Urban Transport Benchmarking Initiative

Annex A1

Common Indicator Report

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Transport & Travel Research Ltd

THE REGIONAL ENVIRONMENTAL CENTER for Central and Eastern Europe

Annex A1

Review of the Common Indicators from the Urban Transport Benchmarking Initiative

Prepared for

European Commission Directorate General for Energy and Transport

by

Transport & Travel Research Ltd

Author(s)	Sam Roberts, Neil Taylor
Quality Control	Sarah Clifford
Project Manager	Jo Baker
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0. EXECUTIVE SUMMARY

The aim of the Urban Transport Benchmarking Initiative common indicators was to provide a useful context for the five working groups and to enable a range of straightforward comparisons to be made between the cities participating in the initiative. The common indicators were carefully chosen to provide some compatibility with the Citizen's Network Benchmarking Initiative, as well as to reflect the interests of the five Urban Transport Benchmarking working groups.

A total of 26 cities submitted data for the 25 common indicators and this data was then analysed by the project team in order to highlight interesting comparisons and identify key trends. The main trends established from the analysis of the common indicators were:

- **Average income levels have an impact upon public transport use and car use in cities**. Where GDP per capita was found to be high, the modal share of public transport was generally lower and the proportion of trips made by cars was higher. This has obvious policy implications both for less affluent cities and wealthier cities, because it implies a clear preference for car travel. People who can afford to travel by car appear to do so unless traffic congestion, lack of parking or access restrictions associated with large, heavily urbanised cities prevent them from doing so (as in London or Rome). It also implies that people in less affluent cities would travel by car, if it were more affordable, but instead rely upon public transport.

- **Cycling was found to be popular where it had been encouraged by investment.** Cities that have larger cycle lane networks tended to be those with higher levels of GDP per capita. The cities that have large cycle lane networks in proportion to the size of the urban road network were also found to display the highest levels of cycling modal share. This sends a clear message to policy makers that are keen to develop a cycling culture in their cities. People are more likely to cycle where they are provided with the facilities that enable them to do it safely and quickly.

- **Car ownership levels vary according to city size.** The cities that displayed the largest urban populations also displayed lower levels of car ownership (cars per 1000 inhabitants) in relation to the less populous cities that participated in the Urban Transport Benchmarking Initiative. Although these large cities do generally contain more cars (in absolute terms) than smaller cities, the level of car ownership is lower and appears to be a particular feature of high density cities (Barcelona, London, Rome and Paris).

- **A critical mass of population is necessary to support a metro system.** The vast majority of cities with populations in excess of 1 million inhabitants were those that had metro systems. These metro networks were all supported by a wide range of other transport modes (bus, train and particularly tram) and were generally focused upon central urban areas (those in Paris and London are exceptions). Averaging the size of metro systems across the 13 metro-cities revealed a demonstrable average of approximately 40 km of metro per million inhabitants. Although this is only a rough threshold, which needs to be considered in relation to the other public transport modes available in each city, it does suggest that both Dublin and Warsaw are potential metro cities.

These headline findings can be developed as the project moves into year two and it is important to recognise that the results of the project may be greatly beneficial to cities from beyond the project that are keen to learn about urban transport systems in other cities. The aim of the project team is to disseminate the findings from the common indicators as widely as possible in order to encourage the process of shared learning. The following recommendations were made by the project team following the analysis of the common indicator data. These recommendations outline the indicators that would be useful for year two of the initiative as well as ideas as to how to share the results with as many urban transport stakeholders as possible;

- Refining the indicators that cover the cost of car use in order that accurate comparisons can be drawn between the participating cities; this would particularly help to develop the finding about GDP per capita and its impact upon modal share by enabling comparisons between costs of car use. In addition this could provide a point of comparison for the cost of car use against the cost of public transport in each of the cities.

- Figures for investment in urban transport infrastructure over the last five years also proved difficult for the participants to collect, although this appears to be part of a larger issue of data sensitivity. A suggested alternative is that the developments or projects realised over the last five years and throughout the course of the project could be documented qualitatively by the participants. Rather than providing a quantitative indicator for the amount of investment in urban transport in recent years, this qualitative information could be used to rate each city in terms of the amount of development being achieved.

