explain almost 68% of the total variance that can be observed in the dataset. Only loadings that are significant have been reported in the table. The minimum value of a factor loading to be considered significant can be determined on the basis of the sample size, the significance level and the statistical power. Hair et al. (1998) show that this value is between .40 and .45 when the sample size is between 150 and 200, assuming a significance level of 5% and a power level of 80%. This is a more stringent criterion compared to the generally followed rule of thumb of considering factor loadings above .30 as significant. We believe that it is advisable to follow this stricter rule in our case, given the exploratory nature of the analysis and the high number of considered variables and factors. To sum up, table 2 shows only factor loadings that are higher than .40.

**Table 2**

Our interpretation of the rotated factors solution that is shown in the table is as follows. The first factor is clearly representative of the implicit motivations that can push a person to make a trip. Factor 2 is related to the appreciation of the on-board transportation performances of the mode, to its frequency of use and to the quantity of trips that have been performed in the past by using this same mode. This factor can thus be seen as a measure of the satisfaction that the person has in using a particular transportation mode. Factor 3 is representative of the liking of the trip under consideration and is grounded on a series of personal sensations, as well on the direct rating of the travel pleasantness and on the desire to make more trips of the same type in the future. Factor 4 lists those performances that depend on the global characteristics of the transportation mode being used, beyond the specific on-board vehicle features that are more represented by factor 2. Factor 5 is also concerned by trip-related performances, but in a larger sense in comparison with items pertaining to factor 2 and 4. Here the stress is in fact more on the environment in which the trip has taken place. Factor 6 represents the desired travel length, intended both in spatial and in temporal sense. The assessment of the importance of the activities performed during the trip is the only variable with a significant load on factor 7. Finally, the last factor is representative of the utility of performing activities at different locations. We note that the FASTER and SPEED variables do not load on any factor, so that they will not be considered in subsequent analyses.

Several comments are possible on the basis of these preliminary results. It is for example interesting to note that the intensity of use of a transportation mode (variables FREQ_MODE and QUANTITY) is more linked to the performances of the vehicle being used than to the performances of the transportation mode as a whole (thus including for example traffic conditions, infrastructure characteristics, environmental factors etc.). On the contrary, the latter are more correlated to the overall travel liking factor. However the observed factor structure could also reflect the use of different transportation modes. Factors 2 and 4 could in fact be representative of car users, whereas factor 3 would be more related to people that used public transport or non-motorised modes to complete their journey. It is also interesting to point out that the desired travel length (factor 6) is something that cannot be identified neither with the utility of performing activities at different locations (factor 8), nor with other dimensions of the primary utility, and seems to constitute a psychological dimension that is independent. Modeling the transportation demand only on the basis of the minimisation of such a "cost" seems then quite reductive.

We run a common factor analysis with 8 factors for the sake of comparison with the above principal component model, but the correlation matrix of the considered variables is singular so that computational problems aroused. Some final communality estimates were in fact greater than 1 (these are the so-called Heywood cases), and we had to set them to 1 in order to achieve a solution, that in any case was similar to that of the principal component model but less easily interpretable. Due to these "technical" and "cognitive" shortcomings, we kept the principal component model as baseline for further analyses. Finally, we run a principal component analysis using a matrix of Pearson correlations as input as it is customarily done, even if this method is more appropriate with metric variables. Eleven factors had eigenvalues greater than 1, a number that largely exceeds the dimensions that we assumed for the primary utility construct. Solutions with fewer factors tended to mix up the above identified factors 2 and 3, and failed to provide a clear identification of factor 1 as the one we had when considering Spearman correlations. This analysis thus provided a solution that is less useful for our purposes.

After having interpreted the factors as they came out of this preliminary analysis, we can start moving from an exploratory to a confirmatory perspective in the measurement model development by comparing the resulting factor pattern with the operational definition of the construct that has been given in section 2. The first factor clearly represents the "implicit trip motivations" dimension. However we will not consider the PURPOSE_IMPORT variable within this factor, even if its load is significant according to our .40 threshold, since this item is considered a measure of the utility of performing activities at different locations in our theoretical definition.

The set of variables linked to the assessment of the transportation means performances has been split among factors 2, 4 and 5. This could make some sense, since it is possible to discern three different "kinds" of performances, as we pointed out when we interpreted each single factor. Then we could split that dimension of our definition in three sub-dimensions in order to adapt it to the exploratory factor analysis results. However we believe that this would imply a substantial complication of the measurement model, whereas we are looking for the most parsimonious one that can explain the observed correlation patterns. For this, we keep the same definition in the confirmatory analysis, grouping all the performance measurement items pertaining to factors 2, 4 and 5 in one factor. The presence of some variables that have a significant loading on more than one of these three factors is another indication concerning the opportunity of merging them.

The remaining factors more directly reflect a corresponding dimension of our definition. The importance of the activities performed during the trip is clearly represented by factor 7, trip-related feelings by factor 3, desired trip length by factor 6 and the utility due to activities at different locations by factor 8.

To sum up, we can say that the exploratory factor analysis gives support to the postulated utility definition, although one dimension has been split in three different factors. However this latter finding is not surprising, given the limitations of this analysis that we mentioned at the beginning of this section. Evidence on the possibility of meaningfully interpreting the correlation patterns in the dataset was found, so that it seems then reasonable to go on in the evaluation and refinement process of the proposed model. At this stage, the tentative measurement model that we would like to assess is represented in table 3, where and asterisk denotes the items pertaining to each dimension. All the corresponding coefficients are expected to be positive.

**Table 3**

These results alone give useful indications but cannot be considered as valid in an absolute sense. In fact, beyond the abovementioned exploratory framework peculiarities, we have also to say that the number of considered variables (40) is too big compared to the number of observations in our dataset, thus not respecting the generally recommended threshold of a 1 to 5 ratio. On the other hand, after having delineated a tentative grouping of the variables into a smaller number of dimension, the following step would be to look for the internal consistency of each dimension of the utility construct. This will be done through an item analysis for every of the above defined dimensions, that will allow for choosing a subset of the best variables to be retained in the final model. Decreasing the number of variables to consider will in turn simplify the model, so that its complexity can be made compatible with the number of observations in the dataset.

