Cost-Benefit-Analysis – A walk through the labyrinth for city level evaluation?

Experiences from CIVITAS PLUS

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Abstract

Urban traffic congestion, accidents and pollution are serious problems in Europe's cities. Within the CIVITAS Initiative – a European Commission co-financed program that supports cities in implementing innovative measures aimed at sustainable urban mobility – an in-depth evaluation of the financial and economic impact are a vital pillar for the identification of good practice in different cities. In order to assess the economic impact, the cities are obliged to an ex-post cost-benefit evaluation within a substantial number of measures within the CIVITAS project. Cost-benefit analysis is a popular tool to assess the impacts of urban transport measures. It allows the monetization of different environmental, social and financial impacts, thereby making them comparable. This is especially important in urban transport since financial gains of projects are often not large enough to cover initial investments. Adding social and environmental impacts however, can make a measure preferable from a society's point of view. In the practice of urban transport measures however, cost-benefit analysis can be quite complex. It raises a number of assumptions about the scope of the assessment, the time-frame, as well as technical issues involved in measuring the benefits and costs. This paper focuses on three examples from the CIVITAS MIMOSA project to demonstrate the breach between information requirements and availability with respect to the evaluation with cost-benefit analysis. The examples include a car sharing service and a traffic control center from the city of Bologna and the Utrecht beer boat. Therefore, this paper aims to narrow the gap between the practitioner's and the economist's perspective on this appraisal instrument.

1. Introduction

Urban traffic congestion, accidents and pollution are serious problems in Europe's cities; therefore transport and mobility are of highest priority to local authorities. In 2002 the European Commission recognized the need for action and launched the CIVITAS Initiative, designed as a program of 'cities for cities'. CIVITAS PLUS is the latest of the three CIVITAS initiative phases. It aims to test and increase the understanding of the frameworks, processes and packaging required to successfully introduce integrated and innovative strategies for clean and sustainable urban transport. Thereby, the European Commission obliges the CIVITAS cities to evaluate the results of the implemented measures. Insights on how the measures performed and the comparisons between different cities and projects will provide knowledge on the effectiveness of specific measures and/or bundles of measures thus helping to identify good practice and transferability.

In doing so, article 40(e) of ERDF Regulation 1083/2006 makes cost-benefit analysis an input, among others, for decision making on major projects co-financed by the European Union. However, the use of cost-benefit analysis in evaluation after a measure's implementation has also been firmly endorsed by the European Commission with the expectation that this will be used for economic assessment of a substantial number of measures within the CIVITAS project. This paper summarizes the elements of evaluation practice referring to the organizational and methodology background in the project. Thereby, it brings examples from the CIVITAS MIMOSA project to demonstrate the breach between information requirements and availability with respect to the evaluation with cost-benefit analysis. It thus aims to narrow the gap between the practitioner's and the economist's perspective on this appraisal instrument.

2. The project background

2.1 CIVITAS and evaluation

CIty – VITAlity – Sustainability is the slogan of CIVITAS, an initiative co-financed by the European Commission and coordinated by cities: it is a program 'of cities for cities'. Cities are at the heart of local public-private partnerships within the projects. Political commitment is a basic requirement for receiving co-funding from the EC. Within CIVITAS cities are living 'laboratories' for learning and evaluating. Currently, more than 210 cities across Europe are a part of the CIVITAS community. The initiative finds itself in its third phase of implementation: CIVITAS I started in early 2002, CIVITAS II in early 2005 and CIVITAS PLUS in late 2008 within the 7th Framework Research Program (see also Figure 1).

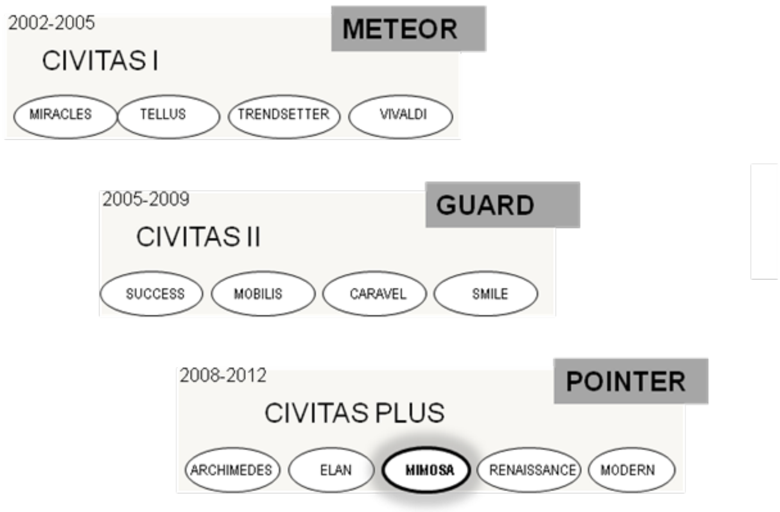

Figure 1: Three CIVITAS phases, demonstration projects and evaluation support projects

From the beginning of CIVITAS, evaluation played a key role for the EC, and special horizontal evaluation support projects were established for each phase (METEOR, GUARD and POINTER). The horizontal projects - in the current phase called POINTER - support the CIVITAS demonstration projects and cities through building up a common understanding of evaluation methodologies and Europe-wide dissemination in cooperation with the demonstration projects, organization of the annual meeting of CIVITAS forum members and the development of policy recommendations for a long-term multiplier effect of CIVITAS. Further, POINTER is in charge of evaluation support activities such as providing trainings, the final evaluation and interpretation and recommendations including cross-site evaluation and transferability.

