

# **Incorporating equity into transport planning: utility, priority and sufficiency approaches**

**Karel Martens**

Associate Professor, Institute for Management Research, Radboud Universiteit  
Nijmegen

**Floriea Di Ciommo**

Senior Research Associate, Universidad Politecnica de Madrid- TRANSyT, Spain

**Anestis Papanikolaou**

Senior Research Associate, Hellenic Institute of Transport-Centre for Research and  
Technology Hellas, Greece

## **ABSTRACT**

The analysis addresses the issue of transport equity and explores three different approaches to equity in transport: utilitarianism, sufficientarianism and prioritarianism. Each approach calls for a different treatment of the benefits reaped by different population groups in the assessment of transport investments or policies. In utilitarianism, which underlies much of the current practice of transport project appraisal, all benefits receive the same weight, irrespective of the recipient of the benefits. In both sufficientarianism and prioritarianism, benefits are weighed in distinct ways, depending on the characteristics of the recipients. The three approaches are illustrated using a fictive case study, in which three different transport investment are assessed and compared to each other. Finally, the assessment of transport investments will be explored using the cost-effectiveness analysis (CEA). The CEA assesses the distributional effects of transport investments for utilitarianism, sufficientarianism and prioritarianism approaches and addresses distinct needs associated with different population groups in respect to their transport.

*Keywords: fairness in public transport, moral principles, utilitarianism, sufficientarianism, prioritarianism.*

## **1. INTRODUCTION**

The aim of this paper is to develop a methodology to assess the benefits resulting from transportation investments in an urban region, emphasizing the inclusion of transport equity impacts and their significance in the overall evaluation process of transport investments.

The objectives of this paper are threefold: (1) to highlight the need for a new approach to take into account equity considerations in transport planning and network design; (2) to propose cost-effectiveness as the adequate methodological tool to address the distinct needs related to different population groups; and (3) to illustrate the approach and methodology to the evaluation of three fictive transport alternative investments.

## **2. EX ANTE EVALUATION OF ALTERNATIVES TRANSPORT MODES**

### **2.1 A fair distribution of accessibility**

Various researches show that the more important barriers to reach access to the out-of-home activities are related with space (distance) and time, with transport playing a key role for the level of accessibility. The approach adopted in this article is related with the ex-ante evaluation of transport interventions and it is closely related with the goal of transportation policy (cf. (Martens 2011)). As is widely supported, that goal is to improve people's ability to travel from one place to another, in order to enable them to participate in out-of-home activities. Government interventions in the transportation domain (e.g. investments in infrastructure, provision of services or public transport subsidies) focus on the former: they aim to improve people's potential mobility, understood as the ease with which a person can move through space (e.g., (Sager 2005)). By doing so, these interventions improve people's accessibility and thus people's ability to engage in out-of-home activities (subject to the ceteris paribus condition). From the perspective of fairness, potential mobility itself is of limited importance. It is the ability to participate in activities that is more closely related to people's well-being. In terms of philosophies of social justice: the ability to participate in activities, as measured in terms of accessibility, is the focal variable ((Sen 1992)). It is the 'space' within which fairness is to be obtained. The fairness of government interventions in the transport system thus depends on the extent to which these interventions contribute to a fair distribution of the ability to participate in activities. Note that actual activity participation is merely an indicator of the extent to which a transportation system provides sufficient accessibility for all to participate in activities. This is so, because accessibility captures only the potential-to-participate. Whether people actually make use of this potential and engage in out-of-home activities obviously depends on more factors than accessibility itself alone, including lifestyle and

personal preferences.

In order to address this complex question about what might be a fair distribution of accessibility, we turn to the relation between accessibility and actual activity participation. The starting point for the argument is the observation that under normal circumstances, a society's dominant mode of transport provides an acceptable level of accessibility for all those that have access to that transport mode. Land use patterns are shaped by transport networks and tend to organize around the speed provided by the dominant transportation mode, i.e. the mode used by the majority of the population. In societies before the industrial revolution, walking was the dominant mode. With the rise of the automobile, land uses started to organize around the speed provided by the car, a process which is still ongoing in many countries. Persons with access to a motorcar have no problem navigating these land use patterns – the motorcar provides them with sufficient accessibility. However, because of the reorganization of land uses following the ascent of the car, motorized transport rapidly turned from a luxury into a necessity. Few people in industrialized societies are now able to manage their daily lives without, individualized or collective, motorized transport (Urry 2004).