## 5. INTERNAL CONSISTENCY OF SCALES: ITEM ANALYSIS

The exploratory factor analysis allowed us to sketch a tentative measurement model for the utility construct. It can be seen from table 3 that this model is rather "rich", since it considers 40 variables and six factors. Hence it is probably too demanding, and the dataset that is needed for its correct use is too complex for most practical applications. In this section we will try to improve the model parsimony through an item analysis of every dimension of the measurement model. The purpose is to check whether it is possible to drop some of the variables without loosing the explanatory power of the model. This can be achieved by maximising the *internal consistency* of every dimension, defined as the correlation between the single variables and the corresponding latent factor. The internal consistency is an indicator of the reliability of the model, that is the portion of the measure that is not affected by random error.

We studied the internal consistency of each model dimension, as they are represented in table 3, through the computation of the Cronbach alpha coefficient (Cronbach, 1951):

$$alpha = \frac{k}{k-1}\frac{s^2 - s_i^2}{s^2}$$

where $k$ is the number of items pertaining to the considered dimension, $s^2$ is the variance of the sum of items and $s_i^2$ is the variance of item $i$. The value of alpha is usually between 0 and 1, higher values indicating greater consistency. Of course this method is not applicable when only one item is present ($k = 1$), so that the dimension pertaining to the importance of the activities performed while traveling has not been assessed. Following standard guidelines in measurement theory, we would like to keep a maximum of five items for each dimension. This is because almost all the items within each scale were quite strongly correlated, so that it should possible to have good scales even considering few of them, thus improving the model parsimony.

Looking at table 3, three model dimensions, namely “Implicit trip motivations”, “Trip-related feelings” and “Transport means performances”, have more than five items. An iterative process has then been set up, involving an initial computation of the item to total correlation of all the variables, the elimination of the variable with lowest correlation and a new computational iteration, until up to five items are left. Thus we obtained three new scales with five items for measuring these dimensions, each scale showing a Cronbach alpha value larger than the recommended minimum threshold of 0.7. The other two dimensions are more problematic to assess with this method, since Cronbach alpha is sensitive to the number of items, and it could not be so meaningful when we have only two of them, like in the scale measuring the utility of activities performed at various locations. However the DESIRED_DISTANCE variable had a negative item to total correlation with the “desired trip length” dimension, so that we decided to drop this variable. This poor performance is probably due to the difficulty that respondents have in evaluating the distance covered during a trip, particularly for short trips and when an individual transport means is not used.

To sum up, we report in table 4 the new definition of the six constructs, with the item to total correlations and the standardized Cronbach alpha values (scaling the variables to a unit variance of 1) for the five constructs that have more than one item. The table also introduces some notation that will be used in the next section: $y_i$ thus indicates the i-th item in the list and $\eta_j$ the j-th dimension.

**Table 4**

This methodology presents some drawbacks. Beyond its inapplicability to single-item dimensions and the fact that alpha is sensitive to the number of items, it also assumes that the measurement error variance is the same for all the items of the scale (i.e. the measures are tau-equivalent) and it does not account for *external consistency* (i.e. the correlation among items pertaining to different dimensions). However we recall that our goal was to define a simpler model without loss of internal consistency, more than assessing its fit. This latter check will now be performed on this more parsimonious version of the measurement model, that includes the 20 variables listed in table 4.

## 6. FINAL MODEL ASSESSMENT: SECOND-ORDER CONFIRMATORY FACTOR ANALYSIS

### 6.1. Model definition

Several different methodologies have been proposed in the past to assess a measurement model, but there is now a growing consensus on the advantages of using a confirmatory factor analysis technique (Gerbing and Anderson, 1988). Unlike the above presented analyses, it is in fact possible to specify and test several different variants of a measurement model, each time evaluating how the model fits the data. However this procedure should always be grounded on a strong theoretical evidence, in order not to violate the confirmatory nature of this technique. Modifying a model only to improve its fit would in fact lead to results that are valid only for the specific case under investigation, with little general validity. This is why our confirmatory analysis comes after considerable preliminary work that has been described in the preceding sections, that can give us a sufficiently robust framework. Another important advantage is given by the possibility of defining hierarchical structures, in which latent dimensions such as those introduced in the preceding sections may be influenced by a higher-order latent variable. In our case, we can then define the primary utility as something that is not directly influenced by any manifest variable, but only by the constructs that are listed in table 4.

The standard notation for the measurement model within a confirmatory factor analysis framework has been developed since the Seventies and is usually called the LISREL notation, from the name of one of the most popular computer programs used to estimate it. Adapting this notation to our case, where we deal with a second-order model, we have

$$\mathbf{y} = \Lambda_{\mathbf{y}} \, \boldsymbol{\eta} + \boldsymbol{\varepsilon}$$

$$\boldsymbol{\eta} = \gamma \, \boldsymbol{\xi} + \boldsymbol{\zeta}$$

where $\boldsymbol{\eta}$ is the vector of the six first-order unobserved factors, that are the latent dimensions listed in table 4, and $\mathbf{y}$ is the vector of the corresponding 20 observed indicators. The rectangular matrix $\Lambda_{\mathbf{y}}$ contains the factor loadings $\lambda_{i,j}$, that indicate the magnitude of expected change in $y_i$ for one unit change in $\eta_j$, whereas $\boldsymbol{\varepsilon}$ is the vector of the measurement errors for $\mathbf{y}$, thus containing 20 elements. Considering the second of the above equations, $\boldsymbol{\xi}$ is the vector containing the second-order factor we defined, i.e. the primary utility $\xi_1$, $\boldsymbol{\gamma}$ is the vector of the factor loadings $\gamma_1, ..., \gamma_6$ of $\eta_1, ..., \eta_6$ on $\xi_1$ and $\boldsymbol{\zeta}$ is the vector of measurement errors for $\boldsymbol{\eta}$. We also define the covariance matrix $\boldsymbol{\Theta_\varepsilon}$ of the measurement errors $\varepsilon_1, ..., \varepsilon_{20}$ and the covariance matrix $\boldsymbol{\Psi}$ of the measurement errors $\zeta_1, ..., \zeta_6$ of the first-order latent variables.