In each demonstration project there is also a horizontal work package installed that is responsible for the coordination and support of the measure evaluation. In MIMOSA this management of project evaluation lies within the Chair of Integrated Transport Planning at the Berlin Institute of Technology. Project evaluation management is the link between POINTER, the special support project for evaluation, and the city evaluation teams known as local evaluation management. All CIVITAS PLUS project evaluation managers meet twice a year with POINTER and the EC in the Evaluation Liaison Group to discuss and adjust evaluation activities at the cross-project level.

2.2 CIVITAS MIMOSA

CIVITAS MIMOSA stands for **M**aking **I**nnovations in **MO**bility and **S**ustainable **A**ctions and is one out of five demonstration projects in the third phase. 16 partners from 7 countries work together towards three main long-term objectives: the improvement of quality of life, the reduction of transport-related CO_2 and NO_X emissions and an increase in the modal split towards sustainable modes. The cities of Bologna (Italy), Funchal (Portugal), Gdansk (Poland), Tallinn (Estonia) and Utrecht (The Netherlands) have implemented in total 69 demonstration measures. The specific objectives are:

- the promotion of clean vehicles and fuels in private and public fleets through large investments and incentive campaigns to reduce the emissions of pollutants;
- the attraction of new customers to public transport through network improvements, fare integration, innovative services and security measures to reduce the number of private motorized trips;
- the adoption of access restrictions, road and parking management in order to reduce congestion (saving time and money) and to collect resources to be reinvested in public transport;
- the promotion of less fuel-consuming vehicles and more sustainable vehicle usage (e.g., car sharing) as well as healthier and cleaner mobility patterns (e.g., cycling and walking); this again, aims at reducing congestion and the emission of pollutants;
- the improvement of safety and security conditions in transport (for public transport, driving, walking and cycling) often with the help of innovative telematic systems;
- the improvement of passenger and goods transport management through the use of technology and innovative solutions to reduce traffic, inefficiencies and negative environmental impacts (MIMOSA, 2008).

The evaluation approach chosen in MIMOSA was the result of a dialogue on the European level (Evaluation Liaison Group) and the learning process within CIVITAS. The evaluation approach in CIVITAS MIMOSA consists of impact and process evaluation following the common CIVITAS guideline but also of concept evaluation, which is MIMOSA specific and analyses the outcome of research and technology activities (see Table 1). In this paper the focus is on the role of cost-benefit evaluation as part of the general impact evaluation, which is required in all CIVITAS PLUS projects.

Type	**Objectives and evaluation procedures**
Impact evaluation	Impacts are measured with valid data, and common CIVITAS indicators are used to ensure cross-site evaluation. Cost-benefit is applied for at least one third of the measures.
Process evaluation	Annual analysis of the measure implementation processes: barriers, drivers, reactions to them and lessons learned from them are assessed.
Concept evaluation	Research and technology development activities are analyzed and described for a broader audience as well as put into the measure- and city context.

Table 1: Three types of evaluation in CIVITAS MIMOSA

All measures will be evaluated and some of them selected for more in-depth evaluation; these are called focus measures. Experiences from previous CIVITAS phases showed that the focusing of resources is necessary for solid evaluation including cost-benefit analysis. A complete impact and a more detailed process evaluation should be conducted. The impact evaluation of the focus measures will include at least a before-after study and - if applicable - a control group approach to determine a correct business-as-usual scenario. Within CIVTAS MIMOSA, 20 out of the 69 measures were selected for evaluation as focus measures. Criteria for the selection of focus measures were the relevance to EC policy (European Commission, 2007) as well as to city policy on urban mobility and, furthermore, the level of expected impact, the level of innovativeness and whether it is prototypical for a group of measures.

3 Cost-benefit analysis expectations

As a part of the focus measure impact evaluation, a cost-benefit analysis is also conducted (Kraffel, Becker, Dziekan & Abraham, 2010; POINTER 2009d; Preston, 2009). The idea behind this request from the EC is that they expect facts to be extracted that could be distributed to other European cities regarding the effectiveness of CIVITAS measures. This was meant to encourage other take-up cities to implement similar measures. By the commission, this is seen in accordance with Article 40(e) of ERDF Regulation 1083/2006 which makes cost-benefit analysis an input, among others, for decision making on major projects co-financed by the European Union (European Commission DG Regional Policy, 2008). This regulation specifically calls for an ex-ante project appraisal where cost-benefit analysis is an important decision tool for project alternatives. Additionally, with the CIVITAS initiative, the use of cost-benefit analysis in the ex-port evaluation has been suggested by the European Commission to demonstrate the impact of the program. Its expectation is that this will be used for an economic assessment of at least one third of all measures within the MIMOSA project, hence to be part of the focused measure impact evaluation. It is thereby requested that the measures are examined in an identical matter to the ex-ante appraisal of larger infrastructure investments. Two questions arise from this request. Is it possible to apply cost-benefit analysis to small[1] urban transport projects and second, are there significant benefits from an ex-post application of this method?

Methods for cost-benefit analysis of large transportation projects co-funded by European and national funds are well established.[2] Costs are typically determined by actual (discounted) project costs, or the opportunity costs of resources devoted to the project, in a manner consistent with general cost-benefit analysis principles. Benefits are typically divided into different parts and monetized. However, cost-benefit evaluations of small urban transport projects present special challenges that have thus far not been genuinely covered in evaluation literature. While some solid guidelines exist for the evaluation of the overall economic impact of municipal transport projects, at this time they can only represent the expectations for good evaluation. They do not specifically address the problems and provide recommendations how the cities can address their current deficiencies. Compared to infrastructure investment projects – for which cost-benefit analysis was originally intended – the bulk of urban transport project are smaller in size and budget involved.[3]

[1] 'Small' is referring to projects that are comparable to the MIMOSA projects; hence projects which are implemented in cities with less that 1 million inhabitants and/ or projects that are implemented by a local government with investments below 1 million Euros.