In motorized societies, patterns of accessibility are shaped by two structuring dimensions ((Martens 2012)): mode availability and space. In terms of mode availability, persons with access to the dominant mode of transport (read: the car-road system) will face few accessibility problems in current societies. On the other hand persons without access to a car, due to legal, financial or physical barriers, will experience insufficient levels of accessibility depending on the accessibility provided by alternative modes of transport (in modern societies, typically the public transport system). In terms of space, place of residence has a strong impact on a person's accessibility levels, because of the inevitable existence of centers and peripheries ((Puu 2005)). It may be clear that persons residing close to centers of employment and services will experience substantially higher accessibility levels, than persons residing in suburban or ex-urban locations.

The fact that space creates, by its very nature, center and periphery implies that accessibility can never be distributed in an equal way over population groups. This implies that the search for a fair distribution of accessibility has to deliver an alternative distributive rule from equal distribution. In order to develop this distributive rule, or fairness principle, we first define the relevant population groups over whom accessibility is 'distributed'. As mentioned above, both mode availability and space strongly shape a person's accessibility level. The analysis of the distribution of accessibility thus has to focus on population groups that differ in terms of mode availability and residential location. In terms of mode availability, it is reasonable to make a distinction between persons with access to a car and persons who lack such

access and are primarily confined to the public transport system in conjunction with walking. This distinction does not capture the full variety in terms of the available modal set observed among persons (as some may also be able to use a bicycle or a moped in addition to public transport), but it does address the most important distinction in current modern societies. In terms of space, it is reasonable to make a distinction between persons in terms of residential location, for instance at the level of a neighborhood or district, or a transport activity zone, depending on available data. These two characteristics lead to a distinction of population groups by mode availability and location. These groups will differ in terms of their accessibility. The question we need to answer is: which distribution of accessibility over these groups is fair?

In order to make the next step in our analysis, we return to the relationship between accessibility levels and activity participation. It may be hypothesized that the level of accessibility and the intensity of activity participation are correlated. All else being equal, it may be assumed that with increasing levels of accessibility, a person's level of participation in out-of-home activities will go up. The relation will be a concave one, as the impact of one unit of additional accessibility in a situation of high accessibility will have little influence on activity participation. Furthermore, it may be assumed that there is no direct relation between accessibility levels and activity participation intensity, as people highly differ in their need or desire to participate in out-of-home activities. For a given level of accessibility, we may thus well observe persons with high and low intensity of activity participation.

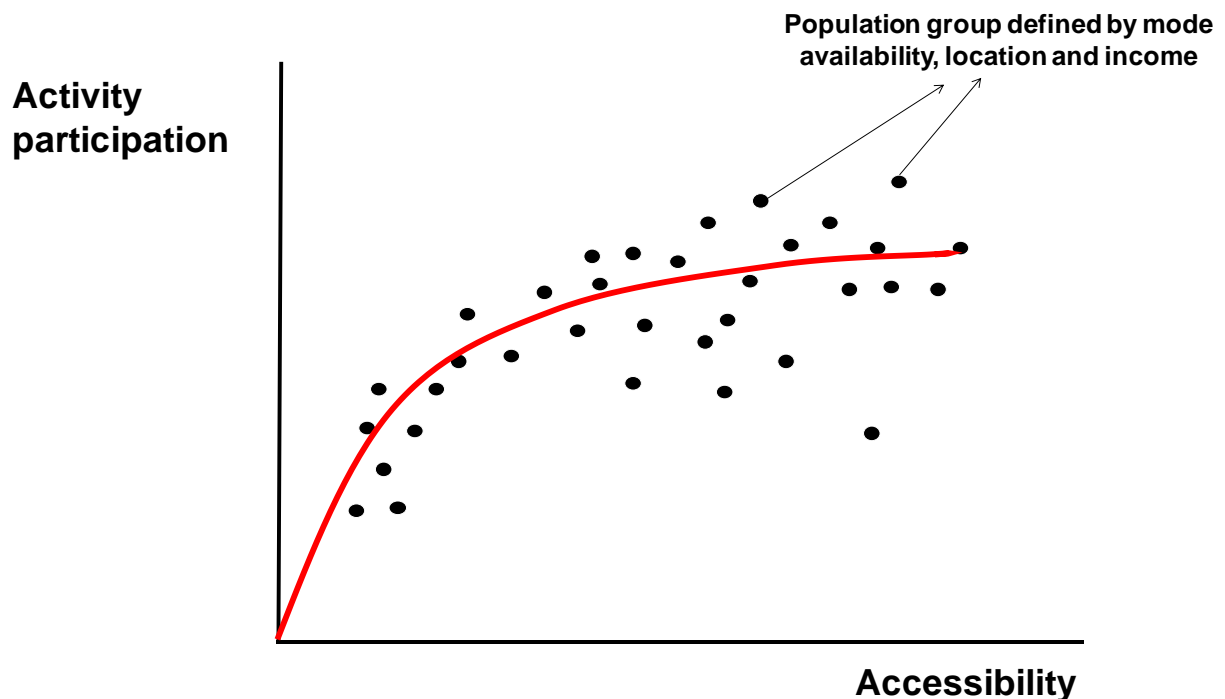
As the accessibility provided by the transportation mode available to a person (as a representative of a particular population group distinguished in terms of mode and residential location) decreases, we may expect a drop in the level of actual activity participation. It could be argued that this drop is unproblematic as long as it has no severe impacts on the quality of a person's life. Part of the decrease may actually be a representation of preferences: people who have less desire to carry out out-of-home activities may well prefer less accessible residential locations in ex-urban settings over highly accessible urban locations. But when accessibility levels drop even further, the transport system may actually create a barrier for people to obtain a job, obtain health services, participate in education, or keep in contact with friends and family. This situation is referred to in the literature as transport-related social exclusion and occurs if systematic problems of accessibility to opportunities lead to significant impacts on a person's life, such as unemployment, deterioration of health, or social isolation (e.g., (Kenyon, Lyons et al. 2002); (Farrington and Farrington 2005); (Lucas 2012); (Martens 2013)).