The path diagram of the proposed measurement model is shown in figure 3. The number of parameters that need to be estimated can be computed as follows. The number of nonzero elements of $\boldsymbol{\Lambda_y}$ equals the number of indicators (20), since we see from table 4 that each indicator loads on only one factor. We have thus only one nonzero element in each row of $\boldsymbol{\Lambda_y}$. Furthermore, we need to provide a scale for the latent variables $\eta_1, ..., \eta_6$, so that one factor loading per dimension is fixed to one, thus having $\lambda_{1,1} = \lambda_{2,2} = \lambda_{7,3} = \lambda_{12,4} = \lambda_{14,5} = \lambda_{19,6} = 1$; the remaining 14 nonzero loadings must be estimated by the model. The second-order latent variable $\xi_1$ is scaled by fixing its variance to one. The diagonal elements of $\boldsymbol{\Theta_\varepsilon}$ represent the variances of the corresponding 20 measurement errors that should also be estimated.

**Figure 3**

Figure 3 shows also one correlation among measurement errors that has been estimated on the basis of theoretical considerations. People seem in fact to perceive in similar ways the fact of travelling for being alone and for organizing ideas, so that we assume a positive correlation between the corresponding measurement errors $\varepsilon_5$ and $\varepsilon_6$. This corresponds to the only off-diagonal nonzero element of $\boldsymbol{\Theta_\varepsilon}$. Finally, we need to estimate the six second-order factor loadings $\gamma_1, ..., \gamma_6$ and the six nonzero elements of the diagonal matrix $\boldsymbol{\Psi}$. The proposed model has hence 47 parameters to be estimated.

After listwise deletion of the missing cases, the dataset we use includes 152 observations, implying that the rule of thumb of having at least five observations per estimated parameter is not met in our case. Given this limitation, we have then to improve the model parsimony, and the above rule suggests that we should have a model with no more than 30 parameters that need to be estimated. Looking at our model specification, we realize then that we must drop two out of the six above dimensions, both having five manifest variables in order to achieve a sufficiently parsimonious model with 25 free parameters. Different model variants have thus been considered and compared, and it turned out the one that excludes $\eta_3$ and $\eta_5$, i.e. the variables pertaining to trip-related feelings and to the transport means performances, outperforms the others. It has then been retained for subsequent analysis, and the omitted dimension $\eta_3$ and $\eta_5$ are shaded in figure 3. This latter simplification was clearly not theoretically driven, and future work on a bigger database will allow to estimate the complete model as developed in the previous sections. Nevertheless, we believe that even this simplified version of the primary utility model leads to some interesting results that will be shown in section 7, despite the fact of not considering all the dimensions of the construct that have been previously identified.

### 6.2. Model estimation

Model estimation has been carried out by using the CALIS procedure within the SAS package and the Maximum Likelihood method. As for the exploratory factor analysis, a Spearman correlation matrix has been used as input, since the considered variables are ordinal. Fit statistics give some support for the model. In particular, the Adjusted Goodness-of-Fit Index (AGFI) is 0.89, the Normed Fit Index is 0.95 and the estimate of the Root Mean Square Error of Approximation (RMSEA) is 0.0585, its 90% confidence interval being [0.0163-0.0913]. The likelihood-ratio $\chi^2$ of 45.51 with 30 degrees of freedom is significant at the 5% level ($p$ = 0.0346), thus potentially indicating differences between the observed and the estimated moment matrix. However this latter statistics suffers from upward biases when the number of indicators rises and departures from normality are observed in the dataset, and our chi-squared / degrees of freedom of 1.5 is below the generally accepted conservative threshold of 2. Standardized factor loadings resulting from the estimation process are reported in table 5.

Table 6 reports the total effects of the observed variables and the first-order factors on the primary utility construct. All these effects have an appreciable influence, thus confirming that the primary utility concept has several different facets that justify the use of a rather complex measurement model.

**Tables 5 and 6**

### 6.3. Validity of the proposed model

On the basis of the results shown in table 5, it is possible to assess the model *validity* in order to determine to what extent it measures what it is supposed to measure. This completes the analyses carried out in section 5, where the internal reliability of the construct has been studied.

Measurement theory usually distinguishes different types of validity. *Content validity* is a qualitative assessment of the representativeness of our items respect the travel utility concept as we defined it. As we mentioned in section 3, panel discussions with experts with different backgrounds have been carried out to check that our measures adequately cover the underlying concept. *Criterion validity* concerns whether a measure relates to an external criterion variable, such as a previously developed measurement model or scale for the same construct. In our case we could not find a previous measure for the primary utility concept, so that this part of the analysis cannot be applied.

*Convergent* and *discriminant validity* can be studied through confirmatory factor analysis. A set of indicators that measures the same construct shows convergent validity if their intercorrelations are sufficiently high, whereas two variables measuring different constructs should show discriminant validity, i.e. low intercorrelations. We are interested in assessing convergent validity for both first- and second- order constructs. One possible measure for convergent validity is the magnitude of the estimated factor loadings $\lambda_{i,j}$ and $\gamma_j$, also called validity coefficients within this framework (Bollen, 1989). Looking at the values reported in table 5, all factor loadings but one exceed the value of 0.45, which supports convergent validity. On the other hand, correlations among latent variables $\eta_j$ can be used to study discriminant validity. Looking at the model estimation results, we found two correlation coefficients among the four considered first-order latent variables that are greater than 0.20, namely the correlation between $\eta_2$ and $\eta_4$ (0.28) and that between $\eta_2$ and $\eta_6$ (0.27). This suggest some overlapping among different dimensions but substantially confirms that the latent variables are capturing different facets of the primary utility construct.

### 6.4. Alternative model specifications

Evaluating different model specifications can be useful to determine the added value of the proposed measurement model in comparison with simpler alternatives.

The most straightforward simplification would be to consider a single-factor model that directly links the considered indicators $y_1$, ..., $y_{20}$ with the primary utility construct $\xi_1$. Fitting such a model lead to poor results, so that the necessity of considering different dimensions when measuring the trip utility seems to be confirmed.