[2] Established guidelines available for European level are for instance: European Commission DG Regional Policy (2008); for the US: Forkenbrock and Weissbrod (2001); for Germany: ITP Intraplan Consult GmbH (2006) – although it is not only a cost-benefit analysis, it includes a majority of the steps involved and approved monetization factors.

[3] CIVITAS MIMOSA has a total investment volume of 23 Mio. Euros and remains thus below the requirements of Article 40(e) of ERDF Regulation 1083/2006 concerning ex-ante cost-benefit evaluation.

To conduct a cost-benefit analysis, it is first essential to obtain a clear understanding of the measure and its costs and benefits prior to the implementation. This is to ensure that the necessary data is available. However, the CIVITAS project has already demonstrated that this is very difficult. Often times, projects were planned, their impacts and outcomes described and proposed for financing to the European Commission. After modifications attributed to political changes, planning, engineering, financial or other reasons the actual implementation of the measure deviates greatly from the first description of work. This leads to a re-evaluation of the (scope of) costs and benefits and sometimes even a change in its objectives as well. This instability and unpredictability of measure progressions unfortunately is a common phenomenon in urban transport projects.

As a result, the expectations for cost-benefit analysis differ from the general framework as they not only demand ex-post evaluation, but with the definition of certain time frames they further demand forecasting into the future. As such, the expected appraisals can mostly be classified as mid-term cost-benefit analysis. This imposes additional tasks upon the cities which they are not always able to cope with. Although well-prepared guidelines and trainings were provided to the local evaluation teams, many discrepancies can be reported when comparing evaluation theory to evaluation practice. In order to answer the two questions raised earlier, the difficulties involved in the application of ex-post cost-benefit analysis will be described on three MIMOSA measures which were implemented in the cities of Bologna and Utrecht.

4 MIMOSA Examples

4.1 Bologna Car Sharing

Cities in the CIVITAS projects usually use different funding resources to implement a measure. This peculiarity is due to the fact that MIMOSA offers a complete funding of management activities, but only partial funding for implementation projects and is a general phenomenon in European funded projects. The strict evaluation requirements however, are then often used to evaluate the entire program. Especially since in this circumstance, the evaluation only needs to be done once but can be used for different programs. One example is the Bologna car sharing which aims to increase the car-sharing fleet including equipment with alternative fuels by increasing reserved parking space and marketing campaigns. The MIMOSA financing however does only include a trial on the protection of reserved parking spaces and the marketing campaign.

Bologna was one of the first Italian cities implementing a car sharing service. Since August 2002, after some pilot trials and a brief running-in period, car sharing is a reality. The service is currently performed by ATC (local public transport company in Bologna). At the moment, the car rental fleet is composed of a proximal 40 vehicles available in the urban area, which can use 55 reserved parking places. Even though the fleet composition includes cars running on natural gas, this option is seldom used. The cars have to be returned with a full tank and are rented by the hour and it takes about 30 minutes to refuel a car with natural gas.

For the general impact evaluation, the indicators which were included in the evaluation plan at the beginning of the MIMOSA project were: average operating revenue, capital costs, average operating costs as well as awareness and acceptance levels (Cartolano et al., 2009). These indicators, however, are not sufficient for an ex-post cost-benefit evaluation, which was expected because of the focused measure status of this measure. Hence, special attention had to be put on the question how people using the car sharing service now were travelling before the service became available. The service was implemented in 2002 while the MIMOSA project started in 2008 and end in 2012. Ideally, the appraisal could conclude on the societal impact of 10 years of service. However, data is not available for these years as the responsible company itself as well as the service has been restructures frequently and data is not available before 2008.

In addition, a far-reaching environmental benefit results from the fact that car sharing participation influences transport behavior in a positive way, or stabilizes existing environmentally-friendly attitudes toward mobility. A comparison of households before and during car sharing participation shows that the proportion of car-free households grows with car sharing participation and the proportion of personal cars kept in the household drops (Maertins, 2006; Bundesverband CarSharing e. V., 2010). With car sharing participation, personal cars become, to a large extent, unnecessary; planned vehicle purchases are not carried out and there is no associated loss of mobility. All of these general benefits, however, could not be demonstrated in Bologna. In fact, it is not possible to clearly evaluate the impact of the measure. All in all, the service only attracts a very small percentage of users (on average, only 200 different people are using the service) and the service is financially not successful. However, it is a national political decision to up-keep the service. Hence, the focus of any reporting and evaluation is on production of 'output'. In other words, it is more important for the local evaluation teams to count newly purchased vehicles or numbers of distributed leaflets than to look at the overall outcome of the measure.

This further hinders the ex-post evaluation with cost-benefit analysis as it now becomes necessary to try to include as much information as possible but also to make assumptions for instance on individual journey costs (which are also based on the average kilometers travelled), car ownership, the kilometers 'saved' because of more rational transport mode choices or the emission modeling. The latter two were taken from a national survey whose raw data and methodology are disclosed. The only information available to the authors was that the emissions modeling is based on the year 2008 and compared the general Italian car park to the overall car sharing car park in all 10 Italian cities who have this kind of service implemented. From the raw data received, the emissions were derived by dividing the emissions from the car sharing vehicles (emissions saved from not driving with a private car) by their average kilometer driven per year (total reduction of private vehicles). From the emission data four types of emissions are considered: NO_X, PM, CO_2 and N_2O. In order to derive the emission for the years after 2008, it is assumed that emissions from private vehicle fleet are reduced by 1.2% each year. This figure is the resultant of a study from the European Federation for Transport and Environment (European Federation for Transport and Environment, 2009) where the average CO2 emission of newly registered vehicles in Italy is reduced by this average from 2007 to 2008. For emission reduction from car sharing vehicles a reduction of 3% per year is assumed. This number results from the fact that car sharing vehicles are at the latest renewed every 3 years and comply with the best emission standard.

