

Evaluation of sustainable transport measures implemented in European cities

1 Objectives

Many European cities are facing environmental problems and profound changes in economic patterns, which are closely connected to the growth of the traffic volume in urban areas. Therefore, it is the aim of this paper to document the current developments of the transport situation in European cities and the negative impact of road traffic as well as to show strategies to foster solutions for a sustainable development. An overview on innovative transport measures implemented recently in several cities within the CIVITAS initiative funded by the European Commission will be given. Furthermore, the evaluation of impacts and implementation processes of the sustainable transport measures on a European level will be presented. It is the goal of the paper to show, how a sophisticated and comprehensive evaluation strategy for the implementation processes and results of innovative transport measures accomplished in different cities can be conducive to make those actions comparable and rateable.

2 Development of urban mobility

The major part of the European population is living in cities, thus it is obvious to concentrate on these areas for the implementation of sustainable solutions for transportation in order to improve living conditions for the inhabitants. Moreover, due to the fact that a high traffic volume is identified in European cities the implementation of sustainable transport measures can achieve valuable benefits on the transport system as well as on the environment. Several reasons have been identified why European cities are facing serious transport problems:

- Increase of the total number of population
- Urban sprawl and shape of the city
- Increase of the car ownership rate
- Changing the way of life to a more car-oriented society
- ...

Over the last decades the number of people living in urban areas has increased considerably, which causes an augmented traffic volume in certain areas. Moreover, due to the economic development the shapes of the cities have been changed from compact city architecture to sparse settlements mainly in the outskirts. Shopping malls on greenfield areas along arterial roads were built resulting in a more car-oriented society [Altrock 2006].

In particular, the transition of the market in New Member States (NMS) of the European Union changes the mobility behaviour fundamentally. Most of the cities in Eastern and Central Europe had good developed public transport systems in the past, but they are facing a more car-oriented transport policy nowadays resulting in worsening the public transport supply [MVV 2007]. The car ownership rate in prosperous cities of New Member States like Bratislava or Ljubljana is underlining this development, where the car ownership rate has been nearly doubled from 1991 to 2004 (Figure 1).

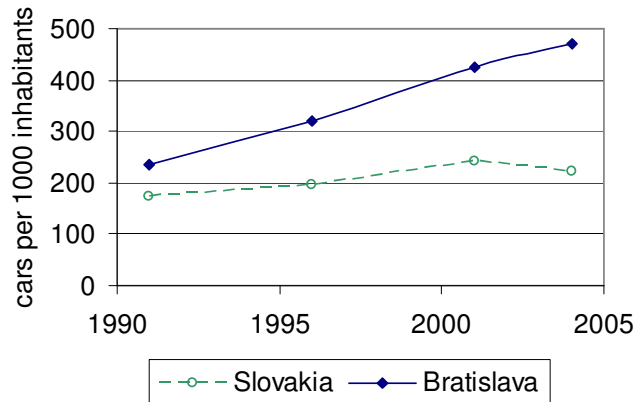


Figure 1: Development of the car ownership rate [Eurostat 2009]

3 Negative impacts of road traffic

Air pollution is influenced by the traffic volume intensively affecting the quality of life as well as the health of the population. The CO₂ and the ozone pollution as well as the content of particulate matter are mainly a result of traffic. Compared to other sectors traffic is responsible for almost 1/3 of the CO₂ in the 27 European member states (Figure 2).