Another possible variant is the multifactor model that does not consider the second-order primary utility construct, but introduces the estimation of the correlations among different utility dimensions $\eta_j$. These correlations could in fact be seen as an alternative way to represent a common pattern among latent variables. The resulting model fits our data slightly worse than the base model, but it could also be accepted. Confirming the convergent validity study carried out in the preceding section, only $\eta_2$, $\eta_4$ and $\eta_6$ show statistically significant intercorrelations. In summary, this competing model is not less acceptable that the original one on a statistical point of view, but its interpretation is more problematic in view of our primary utility concept, since the outcome is the definition of a set of scales, some of which are almost unrelated. This model is then also quite informative, but less appealing on an analytical point of view if one wants to embed a quantitative measurement of the concept in some applicative studies. Hence we deem more appropriate to propose a hierarchical structure for our measurement model, that allows for the identification of the primary utility on a statistically grounded basis.

## 7. MEASURING THE PRIMARY UTILITY OF REPORTED TRIPS

In this section we show an application of the above defined model. We consider again the case study dataset and we measure the primary utility of the 164 reported trips, by determining the scores of the $\xi_1$ construct. These scores are not much meaningful per se, since there is not a norm or a standard measurement unit for the considered construct, nor can they be compared with scores from other samples. However within-sample comparisons, particularly for what concerns differences due to some categorical variables such as the trip purpose, the transport mode being used or the socioeconomic status of the respondent, can be helpful in studying the phenomenon of the primary utility of trips through quantitative analysis. We remind that our trip sampling is not completely representative of all the trips that have been made by the respondents, since weekend trips are not present in the dataset. This should be kept in mind when considering the following results.

Trip scores have been estimated by multiplying the observed variables $y_1$, ..., $y_{20}$ by the latent variables scores regression coefficients and summing the results. Regression coefficients can be computed on the basis of the covariances among latent and manifest variables that are predicted by the model. Mathematical details concerning this procedure can be found in SAS Institute (2000).

Several different analyses are possible. For the sake of briefness here we will limit ourselves to the study of the distribution of the primary utility scores per classes of transport mode and of trip purpose. The corresponding histograms are presented in figures 4 and 5 respectively. In order to have a sufficiently high number of cases, the classes we use in this analysis are obtained by merging more disaggregated information that is present in the dataset. Concerning transportation means, we only consider car drivers on one hand and transit users on the other, excluding from the analysis those modes that have been less frequently reported, such as car passenger, bicycle or motorcycle. Also trip purposes have been grouped into work-related trips and others.

**Figures 4 and 5**

Concerning the influence of the use of a transport mode on the primary utility, we see that the mean score difference between car drivers and transit users is almost irrelevant. It is also interesting to point out that the primary utility for car drivers is more dispersed, with almost 10% of them having a score in the lowest decile and some of them in the highest. These results seem to confirm that the primary utility is not an exclusivity of car drivers, but it is something that involves the users of several different transport modes.

The difference between work and non-work trips is not surprisingly more marked, with non-work trips showing higher mean scores but also higher score dispersion. One might wonder at this point if this result is biased by the potential confusion that respondents are likely to make between the utility of the trip itself and the utility of reaching a pleasant destination. However looking at the histograms of figure 5 we notice that a substantial proportion of non-work trips scores falls in the lowest quartile. Correspondingly, some work trips show a rather high primary utility. These results seem to give an initial support to the idea that the proposed measurement model can discriminate, at least to some extent, between the utility of the trip itself and the utility of the activities performed at different locations. This is mainly due to the "indirect" methodology it uses to measure the primary utility of trips.

## 8. CONCLUSIONS

This paper presented a model to measure the primary utility of trips, i.e. the intrinsic utility that people have through the activity of traveling. The model has been estimated on a sample of responses from a mixed travel and attitudinal survey administered to the staff of the French National Institute for Transport and Safety Research. It has then been possible to metrically study a phenomenon, whereas previous qualitative, empirical and analytical work was mainly focused in providing evidence of this very new concept. As an illustrative example, the relationship between primary utility, mode use and trip purpose has been analyzed in order to test the model capabilities. These early results confirm that recreational trips tend to have greater primary utility, even if we keep into account possible measurement biases, and show that the primary utility is not an exclusive prerogative of car drivers.

Future studies will be aimed at pursuing the model validation through its application to different case studies. The use of larger datasets would allow for performing more disaggregate analyses, studying the primary utility in relation with transport modes less used but potentially interesting under this aspect, such as the bicycle. Under this point of view, the inclusion of a "primary utility inset" in the latest French National Travel Survey of 2007 (Papon et al., 2007) represents a formidable research opportunity. Also two-way comparisons could be helpful in determining the joint effect of variables such as trip purpose and transport mode. Results from different studies could finally lead to the definition of a norm, or a commonly agreed measurement unit for the primary utility construct, against which the outcome of different studies could be matched.

## ACKNOWLEDGEMENTS

This research has been made possible by a French government postdoc scholarship that was granted through INRETS (The French National Institute for Transport and Safety Research). Suggestions from many colleagues working at the Department of Transport Economics and Sociology of INRETS have been much helpful during the data collection phase. Finally, the author is deeply indebted to a referee for his/her very thorough and outstanding work, that greatly contributed in improving an earlier version of the paper in some key theoretical and

methodological aspects, suggesting also some relevant references to previous works on the transport modes performances that have been added in the final version.