With respect to the costs, in order to reduce fixed cost of the service and to even the yearly expenses, cars are not bought but leased from local suppliers. As a consequence, the maintenance costs are also paid for by ATC. Costs data is available divided into general cost (which include maintenance costs for vehicles, costs which derive from monitoring reserved parking spaces, marketing campaigns, investments in new technology for the eco-equipment of vehicles, etc.), costs of vehicle leasing (which also include a fully covered insurance), fuel costs (both petrol and CNG) and the costs for the employment of personal.

Based on the assumption that car sharing customers would drive 2,000 km per year with their own car (450 km with car sharing vehicles and 1,500 km that they do not drive) the cost of vehicle ownership is 1,500 Euro per year (Automobile Club d'Italia, 2009). Since these benefits only derive for users that would buy a car without this service, it is assumed that these savings apply to 45% of car sharing users. This figure results from a study made by IPR Marketing (IPR, 2009) but is also in the same range with the results from a questionnaire given to Bologna car sharing users.[4]

When using the data from the national surveys as well as the available operating costs for the years 2008 to 2012, the net present value is over 2 Million Euro, hence the service is a success from an economical point of view (see Figure 2). Monetization factors from the HEATCO guidelines (HEATCO, 2006) and a discount rate of 5% were used.

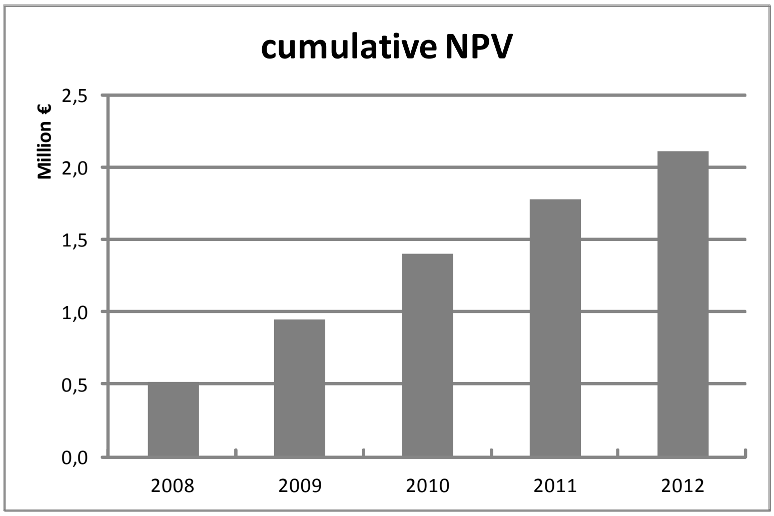

Figure 2: Cumulative NPV for the car sharing measure in Bologna (2008-2012)

Consequently, even though the service is not financially viable, it is able to generate an economic benefit. These results, however, are very optimistic. From approximately 1000 potential user (those that have subscribed to the service or company employees for which the service is available), only 200 use the service more than 3 times a year. From the financial view, the revenues only make up for roughly 70% of the costs. Hence the economical benefit is mostly derived from the reduction of vehicle ownership as can be seen in Figure 3.

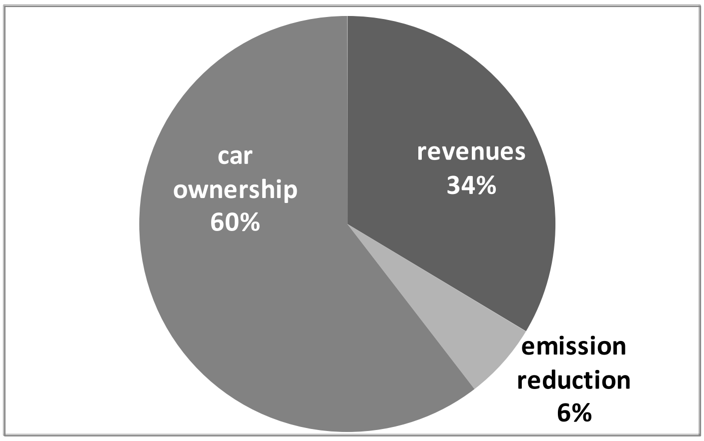

Figure 3: Split of overall economic benefits for the car sharing service in Bologna (2008-2012)

Consequently, this analysis demonstrates the importance for the inclusion of economic benefits in the evaluation. But it is also evidence that even with ex-post cost-benefit project appraisal, many of the concerns with regards to data availability (and thus data validation) cannot be fully cleared in CIVITAS like urban transport measures.

[4] Unfortunately, this questionnaire was returned only by 21 users and is thus not of statistical value on its own.