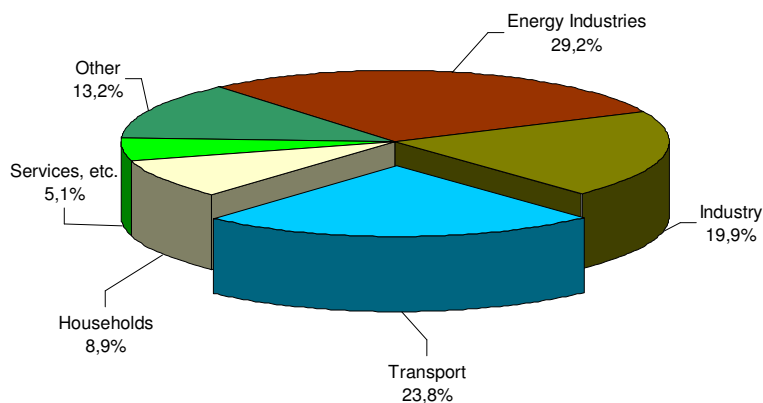


Figure 2: CO₂ emissions by sectors in 2006, EU27 [EEA 2008]

Moreover, since 1990 the CO₂ emission caused by traffic has increased in these countries by about 1/3, whereas all other CO₂ emitting sectors show decreasing emission values (Figure 3). However, this trend differs from country to country. One might expect that the CO₂ emission increases in particular in NMS due to the growing car-availability for the population and the raise of millage driven, but the statistics show another picture. On the contrary, Bulgaria, Estonia and Lithuania achieved a reduction of 21 to 25 % from 1990 to 2006 [EEA 2008]. It can be assumed that this is the effect of replacing the old private car-fleet with vehicles equipped with higher technical engine standards resulting in less pollution as the millage driven by car was not reduced. In all other countries the CO₂ emissions caused by traffic is increasing. For example, in Austria up to 85%, in the Czech Republic up to 133% and in Malta the CO₂ emission in 2006 is even 8 times higher than in 1990 [EEA 2008].

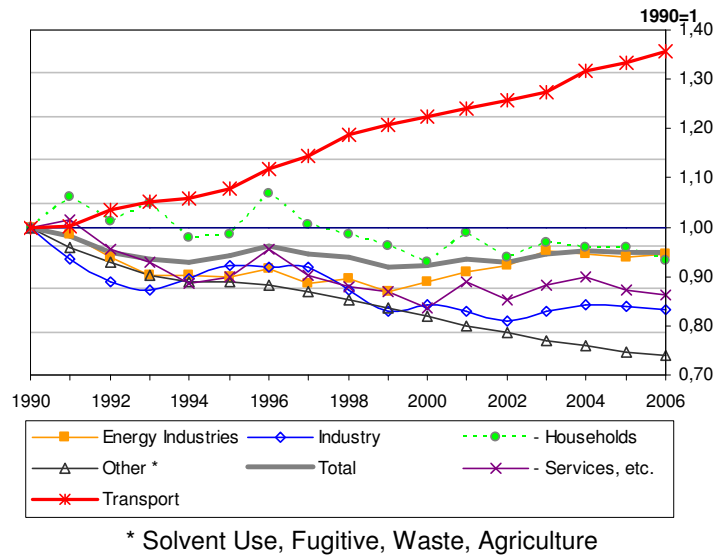


Figure 3: Development of the CO₂ emissions by sectors, EU27 [EEA 2008]

4 EU - CIVITAS Initiative

The Green Paper “Towards a European strategy for the security of energy supply” published by the European Commission in the year 2000 stated already that the CO₂ emissions from transport can be expected to increase by around 50% from 1990 to 2010 within the European Union. Efforts undertaken by the automotive industry was intended to convert this negative trend [European Commission 2000].

However, this progress was recognised as being not sufficient enough to reduce or even come close to stabilise the energy demand of the transport sector and its negative impact on the environment. Therefore, it was one of the ambiguous aims of the European Commission to reverse the trend of traffic growth and to reduce the dependence on oil by fostering sustainable transport modes and policies. This included not only technical measures, like the use of clean vehicles or fuels, but also the implementation of adequate transport politics in European cities. Since then several initiatives and directives have been launched by the European Commission [European Commission 2008/1], e.g.