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## List of figures



## List of tables

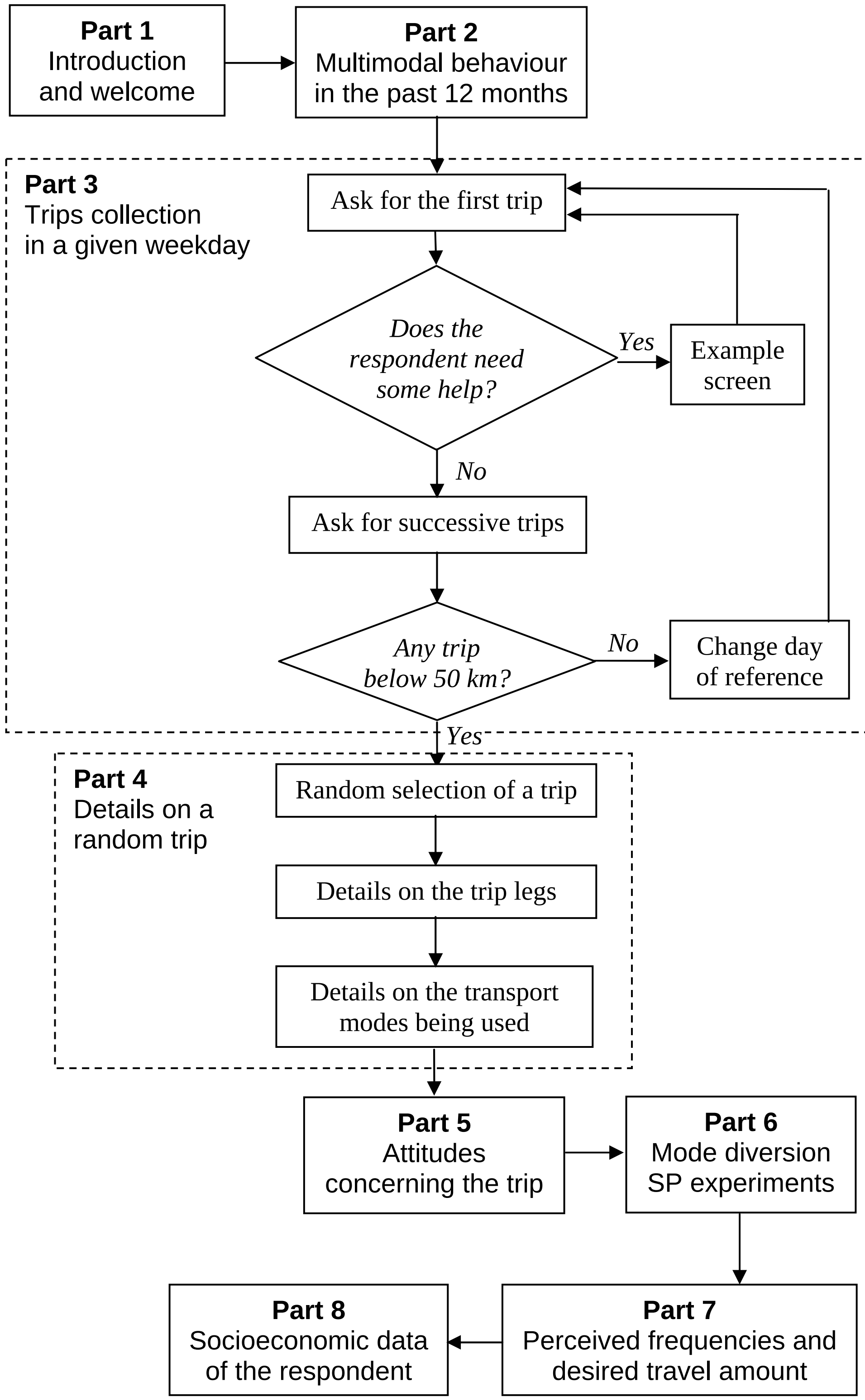


**Fig. 1. Flow chart of the survey instrument**

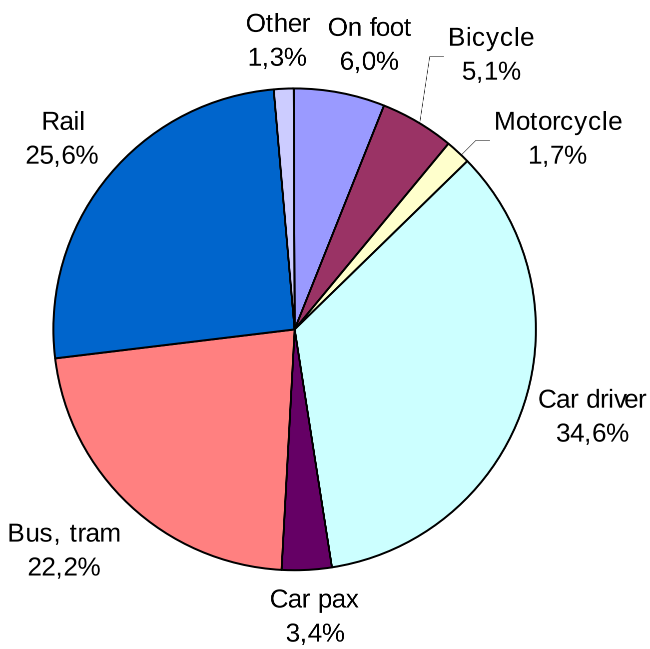


**Fig. 2. Mode share of the reported trip legs (234 legs of 164 trips, one per respondent)**

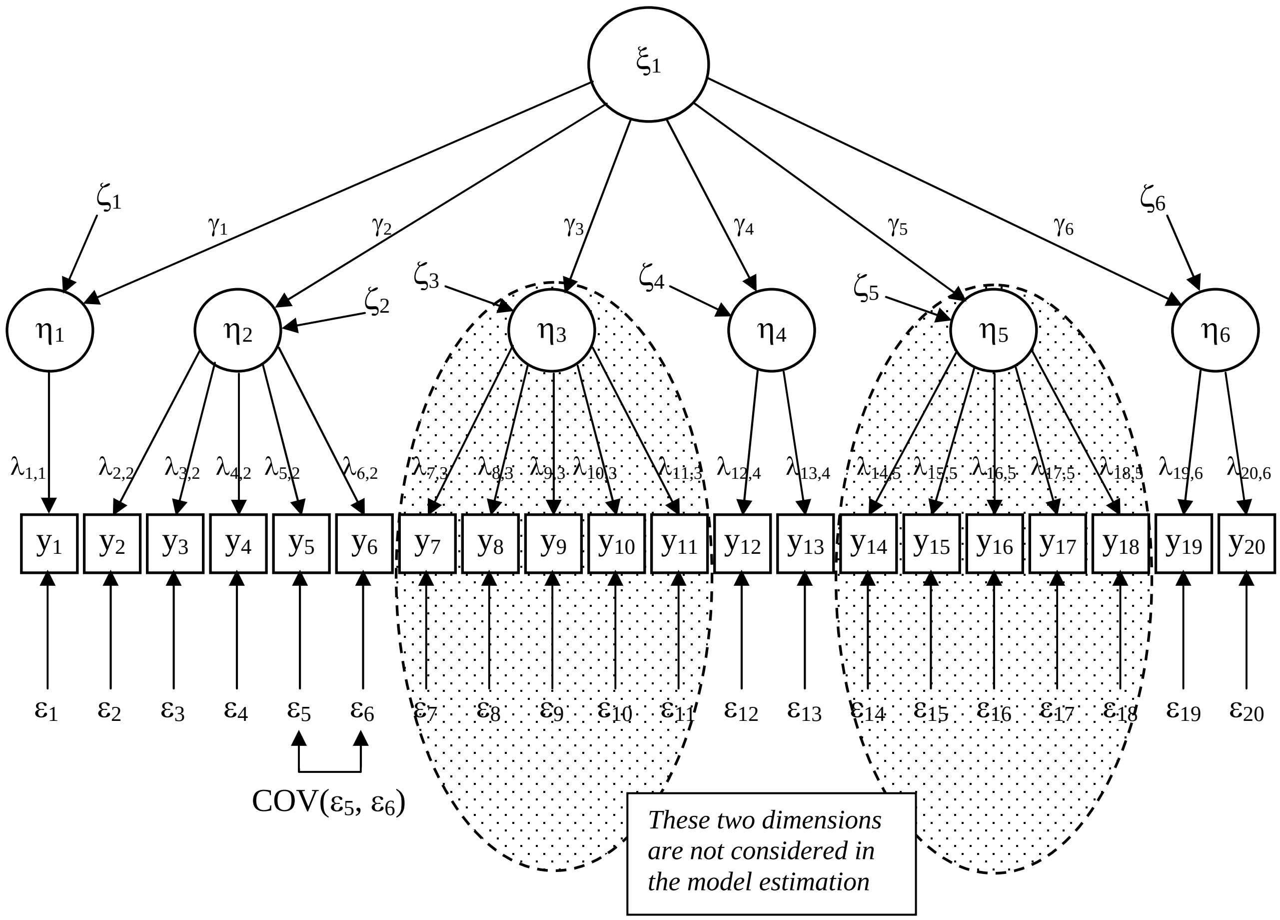


**Fig. 3. Path diagram of the hierarchical confirmatory factor model**

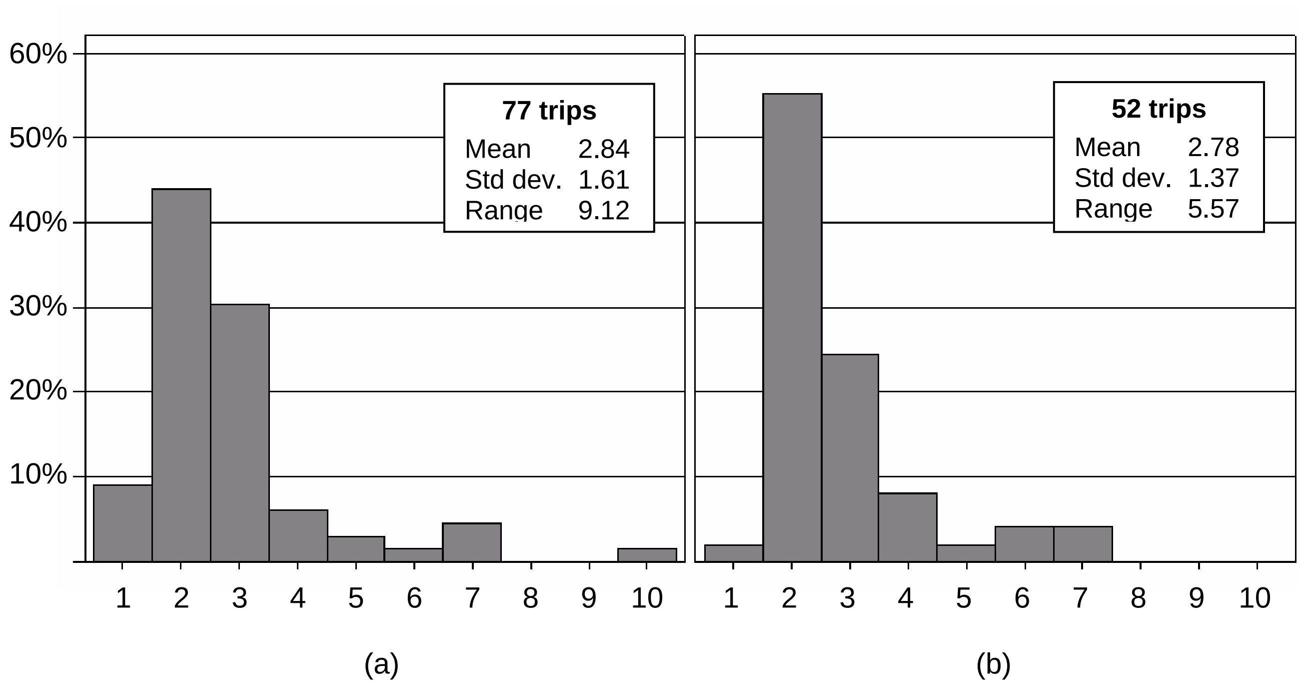


**Fig. 4a,b. Distribution of the primary utility scores for car drivers (a) and transit users (b)**

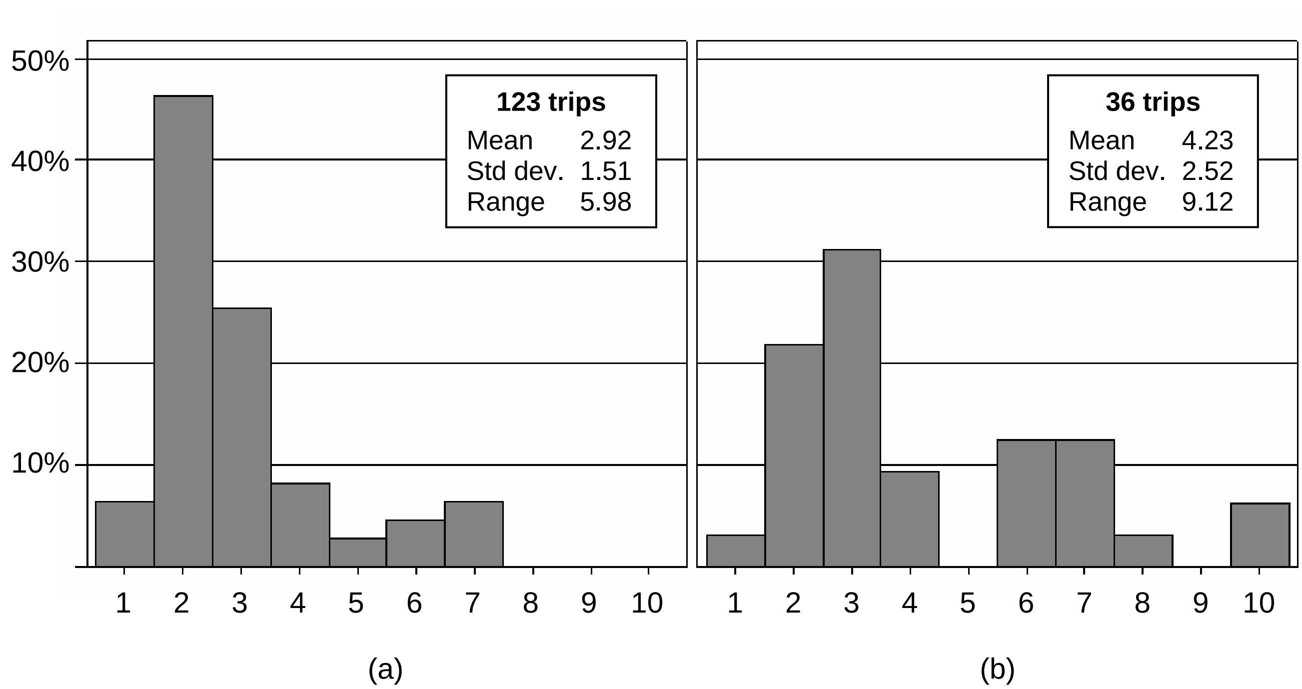


**Fig. 5a,b. Distribution of the primary utility scores for work (a) and non-work (b) trips**

Table 1

| Dimensions and measurement items considered for the model definition | |
|---|---|
| *Importance of the activities performed while traveling* | |
| ACTIV_IMPORT | Importance of the activities performed while traveling |
| *Implicit trip motivations* | |
| DETOUR | Detour to enjoy a better environment |
| EXPLORE | Traveling to explore new places |
| ITINERARY | Unusual itinerary to reach a known destination |
| SAKE_OF_IT | Traveling just for the sake of it |
| LENGTHENING | Longer trip to better know the surroundings |
| RELAX | Traveling just for relax |
| FAR_DESTIN | Destination farther off than necessary |
| NO_PURPOSE | Trip without a well defined purpose |
| IDEAS | Traveling to organize ideas |
| ALONE | Traveling to be alone |
| FUN | Traveling for fun |
| SHOW | Trip to show off a transport means |
| *Trip-related feelings* | |
| FREEDOM | Sensation of freedom |
| SPEED | Sensation of speed |