4.2 Bologna traffic control center

The traffic control system in Bologna has three major functions who, prior to the MIMOSA project were mutually exclusive and operate in isolation. These functions are:

- computerized traffic control and light sequencing to automatically sequence the city's traffic light clusters at the optimum intervals based on traffic levels on the road network;
- real time traffic system monitoring and evaluation to provide real time video and data feedback relating to the performance of traffic junctions in Bologna;
- computer controlled driver information system to provide driver information through the use of roadside variable message signs

The automated traffic light management system is also designed to sequence the lights in order to give priority to bus services, particularly when they are operating behind schedule. Every bus is equipped with a GPS tracker that allows the real time monitoring of the busses and which can send a signal to the traffic control center to request prioritization. Then, the center will send a signal to the traffic light extending its green light period to let the bus pass. If no signal is sent, the traffic light will operate on an algorithm which calculated the optimal green light phases based on the queue on the link (the road segments between two intersections) every three seconds. Additionally, every traffic light cycle the saturation rates and turning percentages are evaluated and transmitted to the next traffic light on the radial to improve the timing. This precise description of the traffic situation is provided through a set of more than 1,000 inductive loops installed in the pavement all over the city. They provide the measure of traffic flows, turning flows in the cross roads, queues and saturation levels.

Through the MIMOSA project, these systems were linked and new optimization algorithms were introduced. In short, this measure aims to improve transport efficiency through the reduction of travel time due to an increase in traffic flow within the city. It is hoped to achieve a decrease of medium waiting time at traffic lights; and an increase in the prioritization factor (possibility to find green on traffic lights) for buses. Unfortunately, the appraisal of this measure is very limited due to the data availability. After careful consideration, it was decided to exclude the effects on the environment since no emission modeling or measurement would be available to determine the effect of better traffic flows. Consequently, this would reduce the analysis to the travel time aspect for private vehicles.

Besides not having data on emission and noise, the choice in data to estimate the travel time reduction – especially for private vehicles – is very limited. Usually, travel time data is collected in the field. In Bologna, it would be possible to record the precise location of a probe vehicle via GPS tracking at specific time intervals and thus record its travel time on a specific journey. If this is done repeatedly throughout the years during different times of the day it would be possible to gain a complete picture of travel times throughout the city. Although this is technically possible, this has not been done on a large scale to produce viable data. From the many cars equipped with appropriate technology, it is still very sensible and on average, only 1 to 2 are available. In combination with the shortage on personnel, this data collection has not been done because it is not thought a priority.

As a consequence, the travel time reduction for private vehicles is estimated by the reduction of average waiting times on the intersections and is further restricted to traffic on radials. This is where bus prioritization takes place and the effects of optimized traffic light timing should have the highest impact. Nonetheless, it should be noted that the overall travel time is the sum of the waiting time and the time needed to accelerate and decelerate. Hence, the value obtained should be increased by a coefficient that takes into account the deceleration and acceleration time. Since this analysis only compares the waiting times due to a lack of appropriate data, this step is not necessary and it is assumed that the travel times between intersections is constant. As a consequence, this approach neglects queuing delays. During times with high traffic flow, the deceleration and acceleration time can be much longer as traffic usually begins moving slowly. Since there is no other data available, this problem is neglected.

Since it would be very time consuming to extract the data for each day in the year, the data from the first full week of March for each year is chosen to determine traffic demand and average waiting times. Thereby, the first week in March represent a typical week in the scholar year where weather conditions are moderate and have minimum effect on traffic conditions. For the benefit calculation, this data is later multiplied by the factor of 40, representing the weeks where both schools and universities are in session and traffic demands should be at an equal level. Data was aggregate in three time bands constituting the morning peak (7 am to 9 am), day traffic (9 am to 5 pm) and an evening peak (5 pm to 8 pm). For convenience purposes, these time bands were also chosen to differentiate between weekday (average of Monday through Friday) and weekend (Saturday/Sunday) travel. Thereby, both the traffic demand and the actual waiting times were taken from the same week in March to ensure consistency.

As of today, traffic lights on all radials in Bologna have been centralized, thus no control site will be available for a business-as-usual scenario. As a consequence, appropriate statistical approaches have to be defined to derive the necessary data. For the data available in Bologna, the Bureau of Public Roads (BPR) curve was chosen because it is provided by the system operator each year. From the raw data provided by the control center about traffic demand and average delay, it is possible to obtain a BPR curve for the radials. It is a measurement of the theoretical delay due to vehicles waiting their turn to clear intersections and is a function of traffic flow and delay time. This curve is available for radials starting as early as 2008. It is important to note that this curve can only be computed for centralized traffic lights. Nonetheless, the first BPR curve determined could be used for the business-as-usual scenario since later curves should show the improvement due to the fine-tuning of the system.

Traditionally the BPR function has been used for planning models. This curve was based on the 1965 Highway Capacity Manual from the Bureau of Public Roads in the United States and was parabolic in shape, and speed is fairly sensitive to increasing flows (Dowling, Singh, and Cheng, 1998). Its general shape is

$waiting\ time\ [ritardo] = t_0 + \gamma * \left(\frac{demand\ [flusso]}{800}\right)^{\beta}$, where

t_0 is the so called free-flow time on a link and γ, β define the shape of the curve.

Thereby, the parameters are defined by fitting the actual data to its general shape. In Bologna, this curve has long been used as measurement for the success of the system and is derived for each quarter of the year by the software supplier. For the fourth quarter of 2008, t_0 equals 13.8152, β equals 2.161141396 and γ equals 37.95946121. The figure below shows the fitting of this curve to the actual data for the business-as-usual scenario.