The relationship between accessibility and activity participation is depicted in Figure 1. Each point in the figure represents a person with a particular residential location (e.g.,

by neighborhood) and set of available transport modes. Note that many persons may experience roughly comparable levels of accessibility, as they are virtual identical in terms of residential location and mode availability. At high levels of accessibility, there will be substantial variation in activity participation, depending on people's preferences and other factors. However, with decreasing accessibility, the relation between accessibility level and activity participation will grow in strength. At a certain point, it can be hypothesized; accessibility levels are so low, that they directly limit a person's possibility to participate in activities. When this occurs, people experience transport poverty or transport-related social exclusion: the accessibility level has decreased to such an extent that people are no longer able to fully participate in the activities deemed normal for society. Empirically, it will not be easy to exactly draw this 'accessibility poverty line' (Golub and Martens, 2013). Conceptually, however, it is possible to define it.

A fair transport system, then, is a system that provides every citizen with a sufficient level of accessibility to participate in activities deemed normal to society (cf. the social exclusion literature). From a fairness perspective, transport policies should first and foremost address the accessibility needs of people with (extremely) low levels of accessibility, as long as they are at risk of experiencing transport-related social exclusion (see for a more elaborate discussion, (Martens 2013).

**Fig 1: Correlation between activity participation and accessibility**



## **2.2 Evaluating fairness: on sufficiency and priority**

The argument developed above provides a general framework for the assessment of the fairness of a transport system. The framework underscores that different proposals for improvements in the transport system should be assessed in terms of their impact on the accessibility levels experienced by population groups in danger of transport-related social exclusion. But this general rule does not specify how different proposals should be compared with one another. More specifically the question is how groups that experience a sub-standard level of accessibility, and are thus at risk of transport-related social exclusion, should be addressed in project evaluation. In order to answer this question, we turn to the notions of sufficientarianism and prioritarianism as developed in the philosophical literature (see (Casal 2007)) and as applied in different fields (e.g., (Meyer and Roser 2006)). We start, however, with a brief elaboration of the mainstream approach to the evaluation of transport interventions.

The mainstream approach to the assessment of transport interventions (infrastructure projects, improved services, policies) focuses on the benefits and costs of such interventions. Typically, in an evaluation exercise, various alternatives are compared in terms of the costs and benefits they generate for society as a whole. Irrespective of the exact evaluation methodology used (notably cost-benefit analysis and cost-effectiveness analysis; see below), usually the weighing of benefits and costs, if applied at all, is not related to the characteristics of the recipient of the particular cost or benefit. Thus, one unit of benefit always has an identical weight, irrespective of the recipient of that unit of benefit. This holds true even in case willingness-to-pay values are used for ascribing a monetary value to a benefit, such as travel time savings, which would be in line with the theory underlying cost-benefit analysis. In such a case, different values are ascribed to one unit of travel time savings, and these values tend to differ systematically between different population groups. However, the underlying rationale is not the weighing of the benefits by population group, but giving equal weight to the monetary value embodied in travel time savings. The other way around, in case equity values are used for ascribing monetary values to a particular benefit, such as travel time savings, the underlying rationale again is not the weighing of the benefits, but giving equal weight to the time persons spend traveling ((Martens 2011)). Mainstream approaches thus give equal weight to benefits and costs generated by a transport intervention. These mainstream approaches, and particularly cost-benefit analysis, rule out explicit consideration for any population group. Such approaches are thus incapable of capturing the extent to which a particular project increases the accessibility levels of those who need it most. The philosophy of justice underlying this approach of equal weighing, certainly in case of cost-benefit analysis, is utilitarianism.