- Directive on the promotion of the use of biofuels or other renewable fuels for transport, setting a target of 5,75% share of biofuels vehicles by 2010 (in a midterm assessment in 2005 it turned out that this value is unlikely to be achieved)
- Directive on promoting market introduction of clean and energy efficient road transport defining public procurement award criteria to take into account operational lifetime impacts of energy consumption, CO₂ and pollutant emissions [European Parliament 2008].

Recently, the European Council adopted the following energy targets to be reached by 2020 [EREG 2008]:

- reduction of at least 20% in greenhouse gases (GHG)
- 20% share of renewable energies in EU energy consumption and
- 20% improvement in energy efficiency by 2020

Being aware that the transport sector is to blame for negative impacts on the environment the CIVITAS initiative was launched by the European Commission in 2000 within the 5th EU Framework Research Programme (FRP). Aim of this initiative is to generate a decisive breakthrough by supporting and evaluating the implementation of ambitious integrated urban

transport strategies. Cities should be supported to achieve a more sustainable, clean and energy efficient urban transport system by implementing, demonstrating and evaluating a manifold mix of technology and policy based measures. Furthermore, a critical mass for technical solutions and innovations should be established. Since then several CIVITAS programmes have been launched by the European Commission (Figure 4):

- CIVITAS I (2002-2006), 19 cities clustered in 4 demonstration projects were co-financed by the European Commission within the 5th EU FRP.
- CIVITAS II (2005 – 2009) continued the approach within the 6th EU FRP and were finalised recently. 17 cities in 4 demonstration projects took part.
- CIVITAS plus (2009 – 2013) is the latest CIVITAS programme supporting 25 cities implementing sustainable transport measures in 5 demonstration projects within the 7th EU FRP.

In total, about 370 measures were co-financed (CIVITAS I & II) so far and further 318 measure are co-financed currently (CIVITAS plus) by the European Commission resulting in a contribution of about 180M€. The overall budget available for the implementation is even 3 times higher than this amount of money (including national funds).