| NO_WASTE | Sensation of not wasting time |
| LANDSCAPE | Good relationship with the surrounding environment |
| NATURE | Harmony with nature |
| WELLBEING | Sensation of well-being |
| TRIP_LIKING | Overall trip liking |
| TREND | Willingness to do the same trip in the future |
| *Desired trip length* | |
| TELEPORT(*) | Willingness to being teleported |
| DESIRED_TIME | Desired trip length in minutes |
| DESIRED_DISTANCE | Desired trip length in kilometers |
| FASTER | Time gain when using a faster means |
| CHEAPER | Money saving when using a cheaper means |
| *Transport means performances and use* | |
| RELIABILITY | Reliability of the transport means |
| FLEXIBILITY | Possibility of schedule adjustments |
| COMFORT | Comfort during the trip |
| RAPIDITY | Sensation of traveling fast |
| FAMILIARITY | Sensation of familiarity with the transport means |
| ACCES | Easily accessible transport means |
| SECURITY | Safety concerning accidents |
| CRIME | Safety concerning crime |
| SPACE | Enough onboard space |
| OTHERS | Nice human interactions |
| TEMPERATURE | Right temperature |
| AIR | Good air quality |
| NOISE | Absence of noise |
| PATH | Nice route followed by the means |
| STRESS | Absence of fatigue and stress |

| | |
|---|---|
| FREQ_MODE | Frequency of use of this mode |
| QUANTITY | Quantity of trips undertaken using this mode |
| *Importance of the activities performed at various locations* | |
| DEST_IMPORT(*) | Importance of reaching the destination |
| TRIP_NECESSITY(*) | Necessity of making the trip |
| PURPOSE_IMPORT(*) | Importance of the trip purpose |

NB: An asterisk denotes an item whose semantic scale that has been reversed in the model