Sufficientarianism, as developed by e.g. (Crisp 2003), challenges this approach to the

assessment of a transport intervention. A key starting point for sufficientarianism is the observation that justice requires first and foremost the avoidance of misery: “What is important from the point of view of morality is not that everyone should have the same, but that each should have enough. If everyone had enough, it would be of no moral consequence whether one had more than others” (Frankfurt 1987, p. 21). Casal ((Casal 2007)) distinguishes between the positive and negative theses embodied by the notion of sufficientarianism. The positive thesis “stresses the importance of people living above a certain threshold, free from deprivation” ((Casal 2007), p. 297-298). The negative thesis underscores the irrelevance of additional benefits for people already above the threshold. Casal argues that pure sufficientarianism embodies both claims. In line with both theses, Crisp, the most prominent representative of sufficientarianism, thus argues that “absolute priority is to be given to benefits below the threshold” ((Crisp 2003), p. 758). The distinctive feature of sufficientarianism, then, is the view that there is a threshold and that benefiting people below the threshold has absolute priority compared to benefiting people above the threshold. One reason why sufficientarianism has attracted important proponents, is the fact that it corresponds closely “to widely held intuitions about the importance of benefiting the badly off” ((Meyer and Roser 2006), p. 235).

The sufficiency approach directly links to the basic framework outlined above, as the ‘accessibility poverty line’ can be seen as a special case of the sufficiency threshold. Basing transport project evaluation on sufficientarianism would thus imply a rigid way of weighing the benefits reaped by different population groups. Only benefits reaped by groups below the poverty line would be given weight, with no value being ascribed to benefits accruing to population groups with already sufficient levels of accessibility. Note that this line of reasoning only holds for the accessibility-related benefits and costs generated by a transport project, as the ‘accessibility poverty line’ refers to accessibility levels only. Hence, the costs related to e.g. capital investments or air pollution should not be weighed in the same way (perhaps a different sufficiency threshold may apply to these costs, such as ‘low air threshold’).

Sufficientarianism has been criticized on a number of grounds. The most important criticism centers on the understanding that it seems practically impossible to justify a strict sufficiency threshold. First, it is difficult to uphold a sharp dividing line between people who do and who do not deserve consideration. Why are people just below the threshold entitled to moral priority over people that are just above that threshold? Both (Casal 2007) and (Meyer and Roser 2006) point at a second, related problem. They point out that, if the threshold is so important, “it better be set in some very principled way with strong reasons supporting exactly this or that point” ((Meyer and Roser 2006), p. 236). A third criticism concerns the lack of “additional distributive requirements” ((Casal 2007), p. 300). By this, Casal refers to the costs to society that may be implied

by the absolute priority for sufficiency. Strictly following sufficientarianism's rules would imply granting small benefits to someone below the threshold even if it would come at the expense of bringing many more people down to that threshold. That, obviously, goes strongly against widely held intuitions about fairness (and efficiency) (Di Ciommo and Lucas, 2014).