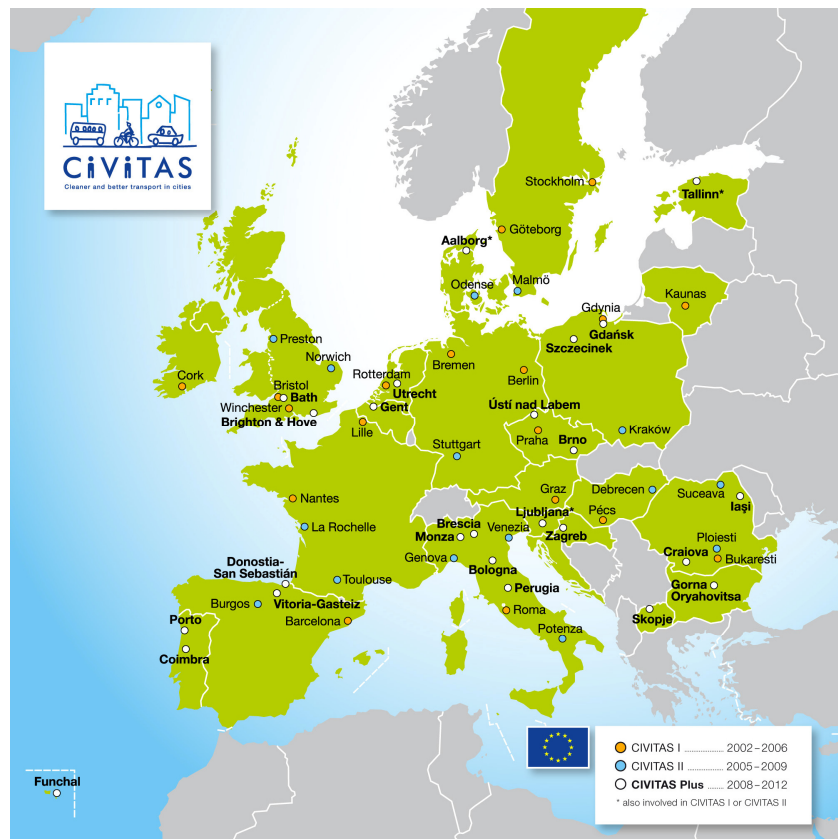


Figure 4: CIVITAS cities co-financed by the EC since 2002

Moreover, the CIVITAS Forum Network provides a platform for the exchange of ideas and experiences between all the demonstration cities co-funded by the EC within the CIVITAS initiative and other cities that are committed to introducing ambitious, clean urban transport strategies. Every European city can be a member of the CIVITAS Forum network, which currently incorporates over 150 cities. Through workshops and training events cities have the opportunity to inspire and aid active exchange of know-how, ideas and experience to facilitate change in the field of transport.

5 Clustering measure types

In order to achieve a common understanding of sustainable transport measures, eight categories of measures have been defined as the basic building blocks of an integrated strategy within the CIVITAS initiative. Each participating city chooses an appropriate set of measures and combines them to form integrated solutions for clean urban transport in cities:

- *Clean vehicles & fuels for passenger or freight transport* (including the necessary infrastructure)
- *Logistics and goods distribution* includes new concepts for the distribution of goods by means of innovative freight logistic services and the use of clean and energy efficient vehicle fleets
- *Alternative car use* includes measures like car pooling and car sharing
- *Access and parking management* includes demand management strategies for inner city areas and other sensitive zones (green zones)
- *Cycling & walking* includes promotion, new services like city bikes and the integration/extension of the pedestrian and cycle route network
- *Traffic control systems* includes the use of innovative transport telematic systems for traffic management and traveller support, including solutions based upon satellite applications
- *Public transport* includes measures enabling an improved information system for passengers, better reliability as well as acceleration of the public transport
- *Mobility management*: measures influencing travel behaviour and modal choice through mobility management plans, marketing, communication, education and information campaigns

For example, more than 200 measures have been implemented in CIVITAS II, most of these measures are related to public transport, however many demonstration sites are dealing with clean vehicles and fuels as well as access and parking restrictions in the city centre or sensitive areas of the city (Figure 5).

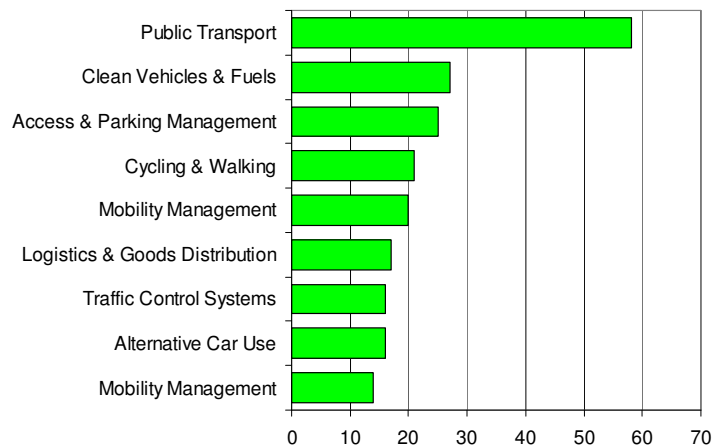


Figure 5: Number of measure types implemented in CIVITAS II

6 Evaluation framework

In order to evaluate the outcomes and the results achieved by the sustainable transport measures implemented in the CIVITAS cities, horizontal projects have been established. Among several dissemination activities (e.g. maintenance of the homepage, production of information leaflets, organising workshops as well as an annual meeting) these projects are responsible for the cross-site evaluation. Therefore a common evaluation concept has to be agreed among all participating cities in order to make benefits achieved quantifiable as well as comparable.

