



# Comparative analysis of passenger transport sustainability in European cities



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## ABSTRACT

Sustainable development in its three dimensions – economic, social and environmental – has become a major concern on an international scale. The problem is global, but must be solved locally. Most of the world's population lives in cities that act as centres of economic growth and productivity, but which – if they develop in the wrong direction – can cause social inequalities, or irreversibly harm the environment. Urban transport causes a number of negative impacts that can affect sustainability targets. The objective of this study is to propose an analysis of sustainability of urban passenger transport systems based on available indicators in most cities. This will serve to benchmark the practices of different cities and manage their transport systems. This work involves the creation of composite indicators (CI) to measure the sustainability of urban passenger transport systems. The methodology is applied to 23 European cities. The indicators are based on a benchmarking approach, and the evaluation of each aspect in each case therefore depends on the performance of the whole sample. The CI enabled us to identify which characteristics have the greatest influence on the sustainability of a city's transport system, and to establish transport policies that could potentially improve its shortcomings. Finally, the cities are clustered according to the values obtained from the CIs, and thus according to the weaknesses and strengths of their transport systems.

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## 1. Introduction

Concern about the evolution of human settlements and the unavoidable effects of social development on the environment were first viewed by the global community as comprising three main dimensions – economic, social and environmental – at the Conference on the Human Environment in Stockholm (United Nations, 1972), which marked the earliest definition of the basis of sustainability. The conclusions included the need to safeguard and improve the human environment for present and future generations as a goal to be pursued together with worldwide economic and social development. Since the declaration of these principles, sustainability has become a major concern for decision makers and management stakeholders (Newman and Kenworthy, 1999; Jeon and Amekudzi, 2005; Haghsheenas and Vaziri, 2012).

*Abbreviations:* CI, composite indicators; EMTA, European Metropolitan Transport Authorities; MMO, Metropolitan Mobility Observatory (Spain); PT, public transport; PTA, Public Transport Authorities.

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This sustainable development must be applied to cities on a global basis, as they play a key role in our society. Cities are important generators of wealth, employment and productivity, and often serve as the engines of their national economies (OECD, 2013). According to the Green Paper, just under 85% of the EU's gross domestic product is created in urban areas, which are home to over 60% of the population (European Commission, 2007). Analyses of the challenges facing cities in their efforts to achieve a more sustainable development invariably give a high priority to the problems of mobility and access (Newman and Kenworthy, 1999; UNECE, 2011). At the urban level, where transport problems are more acute and concentrated, achieving a sustainable form of mobility is a prerequisite for improving the environment – including social aspects –, and enhancing economic viability (European Commission, 1996). Some problems in meeting this challenge were raised in the EU 2011 White Paper on transport, namely congestion and its consequences on delays – and thus on the economy –, noise, air pollution, GHG emissions, impacts on land or accidents (European Commission, 2011).

Urban transport therefore has several negative impacts that can hinder the achievement of sustainability targets. According to TERM (2000), these can be prevented by identifying key indicators that can be tracked and compared with concrete policy objectives,

based on the premise: “You can’t manage what you can’t measure”. Within this framework, the aim of this research is to identify practical indicators to analyse the economic, social and environmental sustainability of urban passenger transport systems. This would help to manage the different aspects of sustainability from a comprehensive point of view and would also make it easier to benchmark one city’s performance against another’s. The first section of the paper explains the process for selecting the indicators and the cities in the analysis. The next section contains the methodologies used to compile, compare and classify the chosen indicators, in order to analyse different sustainability aspects of urban passenger transport systems in the 23 European cities selected. The final sections include the results of the analysis and some conclusions.

## 2. Measuring sustainability using indicators

There is a common consensus as to the usefulness of indicators to highlight the many overlapping areas of sustainability, and the need to achieve sustainable urban transport systems has been largely discussed (TERM, 2000; Newman and Kenworthy, 1999). But before selecting the appropriate indicators for measuring sustainable transport, we should rely on an established definition. We have therefore, selected a definition supported by international institutions (Council of the European Union, 2001; OECD, 2001). According to this definition, a sustainable transport system should be analysed from three different dimensions:

- Economic: affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development,
- Social: allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promises equity within and between successive generations
- Environmental: limits emissions and waste within the planet’s ability to absorb them, uses non-renewable resources at or below the rates of development of renewable substitutes while minimizing the impact on land and the generation of noise.