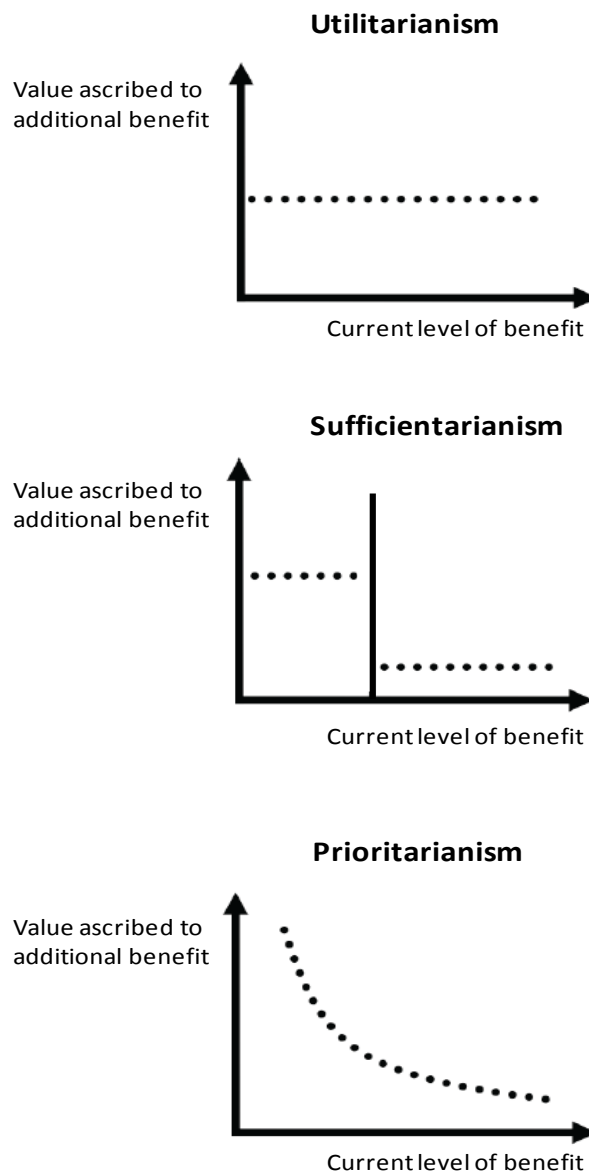
Taken together, these arguments seem to suggest that it is difficult to defend the absolute priority for people below the sufficiency threshold. Prioritarianism offers a way out. Prioritarianism is based on the view that benefits matter and that they matter more the worse off the person is to whom the benefits accrue. Proponents of prioritarianism argue that the moral value of a benefit, or the disvalue of a burden, diminishes as its recipient becomes better off ((Casal 2007)). This higher moral value for benefits accruing to the worse-off groups underscores proponents' concern for equality. The concern is not absolute, however: large gains for well-off people can outweigh small gains for worse-off groups. Meyer and Roser ((Meyer and Roser 2006)) point out that prioritarianism is a very attractive theory: "It explains our intuitions about the importance of equality well and it also explains when and why we approve of aggregate gains which imply inequality. It also explains our intuitions about the importance of giving priority to the badly off and, in addition, explains why equality among the very well off has little importance. It does all this without a strict threshold or without ascribing intrinsic value to equality."

Like sufficientarianism, prioritarianism can be applied to the evaluation of transport interventions. The approach does not imply a rejection of the relationship between accessibility levels and activity participation (as depicted in Fig. 1), nor the existence of transport-related social exclusion. The approach does underscore, however, the extreme difficulty in determining the 'accessibility poverty line'. Rather than focusing on that threshold value, prioritarianism proposes a weighing of benefits depending on the position of a person in the distributive spectrum. For the transport domain, in light of the goal of transport policy (to improve people's ability to travel from one place to another), this implies a ranking of population groups in terms of their accessibility levels. The higher the current levels of accessibility of a group, the lower the value ascribed to the accessibility benefits reaped by that group. Note that this is different from the notion of diminishing marginal value of 'accessibility gains' as developed by Martens ((Martens 2006)). The latter is based on an empirical conjecture: people with higher levels of accessibility will attach a lower value to a one-unit increase in accessibility than people with low levels of accessibility. Prioritarianism suggests that, even if both groups would ascribe the same value to one unit of accessibility gain, the benefit reaped by the well-off group should be valued less than the same unit accruing to the worse-off group.



Following Meyer and Roser (2006), the difference between the three approaches described above can be captured in a graphical representation (Fig. 2). The x-axis depicts the initial (current) accessibility level experienced by a particular population group. The y-axis represents the moral value that should be ascribed to the benefits being accrued by a population group. In mainstream transport evaluation, all benefits (and costs) are ascribed an identical value, (implicitly) based on the theory of utilitarianism (Fig. 2a). In contrast, in sufficientarianism, no value is attached to benefits accruing to people positioned above the ‘accessibility poverty line’. Below that line, various ways of valuing or weighing benefits is possible. In this paper, we will use a uniform valuing of benefits, as depicted in the figure by the horizontal dotted line left of the accessibility poverty line (Fig. 2b). The bottom figure (Fig. 2c) represents prioritarianism. Benefits accrued by all recipients are valued, but the value decreases with rising initial accessibility levels. We will return to the exact shape of the ‘priority curve’ below.