Furthermore, it is the ambiguous goal of the evaluation projects to demonstrate potential impacts achievable by up-scaling successful measures within a city or by transferring the knowledge to other European conurbations. Harmonising cross-site evaluation within CIVITAS needs a clear strategy and a common understanding, as measures are implemented under different institutional, legal and cultural framework conditions which need to be considered.

In the METEOR project, which was responsible for the cross-site evaluation of measures undertaken in CIVITAS I, the following 3 step evaluation concept has been proposed [METEOR 2003]:

- (1) Development of a consistent definition of reliability and quality of data, which are forming the basis for the overall evaluation, calling for a common framework of variables and indicators
- (2) Carrying out a comparison between the values of indicators defined with or without the implementation of the measures across all CIVITAS cities (before and after situation) including the definition and evaluation of the “do-nothing” scenario (trend scenario)
- (3) Drawing conclusions at the European level by using a transferability framework whereby city-level achievements are evaluated considering the specific characteristics of each city

The evaluation framework developed in METEOR considered both, the monitoring of the implementation process and the evaluation of the impacts achieved by the accomplishment of sustainable transport measures. However, the evaluation undertaken in METEOR was mainly focused on the assessment of the impacts, the implementation processes were evaluated ex-post.

In order to be consistent with the results of the assessment of CIVITAS I measures, the concept of the METEOR project formed the basis for the development of the evaluation of CIVITAS II measures undertaken by the follow up project, called CIVITAS-GUARD. Again, the approach is twofold: impact evaluation deals with the understanding of measurable effects of measures, whereas process evaluation is concerned with the understanding “why” measures have succeeded or failed [GUARD 2005].

It is clear that a European wide cross-site evaluation has to build up on the assessment undertaken by the cities. Thus, the evaluation concept as well as the indicators used must be consistent across all CIVITAS cities as well as the methods of measurement must be harmonised in order to achieve comparable results.

Figure 6 shows the general evaluation concept of CIVITAS II measures. Each city has to fulfil its own evaluation at measure and city level. However, relevant information is given at the same time to the leader of the evaluation team responsible for cross-site evaluation on the European level. In return, the leader of the impact evaluation produces common guidelines for defining evaluation scenarios and the measurement of common core indicators as well as guidelines for up-scaling and reporting on city level. Task of the process evaluation at the European level is to collection information on a regular basis at all stages of the implementation process, to provide feedback as well as support and to draw conclusions for relevant factors of a successful implementation of sustainable transport measures. Finally, the cross-site evaluation is based on the information collected as well as the individual evaluation results on measure and city level.

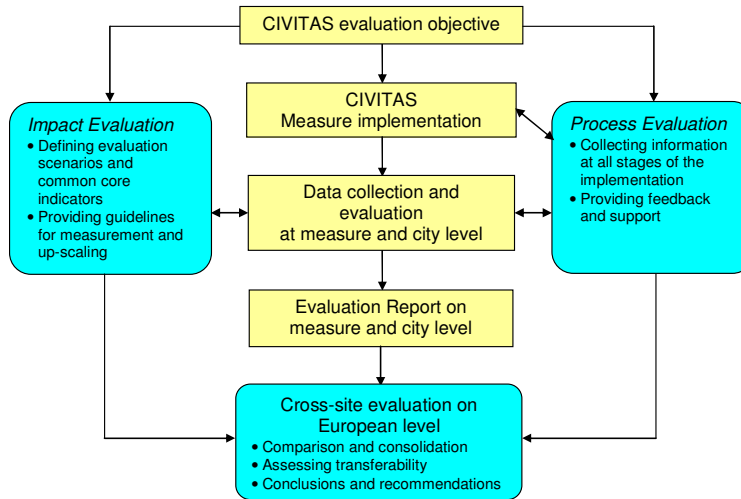


Figure 6: Evaluation framework developed in CIVITAS II [GUARD 2005]

7 Evaluation of the impact of sustainable transport measures

7.1 Method of approach

The approach used in the evaluation of measures undertaken in CIVITAS II is based on the evaluation guidelines developed within the MAESTRO project funded by the European Commission under the 4th EU FRP and consists mainly on a comparison of the before and after situation (in consistent with the evaluation undertaken in CIVITAS I).