There are some authors that propose other dimensions of sustainability (Holden et al., 2013) according to different approaches of the Brundtland Report (WCED, 1987). In this paper we have chosen the above mentioned definition that has been used in many studies in the field of urban passenger transport (Miranda and Rodrigues da Silva, 2012; Haghshenas and Vaziri, 2012). However most of the aspects included in any of the approaches are common although they are structured in different way.

### 2.1. Literature review

In order to select which indicators were more appropriate to assess sustainability of urban passenger transport systems, a literature review of several initiatives with similar scope was carried out. This section summarises this literature review in regard to the indicators used. The indicators selected should as far as possible incorporate all the aspects mentioned in the chosen definition of sustainable transport systems.

Some authors consider sustainable transportation indicators as decision-making tools which should reflect economic, social and environmental impacts (Litman, 2009), while others (Nicolas et al., 2003) focus their indicators on the issues raised by urban resident mobility and consider surveys of household trips as a highly valuable data source. Here it is worth noting the study carried out by Jeon and Amekudzi (2005), who characterised the emergent thinking on what constitutes urban transportation sustainability

and how to measure it in their collection and classification of indicators used by 16 international institutions – mainly relating to planning and infrastructure provision. Finally, other approaches have focused their analysis on the assessment of policies, in terms of efficiency and equitable functioning (Savelson et al., 2006; Zito and Salvo, 2011).

As a result of this literature review, Table 1 shows the most commonly used indicators directly related to urban transport sustainability, we have classified them into three dimensions – economic, social and environmental. There is a greater range of indicators in the social and environmental than in the economic category. The most frequently applied indicator for measuring social sustainability is the number of transport fatalities; for environmental sustainability it is land consumption of transport infrastructures; and for the economic aspect user transport costs and public expenditure.

The aim of this review was to identify significant indicators for measuring sustainability in order to choose appropriate and available indicators from our sources which are described below.

### 2.2. Data collection

The research to develop a group of indicators in and to analyse the different dimensions of sustainability regarding urban passenger transport, was initially focused in Spanish cities, due to the existence of a homogeneous database with a sufficient number of cities. In order to achieve a wider scope for comparison, and to avoid an overly biased analysis – referring only to cities in southern Europe – we decided to include other cities from central and northern Europe.

#### 2.2.1. Main data sources

At the European level there are two associations that collect and publish urban transport information from a representative group of cities<sup>1</sup> and promote the exchange of information and good practices in the field of public transport organisation, planning and funding. The Metropolitan Mobility Observatory (MMO, 2014) is a platform comprising 24 public transport authorities (PTA) in the main Spanish cities. The European Metropolitan Transport Authorities (EMTA, 2014) is an association whose members are the bodies responsible for public transport in 28 European cities. Both publish reports analysing the mobility patterns of the participating cities, using indicators. These reports were the main sources for our research; the year of reference for the analysis was 2010 (Monzón et al., 2012; EMTA, 2012a,b).

For the analysis, we selected 18 of the 24 cities in the MMO – those that had sufficient information available for the scope of the study. As the MMO is a national observatory, all of them were Spanish. For a wider scope, the cities to include from central and northern Europe needed to be from different countries and to have enough information on them available. Four cities with these criteria were selected from the EMTA report: Paris, London, Stockholm and Amsterdam. The rest were discarded, mainly due to lack of key data.

While Paris and London were notable for being the most populated cities (>7 mill. inhab.) in the EMTA association, Amsterdam (1.4 mill. inhab.) was characterized by having the highest modal share of non-motorised modes (56%), and Stockholm (2 mill. inhab.) for having the highest ticket prices. All these differences could through up interesting conclusions in the

<sup>1</sup> In this context, the term “city” refers to the urban geographical area in which there is a high degree of interaction between its urban centres in terms of trips, relationships and economic activity. This concept is often called the Metropolitan Area (MMO, 2014; EMTA, 2014).

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