**Fig 2: Illustrating benefits under utilitarianism, sufficientarianism and prioritarianism**



### **3. COST-EFFECTIVENESS ANALYSIS APPLIED TO UTILITARISM, PRIORITARISM AND SUFFICIENTARISM EQUITY APPROACHES**

Transport assessment analysis has long been interested in strategies that can increase social benefits using cost-benefit analysis (CBA). However, policy makers and political institutions (i.e. European Commission) are aware that cost benefit analysis could hide the real benefits of new projects or investments. On the other hand, recent transport research has showed that CBA analysis is an easy tool for evaluating policy measures and transport investments, but it deeply depends on subjective values of a wide number of elements of the CBA (i.e. discount rate, population groups who benefit, monetary and time benefits). All that could lead to multiple solutions, without providing insight into the size of the benefits reaped by different beneficiaries (Guzman et al. 2014).

In contrast to cost-benefit analysis, cost-effectiveness analysis in transport is used to assess the marginal benefit per euro spent. In transport, cost and effectiveness of investments is mainly related to three key elements: monetary cost, time and services availability (when a person does not have access to any transport services, her marginal benefit tends to infinitive). Therefore the most cost-effective policy is when new services and infrastructure are provided to users who have no access to them. In this kind of analysis the highest marginal benefit is for people who do not have any transport for moving and no access to activities. Cost-effectiveness analysis can be helpful for analyzing the sufficientarism approach as well as both prioritarism and utilitarianism approaches.

In what follows, we perform a comprehensive analysis for three fictive transport accessibility interventions in which three main inputs are assumed: spatial setting, various population groups and three investment options.

Transport investment output is related with any behavioral and technological strategy that reduces the probability of no-mobility/no accessibility among a specific population group. We use three fictive examples of investments and estimate their cost-effectiveness in terms of their contribution to population groups' accessibility levels. In order to increase the comparability of cost-effectiveness estimates drawn from different economic analysis, we established seven definitional goals:

1. The effectiveness is defined in terms of the change in the average number of activities that can be accessed by different population groups.
2. Cost and effectiveness is evaluated from three different perspectives: utilitarianism, prioritarism, sufficientarism.
3. We only include direct c; indirect costs, such as foregone earnings, are excluded in our assessment.
4. Costs and effectiveness should be "net". Any resource savings or accessibility

decreases due to the investment should be subtracted from any improvements.

5. Future costs and changes in access to activities should all be discounted to their present value at a rate established following the inter-temporal preferences rate of the relevant population groups, operators or investment actors (Guzman et al. 2014).

6. Cost-effectiveness ratios should be marginal or “incremental”. Both costs and effectiveness should be evaluated with respect to a well defined baseline alternative (base scenario).

7. Costs should be expressed in year based euros using the general consumer price index.

Behind all these assumptions we implemented the cost-effectiveness analysis using three different societal and moral approaches (i.e. utilitarianism, prioritarianism and sufficientarianism).

### **3.1 Transport projects categorization**

We distinguish four different transport projects : (1) road capacity increase; (2) public transport speed increase; (3) introduction of demand responsive transport (DRT); and (4) Introduction of new rolling stock on bus lines to allow bus access for disable people. The effects of the transport projects were classified in terms of increase in accessibility increase for car owners, increase in accessibility for public able-bodied transport captives, and increase in accessibility for elderly and disabled people.

We carried out a simple cost-effectiveness analysis for each of the four transport projects, taking into account the following elements:

1. Spatial setting within which our population groups live and for whom we improve the transportation system.
2. Different population groups. The groups should be different in terms of their ‘current situation’ (e.g., the current level of accessibility or the current average travel speed experienced by a group), in the priority and sufficiency approach the weight attached to the benefits depend on the ‘current situation’.
3. Different investment options (bus improvement, road extension etc), as we want to compare how the different options will be ranked in case of applying the utilitarian, priority and sufficiency approach.
4. The costs of each investment option, as we need the costs of each option for the calculation of the cost-effectiveness analysis (=effect per euro invested).

5. The impact of each investment option on each of the groups (e.g., the increment in accessibility (=improvement = effect = impact), or the increase in average travel speed (=improvement = effect = impact).

The main characteristics of our fictive scenarios are:

1. Spatial setting

We choose a simple setting of four areas that are both origins and destinations of trips (i.e. urban type, suburban, peri-urban and rural) .