In a first stage the current situation is analysed prior to the implementation of the CIVITAS measures. The objective is to collect data available and necessary for the impact evaluation as well as for the prediction of the do-nothing scenario (trend), which describes the development of the situation due to other (external effects) and without implementing the measure evaluated. Two ways to calculate the trend scenario are proposed: Forecasting the indicators from historical data, or to monitor a parallel site with the same characteristics, without implementing a comparable measure at this site. The ex-post analysis provides a set of indicators for the “after” situation. The comparison of the values of the indicators between the before and after situation forms the basis for the evaluation of the effect of the measure implemented (Figure 7).

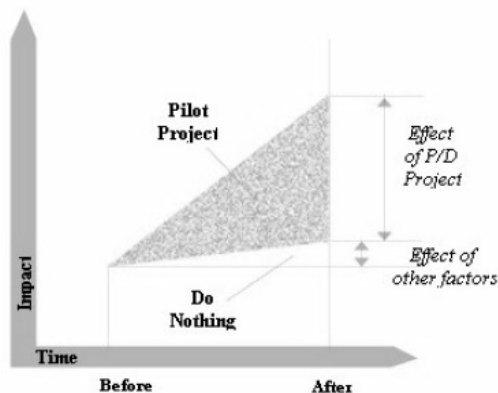


Figure 7: Impact of the project [MAESTRO 1999]

7.2 Method of data collection

It is obvious that a common framework of indicators as well as a consistence data collection methodology has to be developed in order to make the results comparable on a European level. As a bottom up exercise, cities were contacted and asked for their opinion about common indicators, their requirements and their suggestions for changes and alternatives. Workshops have been organised and a detailed description on the measurement of the indicators were provided. Finally, a set of indicators and adequate measurements were agreed among the responsible project teams in each city. A common template for data collection has been developed and distributed among all measure leaders covering the following main areas:

- Economy (benefits, costs)
- Energy consumption
- Environment (pollution, nuisance, ressource consumption)
- Society (acceptance, accessibility, employment, health, ...)
- Transport (quality of service, safety, transport system)

The evaluation of the pollution was based on the following indicators:

- Air quality: CO, NO_x, PM in ppm or g/m³ to be measured quantitative
- Emissions: CO₂, CO, NO_x, small particulate emissions g/vkm to be measured quantitative or derived
- Noise perception to be evaluated by index, by the means of a survey or measured qualitative.

It is obvious, that a detailed description of the measure implemented, including target population and area concerned, has been collected, in order to be able to indentify the size of the area the indicators are related to and to make the results comparable across European cities.

8 Evaluation of the implementation process of sustainable transport measures

8.1 Scope of process evaluation

Special attention has been drawn to the evaluation of the implementation process as success of a measure is influenced not only by its technical solution, but also by optimising the process of planning and implementation including the accompanying activities such as information, promotion or a well-prepared engagement process. Main goal of process evaluation is to receive information about factors of success, to identify potential barriers, which might lead to serious delay of the implementation or even to the cancellation and to learn about strategies who to overcome these barriers.

8.2 Data collection

The process of data collection is linked to the typical phases of the implementation of a transport measure:

- (1) Planning, preparation and design phase
- (2) Implementation phase
- (3) Initial phase of operation
- (4) Long term running phase

In order to receive information about the first three phases at least an online data collection tool (process diary) has been developed. Measure leaders are asked to fill in the data requested on a regular basis. The process diary consists of three parts:

- (1) Part A mainly concerns information which need to be provided in most cases only once (however updates are possible at any time):
 - Specification and description of the measure
 - Target population, stakeholders to be addressed and target area
 - Financial aspects (including expected revenues)
 - Project team and competences for decisions
 - Available information & know-how
 - Formal decision required for the implementation
- (2) Part B concerns the main important implementation steps, which need to be updated on a regular basis:
 - Activities undertaken
 - Stakeholder involvement and drivers
 - Barriers, risks and strategies to solve problems
- (3) Part C reflects on the strategies and implementation process as a whole and for each specific item defined as well as on lessons learnt (self-assessment) in order to be able to analyse indicators relevant for a successful implementation with a statistical model.