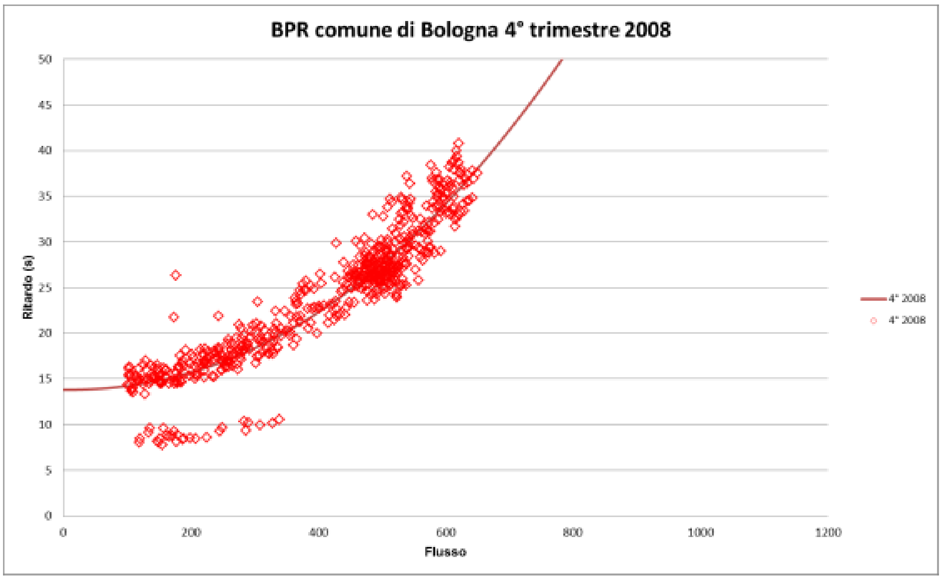

Figure 4: Fitting of Bologna BPR curve with the actual data for 2008 (Bologna Municipality)

For the calculation of the benefit it is assumed that the traffic demand is the same in the business-as-usual and the with-measure scenario. The monetization of the benefits differentiates between travel purpose and the occupation of vehicles. Unfortunately, no reliable data is available on car occupancy which is therefore assumed as one (on weekdays and weekends). With this assumption the benefits are certainly underestimated, nonetheless, this is the only reasonable assumption since no other comparative data is available.

Also, no figures for travel purposes are available. In order to make any calculation at all, it is assumed that the travel purpose for private vehicle traffic is the same as the travel purpose from a study on public transport users in 2010. The study concluded that on a weekday, 46% of passengers were travelling to work, 7% are school trips and the other 54% are other unspecified destinations. Due to the lack of reasonable comparative data, these figures are also applied for the weekend. Also no freight traffic is considered. Costs for the cost-benefit analysis include the personnel costs and software maintenance as well as the centralization of the traffic light and the investment costs for the installation of the traffic control center.

Following the HEATCO guidelines (HEATCO, 2006) the net present value with an interest rate of 3.5% is calculated for the economic evaluation of the traffic light centralization. The results of this study shows that the net present value is negative in the first year due to the investment cost, but this negative balance is consumed by the high net cash flow in 2010 and amount to a total of roughly 10 Million Euro in 2012. Hence the centralization of traffic lights generates an economic benefit despite the fact that in itself is not financially viable since it does not generate revenues. In fact, the net present value is even higher than that of the car sharing measure described in 4.1. Consequently, this analysis demonstrated that cost-benefit analysis is generally possible with little data obtainable; however, it should be refrained from interpreting too much into the results.

4.3 Utrecht beer boat

Inland waterway transport is a competitive alternative to road and rail transport. In particular; it offers an environmental friendly alternative in terms of both energy consumption, noise and emissions (European Commission Mobility & Transport, 2010). The canals in Utrecht are a proof of the rich trading-history of the city during the Middle Ages and are unique in its sort. In the early nineteennineties brewers signalized that the unloading of containers and crates as well as heavy trucks imposed damage on the historical city infrastructure (Schiller, Bruun, and Kenworthy, 2010). A main reason for the damage was the fact that heavy goods had to be carried down from the street level to the wharf-basements which damaged the stairways. To solve this problem the city of Utrecht, in cooperation with the department of inland shipping, decided to use the inner city waterways to distribute the catering business. In 1995, after deliberations between the city and breweries, the use of a vessel to supply the catering business was championed. It was originally called the 'mini-distrivaart', but since the vessel openly transported beer and other beverages, it got its nickname 'the beer boat'. In 2008 a new beer boat was purchased by the city. Where the old vessel was powered by diesel, the new one can operate fully on electricity (Dziekan, Champlin, Hogenberg, Wilfert, 2012).

The main clients of the Beer Boat are breweries who use the Beer Boat to deliver goods to catering businesses along the inner city canals. Without a Beer Boat, breweries are restricted to using small freight trucks with EEV4-norm to make deliveries to the inner city. This is due to length-, weight- and emission restrictions imposed by the city council in order to protect the inner cities old infrastructure. These small vehicles, on average, have a loading capacity of up to five roll containers, meaning that the Beer Boat has the capacity of up to ten small freight trucks. On an average trip the Beer Boat transports around 30 roll containers per trip, delivering between 10 and 15 clients. Hereby the delivered number of roll containers per client lies between 2 and 3 and normally an equal number of empty roll containers is returned. The harbor is only responsible for the unloading of cargo from the boat onto the wharf and takes no part in the rest of the delivery process. Therefore, there must always be a representative from the transporting company present. A round trip costs the Beer Boat around six hours, which is mainly due to problematic delivery arrangements between the transporter and its clients. Many clients can only be delivered at certain times which often causes long waiting times and complicated delivery routes. The Beer Boat is rented per hour for the sum of 85 Euros. As of March 2012, the Beer Boat is operational around 4 till 5 times per week.