2. Different population groups

We need to identify vulnerable groups (gender, age etc). For this methodological paper we simplify using the **current level of accessibility** (to jobs and other key life activities such as health and education) as the measure to distinguish groups. The accessibility depends on the mode availability of the groups. We could distinguish three groups in each of the four areas:

- People with cars
- People without cars, but able-bodied, with access to all public transport
- Disabled people without cars, who can only access adjusted public transport services.

We can then define 12 accessibility levels (4 areas \* 3 groups = 12), assuming that the connections between the four areas are not identical in quality because of their spatial characteristics (i.e. urban, suburban, peri-urban and rural)

3. Different investment options

We have four different investments options, which are ranked based on the utilitarian, priority and sufficiency approach.

The investment options are:

- a. Road widening
- b. Public transport improvement
- c. DRT introduction
- d. Making public transport accessible to disabled

Improvements in travel speeds	baseline level	Size of neighborhoods	19000	19000	19000	19000
			alternative 1	alternative 2	alternative 3	alternative 4
			Road improvement	PT improvement	RT improvement	Disable accessible
access to car only	1200	50	2,1	0,2	0	0
access to pt only, able-bodied	300	10	0	3,1	1,3	0
access to pt, disabled	20	10	0	0	13,2	17,9
access to car only		200	1,7	2,5	0	0
access to pt only, able-bodied		20	0	2,4	1,6	0
access to pt, disabled		2	0	0	11,2	13,2
access to car only		100	...	...	0	0
access to pt only, able-bodied		50	...	...		
access to pt, disabled		10	...	...		
access to car only		150	...	...	0	0
access to pt only, able-bodied		150	...	...		
access to pt, disabled		30	...	...		

Table 1: Districts characteristics and transport improvement for each population groups.

We specify the level of improvement for each population groups (population groups\*types of areas, i.e. it is not the same to don't have car in an urban space than in the rural space, therefore public transport captive users could be very well served in an urban area and not so well served in a rural area: they are two different population groups at our end) as a result of each of the investment options. Since we have groups with and groups without a car, this can be relatively straightforward:

- Population groups with car: they do not profit from public transport investments, because car accessibility (or speed) is always better than public transport. They do profit from investment in roads, but size of the benefit may differ between the four neighborhoods we distinguish.
- Population groups without car, but able-bodied: they do not profit from road investments. They do profit from all public transport investments, but the level of benefit differs by neighborhood.
- Population groups without car, but disabled: they do not profit from road investments or public transport improvement. They do profit from DRT introduction or making public transport accessible for the disabled. Again, the benefit level differs between neighborhoods.

4. Impact of each investment option on population groups. This impact will be weighted by the selected moral approach adopted by policy makers or more general by the society. In this case the weight for each population group is the improvement (i.e. gain in terms of travel time) of each group (see table 1).

For assessing the impact of each investment alternative on the current situation of the transport system we implement the following methodological steps:

1. Define the structure of the transport system in its current form: This will be represented by the O-D flows for each neighborhood/zone broken down per

population group and one table and transport mode showing the average speed between the neighborhoods/traffic zones in the current situation (Do-Nothing scenario). This information is provided in the tables below.

Even though the example is fictive the network obeys some basic logical ‘reality rules’ capable of representing in approximation travel speeds and time of real networks. Specifically, the rules are:

- Public transport is assumed to have an average speed two times lower than the one of the private car.
- The distribution of the population to the other zones is random, however we consider that the main flows will exist between the urban area and the rest of the zones (as we could also expect in reality).
- For this reason, it is also assumed that the links with zone 2 (urban area) allow greater speeds.
- The speed from A to C is assumed to be approximately the average of the speeds from A to B and from B to C (provided in small tables). The empty cells are equal with the reverse ones due to symmetry.
- The total benefit of the current situation is the sum of products between the speed and the size of the population of each group.

### 3.2 Results

Crossing cost-effectiveness analysis with utilitarianism, prioritarianism and sufficientarianism approaches, we will weight each result for each population group. The results show that the estimation for four policies investments using the same amount of investment (i.e. 19,000€).

For the CEA analysis, it is sufficient to divide the Investment amount among specific population groups of each neighborhood/district and use different weights following the three moral approaches of utilitarianism, prioritarianism and sufficientarianism.

For this first fictive example we use data from table 1. We test the methodology only for the first neighborhood/district presented in this table.