Table 2

Exploratory factor analysis results

| *FACTOR* | *1st* | *2nd* | *3rd* | *4th* | *5th* | *6th* | *7th* | *8th* |
|---|---|---|---|---|---|---|---|---|
| RELIABILITY | | | | 0.683 | | | | |
| FLEXIBILITY | | 0.415 | | 0.633 | | | | |
| COMFORT | | 0.688 | | | | | | |
| RAPIDITY | | | | 0.726 | | | | |
| FAMILIARITY | | | | 0.643 | | | 0.426 | |
| ACCES | | | | 0.658 | | | | |
| SPACE | | 0.717 | | | | | | |
| OTHERS | | | | | 0.538 | | | |
| TEMPERATURE | | 0.671 | | | | | | |
| AIR | | 0.451 | | | 0.705 | | | |
| NOISE | | 0.524 | | | 0.580 | | | |
| PATH | | | 0.403 | | 0.631 | | | |
| STRESS | | | | | 0.743 | | | |
| DEST_IMPORT | | | | | | | | 0.587 |
| PURPOSE_IMPORT | 0.552 | | | | | | | 0.465 |
| FASTER | | | | | | | | |
| FREEDOM | | | 0.707 | | | | | |
| SPEED | | | | | | | | |
| NO_WASTE | | | 0.802 | | | | | |
| LANDSCAPE | | | 0.559 | | | | | |
| NATURE | | | 0.638 | | | | | |
| WELLBEING | | | 0.696 | | | | | |
| TELEPORT | | | | | | 0.501 | | |
| ACTIV_IMPORT | | | | | | | 0.787 | |
| DETOUR | 0.694 | | | | | | | |
| EXPLORE | 0.813 | | | | | | | |
| ITINERARY | 0.719 | | | | | | | |
| SAKE_OF_IT | 0.799 | | | | | | | |
| LENGTHENING | 0.864 | | | | | | | |
| RELAX | 0.863 | | | | | | | |
| FAR_DESTIN | 0.858 | | | | | | | |
| NO_PURPOSE | 0.778 | | | | | | | |
| IDEAS | 0.857 | | | | | | | |
| ALONE | 0.861 | | | | | | | |
| FUN | 0.881 | | | | | | | |
| SHOW | 0.817 | | | | | | | |
| TRIP_LIKING | | | 0.522 | | | | | |
| DESIRED_TIME | | | | | | 0.741 | | |
| DESIRED_DISTANCE | | | | | | 0.827 | | |
| FREQ_MODE | | 0.904 | | | | | | |
| QUANTITY | | 0.871 | | | | | | |
| TREND | | | 0.596 | | | | | |