Before implementation of the Beer Boat, suppliers out of Utrecht drove many small trucks, with small loads into the city centre to deliver goods to the catering businesses. The Beer Boat offers logistics companies the freedom to deliver all their goods using one truck to the edge of the city center, because no length and weight restrictions are imposed there. From there the goods are transferred onto the Beer Boat and delivered. This change in transport situation is the subject of evaluation with cost-benefit analysis (Hogenberg, 2012). The interest of the city doesn't lie in the replacement of an existing vessel with a cleaner vessel – as it was done in the MIMOSA lifetime – but in the evaluation of the difference between the implementation and exploitation of one or more vessels against no vessel at all.

This implies that data from as soon as 1995 is needed. However, the need for evaluation did not originate until early 2008, which means that this data cannot be collected anymore. This lack of data-availability makes it necessary to assume that vehicle restrictions and the low-emission zone were already imposed and a zero emission Beer Boat was implemented in 1995 and all logistics companies use the same type of vehicle to make inner city deliveries. These assumptions make evaluating easier because less (specific) data is required but it also puts the cost-benefit analysis in a more current perspective.

In addition, with regards to cost-benefit analysis, it is assumed that congestion levels do not change for the reason that the reduction of freight traffic is not proportional to the traffic intensity in and around the city cordon. Also, it is not clear how much of the infrastructure damage – which originally led to the implementation - is caused by the freight traffic and more importantly, how much it will be reduced by use of the beer boat. As such, they are excluded along with the measures impact on noise levels (Hogenberg, 2012).

With regards to the benefit of the measure, the transported volume on the beer boat is translated proportionally into vehicle reductions. Hereby it is chosen to use one type of vehicle; a Mercedes Sprinter. This vehicle is chosen because it can operate at full capacity, transporting 5 roll containers per trip, without violating the weight restriction of 2000kg. Also a sprinter is assumed to be among the cleanest EEV4 vehicle, thereby eliminating overestimating of potential emission reductions. Dependent on the average transported number of roll containers per Sprinter, one beer boat trip therefore saves a minimum of 6 Sprinters.

The input for the cost-benefit analysis depends on several assumed causal effects, such as the number of beer boat trips and the resulting truck reduction. These causal relationships are however difficult to verify because real measured data on them isn't available. They are however very important in judging the measure's success. If for instance logistics companies operate their vehicles at full capacity the actual vehicle reduction will be a lot lower than if logistics companies do not operate their vehicles at full capacity. It is for this reason that, where needed, indicators are estimated using best-case / worst-case modeling. The advantage of using this method is that an absolute pessimistic- and optimistic outcome can be calculated, which implies that the full measure scope can be assessed. This will yield two scenarios: a 'low-scenario' with worst-case values, chosen to yield the lowest potential net present value and a 'high-scenario' with best-case values, chosen to yield the highest potential net present value.

A zero emission Beer Boat is amortized over a period of 30 years, which means the evaluation will run from 1995 until 2024. This means that back-casting on past beer boat deliveries- and forecasting on future beer boat deliveries has been done. For the future development and the 'low-scenario', it was assumed that the number of trips stays the same. In the best case scenario a the number of trips increases from 4 to 12 trips per week with increasing exponential decrease. Travel distances by Mercedes sprinter have been estimated, by studying the expected travel routes into the city center and emission estimates were solely based on traveled kilometers but have been calibrated on travel in city centers.

The operational costs for Beer Boat use are based on assumptions on revenues and the current number of Beer Boat trips. The economic benefit is calculated in accordance with the HEATCO guidelines (HEATCO, 2006) and the results for both scenarios can be seen in figure 5. In 2024, both scenarios present a positive net present value, but the span lies between 100,000 Euros and 4.2 Million Euros.

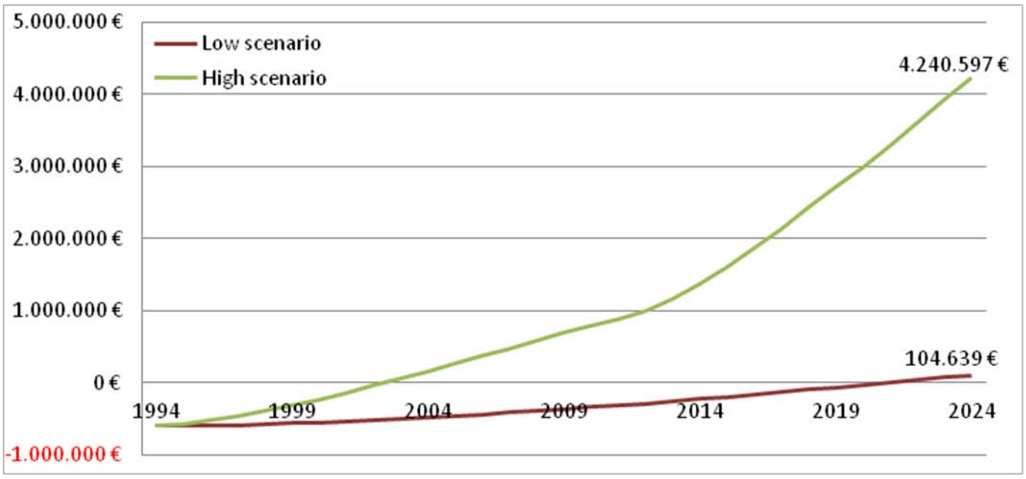

Figure 5: Cumulative net present values for the different scenarios (Hogenberg, 2012)

The highest economic impact comes from the reduction of operational costs for the Sprinters. Also the operational costs for beer boat use play a substantial role in the net present values. Beer boat renting costs/revenues are important cost/benefit factors but actually play no role in the calculation of the net present value. The low- and high scenarios give a good insight in the potential of the measure but it cannot be concluded that the scenarios speak in favor of the measure because the margin of error is very low in the low scenario. As a result, this analysis shows that even though this cost-benefit analysis was intended as an ex-post analysis, the majority of benefits can still occur in the future and the need for forecasting has not been eliminated. The even greater distress, however, relies in the fact that even after a projects implementation the data is not fully available. This is due to the fact that especially private operators are reluctant to share their data for evaluation purposes in particular if their usage entails no direct benefit to them. This then leads again to having to make assumptions about casual relationships and thus a decrease in accuracy of the results.