Road widening investment = 19,000€:

1. Utilitarianism approach:  $19,000/50$ , by using the same weight for all. The result is 380€ for utilitarianism approach;
2. an infinitive value for Prioritarianism and Sufficientarianism approaches because nobody from PT captive people and disable people with a low accessibility will have direct benefices by a road investment, at least under the condition of free flow (i.e. without congestion)

Public transport improvement = 19,000€

Using data from Table 1:

1. Utilitarianism: Cost-Effectiveness indicator = 316
2. Prioritarianism: Cost-Effectiveness indicator =  $463 = 19,000 / (0.2 * 50 + 3.1 * 10)$
3. Sufficiency: CEA =  $19,000 / 0 =$  infinitive value

DRT introduction = 19,000:

1. Utilitarianism:  $19,000 / 20 = 950$
2. Prioritarianism:  $19,000 / (1.3 * 10 + 13.2 * 10) = 131$
3. Sufficiency:  $19,000 / (13.2 * 10) = 143$

Introduction of new rolling stock on bus lines = 19,000

1. Utilitarianism:  $19,000 / 10 = 1,900$
2. Prioritarianism:  $19,000 / 17.9 * 10 = 106$
3. Sufficiency:  $19,000 / 17.9 * 10 = 106$

In the case of a specific measure for disabled people, prioritarianism and sufficiency approaches achieve the same result.

#### **4. CONCLUSIONS**

The results are methodological, but highlight that a transparent cost-effectiveness estimate allows us to say which moral criteria we are using for making a transport decision. The main conclusion is that it could be a cost-effectiveness estimate positive even if in demographical terms it is not, crossing cost-effectiveness with three moral approaches, gives us the way to clearly and easily estimate for who we are increasing the transport services.

All three approaches (utilitarianism, prioritarianism and sufficiency) could be used to justify transport investments, but we need to be explicit about the goals of each transport investment. From an equity perspective, transport investments should first and foremost address the transport needs of population groups experiencing insufficient accessibility levels. The utilitarian approach is not suitable to address this equity concern and should be replaced by a priority or sufficiency approach.

## 5. REFERENCES

- Casal, P. (2007). "Why Sufficiency Is Not Enough." *Ethics* 117(2): 296-326.
- Crisp, R. (2003). "Equality, Priority, and Compassion." *Ethics* 113(4): 745-763.
- Di Ciommo, F., & Lucas, K. (2014). Evaluating the Spatial and Social Equity Effects of Road Pricing in the European Urban Context: Madrid Metropolitan Area, Spain. In Transportation Research Board 93rd Annual Meeting (No. 14-2076).
- Farrington, J. and C. Farrington (2005). "Rural accessibility, social inclusion and social justice: Towards conceptualisation." *Journal of Transport Geography* 13(1): 1-12.
- Kenyon, S., G. Lyons, et al. (2002). "Transport and social exclusion: investigating the possibility of promoting inclusion through virtual mobility." *Journal of Transport Geography* 10(3): 207-219.
- Lucas, K. (2012). "Transport and social exclusion: Where are we now?" *Transport Policy* 20: 105-113.
- Martens, K. (2006). "Basing transport planning on principles of social justice." *Berkeley Planning Journal* 19: 1-17.
- Martens, K. (2011). "Substance precedes methodology: on cost-benefit analysis and equity." *Transportation* 38(6): 959-974.
- Martens, K. (2012). "Justice in transport as justice in access: applying Walzer's 'Spheres of Justice' to the transport sector." *Transportation* 39(6): 1035-1053.
- Martens, K. (2013). Accessibility and potential mobility as a guide for policy action. Paper presented at the Colloquium Vervoersplanologisch Speurwerk, 22-23 November 2013, Rotterdam.
- Martens, K. (2013). "The role of the bicycle in limiting transport poverty in the Netherlands." *Transportation Research Record: Journal of the Transportation Research Board* 2387: 20-25.
- Meyer, L. and D. Roser (2006). "Distributive justice and climate change: the allocation of emission rights." *Analyse und Kritik-Zeitschrift für Sozialwissenschaften* 28(2): 223.
- Puu, T. (2005). "On the genesis of hexagonal shapes." *Networks & Spatial Economics* 5(1): 5-20.
- Sager, T. (2005). "Footloose and Forecast-free: Hypermobility and the Planning of Society." *European Journal of Spatial Development* September 2005(17): 1-23.
- Sen, A. K. (1992). *Inequality reexamined*. Cambridge, Harvard University Press.
- Urry, J. (2004). "The 'system' of automobility." *Theory, Culture & Society* 21(4-5): 25-39.

## AKNOWLEDGMENTS

Authors would like to thank COST Action TU1209: Transport Equity Analysis (TEA) in the framework of which the present research was conducted