One crucial element of the process diary is the formulation of pre-defined answers, which ensures a standardised evaluation. For example, organisations involved are clustered according a pre-defined categorisation, such as local administration, private company or private investor (Figure 8). Potential barriers are to be allocated to financial, organisational, technical risk etc. Moreover, the degree of the level of risk of cancellation due the barrier described has to be estimated beforehand (low, medium or high risk). However, if the pre-defined answers are not appropriate in a specific case, measure leaders are free to add new categories.

The screenshot shows a software window titled "001 - Activities related to the preparation of the measure". The window contains a form with several fields and a dropdown menu. The fields include: "Title of the activity" (Pre-analysis of average daily traffic), "Start date (mm, yyyy)" (06, 2006), "Duration (month)" (2), and "State" (completed). The "Organisations involved" field is a dropdown menu with a list of options: town planning department, private consultant, European Union, national politicians, national administration, local, regional politicians, local, regional administration, transport department, town planning department, police, public enterprise, transport operator, research institution, private consultant, private investor, private manufacturer, and others... The dropdown menu is currently open, showing the list of options. The form also has a "confirm entry" button and a "confirm" button. The window title bar includes standard window controls (minimize, maximize, close) and a toolbar with "confirm", "edit", "delete", and "add new item" buttons.

Figure 8: Example for pre-defined categories of the process diary

9 Cross site evaluation and transferability

The overall evaluation on a European level comprises the outcomes of the impact evaluation as well as of the process evaluation according to the measure clusters defined in section 5. Further on, a crucial issue is the definition of "success". Therefore, it is evaluated which effects are achieved by the implementation of the measure clusters according to the indicators defined (e.g. reduction of CO₂ emission or the percentage of modal shift).

Moreover, measure leaders are asked to carry out a self-evaluation. First of all they have to report whether the measure has been completed or not. If yes, the measure leaders are asked to assess the measure by comparing the objectives and goals defined at the beginning of the project with the results achieved (*How successful is the outcome with regard to the objectives?*). This assessment has to be done on a quartered scale from not successful to very successful. Furthermore, it is asked if substantial revisions, downgrading or downsizing of the measure has been necessary. Finally, the time schedule and budget planned are compared to the actual values spent.

Based on these indicators and variables described above a statistical model will be developed for each measure cluster considering the framework condition of each city (city size, car-ownership rate, modal split etc.). The expected outcome is a value for defining the degree of success for each measure implemented. The model is supposed to identify the measures which have been implemented successfully in one city and are likely to be successful in another European city with similar framework conditions.

10 Examples of evaluation outcomes

10.1 CIVITAS I

In September 2006 the evaluation results have been published. Summarising it has been found that the main driver of a successful implementation of sustainable transport measures is political commitments at city level. It is essential to achieve an understanding that supporting sustainable transport measures should stand above all parties. However, political champions are needed to bring forward the smooth implementation. Further important aspects identified are an effective co-operation between all relevant stakeholders involved as well as sufficient funding [METEOR 2006/1].

Due to the limited availability of impact data on comparable measures only in some cases "hard" (measurable) figures of environmental effects have been reported, e.g. due to the implementation of access restrictions for private cars in the city centre the city of Rome and the city of Stockholm were able to reduce traffic by 20 to 25 % in the concerned zone resulting in a reduction of 40% CO₂ emissions (Stockholm) or a reduction of particulate matters between 11 and 13 % (Rome, Stockholm). Göteborg achieved a CO₂ reduction of about 10% due to the implementation of an environmental zone based on emission classes for heavy duty vehicles. [METEOR 2007].