5. Conclusion and recommendations

Cost-benefit analysis has become popular with policymakers because of its perceived numerical rigor. In particular the application in the Bologna examples should have demonstrated that the same rigor that is applied in the ex-ante comparison of infrastructure investments is not applied to these urban transport projects. Reasons for this are multifaceted, for instance timing problems, resource limitations or a lack of skills at the local level. Until this day, the cities involved in the project have no or very little experience with the application of cost-benefit analysis in urban transport strategies.

Cost-benefit analysis is also a popular method because it simplifies decisions and evaluation outputs – it reduces complexity by converting all known factors into economic values and comparing options on a single scale. Because of this, it is transparent, at least as far as declaring the basis of the calculations. However, it also has its flaws. Relying on cost-benefit analysis alone can be problematic, because of its sensitivity to the selection of relevant factors, and the assignments of values based on expert information. Furthermore, not all relevant factors are easy to value, and some would argue that there are things which simply cannot be valued in money terms. Especially in projects which aim to implement pilot projects, the use of cost-benefit analysis can divert from the more important question: why are certain measures not successful in the implementation? The cities tend to focus on producing good results because a negative net present value is perceived as a failure. The latter implies also that ‘bad’ results or not satisfying results need to be reported and the processes need to be analyzed. In the case of some cultural contexts, this still requires a change in attitude.

In MIMOSA and also in CIVITAS PLUS, generally speaking, many efforts are undertaken to apply good evaluation practise in order to show the effects of implemented measures and to provide information and lessons learned to other cities and future projects. But there are also many reservations, especially since negative results are unwanted. Moreover, the evaluation practice showed that although the MIMOSA evaluation framework stresses the importance of measuring demonstration based impacts, in reality this is hardly possible. In Utrecht many measures are implemented in the same study area and the small-scale character of these measures and the relative long lifespan makes it impossible to measure impacts on safety, noise and vehicle reductions as a result only of the beer boat example. These impacts therefore had to be discarded or estimated. Estimating hereby relied on assumed causal relationships on e.g. the use of the vessel and vehicle reduction which affects the reliability of results.

Using cost-benefit analysis for ex-post evaluation – as requested by the EC – should have the advantage that it is not necessary to make assumptions over demand forecasting, cost developments or the nature and extend of some benefits. There is however, a tendency to assume that once an impact has occurred, all uncertainty associated with the impact is removed. In practice, impacts are often observed, recorded, or interpreted inaccurately. The extend of problems ranges from the neglecting of data provision, the measurement equipment (technology) and on the ability of statistical or econometric methods to make inferences in the presence of measurement errors (methodology). These problems have received little specific attention within the CBA literature. One possible explanation is that they are perceived as being of relatively little importance compared to other problems. They are, however, a major concern in ex-post evaluation. Because as consequence, assumptions have to be made and creative computation methods are then used to define the impact of a measure. On the other hand, when the measurement of costs and benefits becomes a complex, detailed process, the calculation loses transparency. Transparency, however, is important when it comes to the funding of any project with the more and more limited funds available. Hence, obscure and little traceable evaluations only hinder the application for further funding from national and supra-national sources and cannot be in the interest of any party involved.

Thereby, good evaluation reports strike a balance between depth and length; combine an appropriate match of methods and methodology to address the key evaluation questions and have a clear communication of evaluation findings. As consequence, the evaluation with cost-benefit analysis of small urban transport measures should be re-evaluated and its aim clearly stated. The MIMOSA examples demonstrate that although the application of an ex-pot cost-benefit analysis is generally feasible, they do not add a benefit to the evaluation. The results rely as much on assumption, forecasting and interpretation as would be expected from an ex-ante evaluation. Thus, simply requesting cost-benefit analysis for a certain number of measures within a project is not wise. There has to be a case-by-case decision as to where, when and how cost-benefit analysis can contribute to the evaluation of a measure in addition to its general evaluation. In the worst case, such a general requirement for cost-benefit analysis will redirect energy and funds from a systematic impact and process evaluation to a less-meaningful economic evaluation.

Nonetheless, apart from the assessment of economic impacts of measures the cost-benefit analysis results are meant to serve as input for two additional decision processes, including up-scaling (the potential for further deployment of the implemented experimental measure) and transferring (identifying if measures can be implemented successfully in other European cities). Especially the transferability aspect of a measure is of high importance for the CIVITAS initiative. In its current application, the cost-benefit analysis can only marginally contribute to this assessment. There could be, however, other options for CIVITAS like measures including multi-criteria analysis, multi-attribute tradespace exploration, holistic evaluation of costs and benefits and cost-effectiveness analysis. This then calls for good examples that are yet to be seen in the evaluation of measures aiming at sustainable urban mobility.

Beside the disappoint results concerning cost-benefit analysis, CIVITAS MIMOSA will definitely act as a catalyst for an evaluation-friendly atmosphere in the cities of Bologna, Gdansk, Funchal, Tallinn and Utrecht and hopefully also beyond. It will show that good evaluation is worth the effort to bridge the gap between scientific research and applications in real life.

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