**NB.** Analysis drawn on a Spearman correlation matrix with pairwise deletion of the missing cases, so that the sample size varies from 152 to 164

Table 3

Tentative measurement model

| *DIMENSION* | *Trip activities importance* | *Implicit trip motivations* | *Trip-related feelings* | *Desired trip length* | *Transport means perform.* | *Location activities importance* |
|---|---|---|---|---|---|---|
| RELIABILITY | | | | | * | |
| FLEXIBILITY | | | | | * | |
| COMFORT | | | | | * | |
| RAPIDITY | | | | | * | |
| FAMILIARITY | | | | | * | |
| ACCES | | | | | * | |
| SPACE | | | | | * | |
| OTHERS | | | | | * | |
| TEMPERATURE | | | | | * | |
| AIR | | | | | * | |
| NOISE | | | | | * | |
| PATH | | | | | * | |
| STRESS | | | | | * | |
| DEST_IMPORT | | | | | | * |
| PURPOSE_IMPORT | | | | | | * |
| FREEDOM | | | * | | | |
| NO_WASTE | | | * | | | |
| LANDSCAPE | | | * | | | |
| NATURE | | | * | | | |
| WELLBEING | | | * | | | |
| TELEPORT | | | | * | | |
| ACTIV_IMPORT | * | | | | | |
| DETOUR | | * | | | | |
| EXPLORE | | * | | | | |
| ITINERARY | | * | | | | |
| SAKE_OF_IT | | * | | | | |
| LENGTHENING | | * | | | | |
| RELAX | | * | | | | |
| FAR_DESTIN | | * | | | | |
| NO_PURPOSE | | * | | | | |
| IDEAS | | * | | | | |
| ALONE | | * | | | | |
| FUN | | * | | | | |
| SHOW | | * | | | | |
| TRIP_LIKING | | | * | | | |
| DESIRED_TIME | | | | * | | |
| DESIRED_DISTANCE | | | | * | | |
| FREQ_MODE | | * | | | | |
| QUANTITY | | * | | | | |
| TREND | | | * | | | |

Table 4

Confirmatory model specification with Cronbach alpha coefficients and item to total correlations (N = 152)

| | |
|---|---|
| *$\eta_1$ : Importance of the activities during the trip* | - |
| $y_1$ : ACTIV_IMPORT | - |
| *$\eta_2$ : Implicit trip motivations* | alpha = 0.87 |
| $y_2$ : SAKE_OF_IT | 0.75 |
| $y_3$ : RELAX | 0.83 |
| $y_4$ : FAR_DESTIN | 0.45 |
| $y_5$ : IDEAS | 0.79 |
| $y_6$ : ALONE | 0.64 |
| *$\eta_3$ : Trip-related feelings* | alpha = 0.84 |
| $y_7$ : FREEDOM | 0.66 |
| $y_8$ : NO_WASTE | 0.72 |
| $y_9$ : NATURE | 0.54 |
| $y_{10}$ : WELLBEING | 0.76 |
| $y_{11}$ : TRIP_LIKING | 0.52 |
| *$\eta_4$ : Desired trip length* | alpha = 0.50 |
| $y_{12}$ : TELEPORT | 0.33 |
| $y_{13}$ : DESIRED_TIME | 0.33 |
| *$\eta_5$ : Transport means performances and use* | alpha = 0.82 |
| $y_{14}$ : RELIABILITY | 0.60 |
| $y_{15}$ : FLEXIBILITY | 0.57 |
| $y_{16}$ : COMFORT | 0.62 |
| $y_{17}$ : RAPIDITY | 0.69 |
| $y_{18}$ : SPACE | 0.55 |
| *$\eta_6$ : Importance of the activities at locations* | alpha = 0.45 |
| $y_{19}$ : DEST_IMPORT | 0.29 |
| $y_{20}$ : PURPOSE_IMPORT | 0.29 |

Table 5

Standardized factor loadings of the confirmatory factor model (N = 152)

| *First-order coefficients* | | *Second-order coefficients* | |
|---|---|---|---|
| $\lambda_{1,1}$ | 0.61 | $\gamma_1$ | 0.37 |
| $\lambda_{2,2}$ | 0.87 | $\gamma_2$ | 0.73 |
| $\lambda_{3,2}$ | 0.95 | | |
| $\lambda_{4,2}$ | 0.76 | | |
| $\lambda_{5,2}$ | 0.90 | | |
| $\lambda_{6,2}$ | 0.87 | | |
| $\lambda_{12,4}$ | 0.79 | $\gamma_4$ | 0.54 |
| $\lambda_{13,4}$ | 0.45 | | |
| $\lambda_{19,6}$ | 0.46 | $\gamma_6$ | 0.95 |
| $\lambda_{20,6}$ | 0.84 | | |

Table 6

Total effects of manifest and latent variables on the primary utility $\xi_1$ (N = 152)

| *Manifest variables* | | *Latent variables* | |
|---|---|---|---|
| $y_1$ | 0.23 | $\eta_1$ | 0.23 |
| $y_2$ | 0.64 | $\eta_2$ | 0.64 |
| $y_3$ | 0.69 | | |
| $y_4$ | 0.56 | | |
| $y_5$ | 0.66 | | |
| $y_6$ | 0.63 | | |
| $y_{12}$ | 0.43 | $\eta_4$ | 0.43 |
| $y_{13}$ | 0.25 | | |
| $y_{19}$ | 0.44 | $\eta_6$ | 0.45 |
| $y_{20}$ | 0.80 | | |