Generally speaking, the impact on energy use, environment, economy and on the transport systems of the CIVITAS I program is less obvious as many of the measures were on a small scale. However, the evaluation shows that many measures are able to be implemented on a broader scale and to be transferred to other cities to achieve a more sustainable urban transport system in European cities [METEOR 2006/2].

10.2 CIVITAS II

Measures implemented in CIVITAS II have been finished in the first half of 2009 and the overall evaluation is currently ongoing. However, it can be said that the evaluation concept developed for CIVITAS II measures has been accepted by the measures leaders and that the templates and questionnaires distributed have been filled in sufficiently.

For example, detailed figures are given for the reduction of the emissions due to the renewal of the public transport bus fleet in different European cities and barriers as well as drivers are described in a detail manner for nearly all measures. Figure 9 shows the number of barriers mentioned by measure leaders within CIVITAS II. Most of the barriers are concerned with solving technical problems. This is just an example of data collected which form the basis for the development of a statistical model with the aim of explaining pre-requisites of a successful implementation of sustainable transport measures.

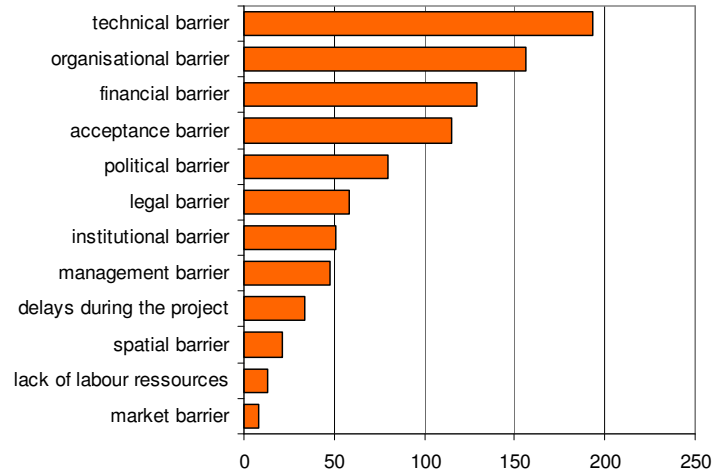


Figure 9: Number of barrier types mentioned within CIVITAS II

The current status of the overall evaluation on a European level of measures implemented in CIVITAS II is that all indicators identified have been collected for all measures and the cross-site evaluation according to the measures clusters described in section 5 has been started recently.

11 Conclusion

It is the ambiguous aim of the CIVITAS initiative to save energy, to reduce CO₂ emission and to minimise pollution caused by traffic due to the implementation of sustainable transport measures in European cities.

Within the paper it was pointed out that an overall evaluation is necessary to achieve a multiplier effect of the success achieved in the several demonstration sites. The assessment strategy is essential to show the impact and the positive effects on the environment of the measures implemented as well as to identify “successful” measures. Indeed, it is challenging to provide a concept which is appropriate for each measure type and for each city characteristics. However, the following recommendations are given in order to achieve comparable results and to be able to draw conclusions on a European level:

- Provide a set of indicators to be measured
- Define the units of the indicator exactly
- Propose adequate measurements for collecting data required (including the measurement area)
- Set clear rules on how to define scenarios evaluated
- Provide city support by organising workshops on data collection

In any case, all the items mentioned have to be defined adequately for all measure types. Moreover, it is essential to agree on the items with all relevant persons involved in the data collection in order to follow a bottom-up-approach and to achieve a common ownership on the results. Taking into account all these issues it is possible to develop and implement an evaluation strategy which makes measures comparable. This is the pre-condition to develop recommendations and advises for cities which want to implement similar measures in order to reduce pollutant emissions as well.

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