- A set of 5 to 10 core indicators could be drawn up based upon those that have been successful in year one of the initiative. This would enable new entrants to the project to submit data which is readily comparable and permit time series data to be collected by the existing participants in the project. Time series data would facilitate the identification of trends in urban transport, as well as to help to unify the methods of data collection / measurement applied in the cities involved in the initiative.

Further recommendations for year two of the Urban Transport Benchmarking Initiative include the development of international links which have been formatively established during year one of the project. One suggestion is that interested cities from other continents could participate remotely by submitting data for the benchmarking exercise to broaden the scope of data comparison. In addition, links to other transport benchmarking projects will be renewed and, where relevant, there is potential for the sharing of data in order that the scope of the benchmarking exercise is widened.

Finally, a planned on-line benchmarking facility is another possible development of the benchmarking initiative. This would enable cities not participating in the initiative to submit items of data on selected scatter-plots to see how their city measures compares with those that have participated in the initiative. Accessible via the project website, this facility could be a valuable tool in attracting cities to the initiative, as well as aiding the dissemination of the results of the project.

1. INTRODUCTION

1.1 Project background and overview

The Urban Transport Benchmarking Initiative has sought to apply the concept of benchmarking to the urban transport systems present in cities across the EU, including the New Member States. This is in keeping with the European Union's policy approach which places considerable importance upon the role that attractive, efficient local and regional transport systems can play in the economic development and social cohesion of the EU. In the field of urban transport the exchange and promotion of best practices is one of the main policy tools that the European Commission possesses. The Urban Transport Benchmarking initiative has therefore compared the transport systems of the participating cities in order to identify and promote interesting practices in urban transport.

The benchmarking concept has great potential when applied to urban transport systems. A range of previous initiatives have provided this project with the opportunity to deepen the focus of the benchmarking process and, by learning from previous experiences, provide more comparable results. The development of more practical data indicators has aided the learning process for the organisations involved in the project and this has greatly helped to improve the robustness of the data collected for the project.

The Urban Transport Benchmarking Initiative has adhered to the European Commission's subsidiarity principle by including as many urban transport stakeholders as possible. The process of the Urban Transport Benchmarking Initiative has been a fluid one, responding to the issues which were raised by participants in the project, rather than following a rigid, predetermined process. In this way the subsidiarity principle has been fulfilled, because the recommendations of interesting practices are coming from a network of urban transport operators, user groups, local authorities and municipalities, rather than a single centralised institution. It is therefore hoped that the project findings will provide a useful resource for other urban transport stakeholders and help them to implement innovative solutions to commonly experienced urban transport problems.

The Urban Transport Benchmarking Initiative has been based around five themes, for which data has being collected by the participating cities. These themes have been organised as working groups and these are listed below:

- Behavioural and Social Issues in Public Transport
- City Logistics
- Cycling
- Demand Management
- Public Transport Organisation and Policy

The working group themes have been chosen by the participating cities to reflect their interests in terms of urban transport systems in cities. The participating cities have also been responsible for helping to select common data indicators, that have been used to benchmark general aspects of urban transport, and thematic indicators, that have been collected by cities within each of the five themed working groups. The thematic indicators are specific to each working group and aim to answer the group's chosen research questions. The participants have been aided with the definition and analysis of thematic indicators by their working group rapporteur and expert.

The common indicators have been collected by all of the Urban Transport Benchmarking participants and have provided a quantitative data set of the general features of each city's transport systems. The thematic data indicators are different for each of the working groups and are based strictly around each group's chosen theme. This report explains the headline findings from the common indicators collected by all participants in the project.

1.2 What is Benchmarking?

The concept of benchmarking has been used widely by many different types of organisation seeking to learn more about their operational shortcomings. The process of benchmarking involves comparing operational performance with similar institutions, organisations or enterprises in order to gain some understanding of the best practices employed within a given industry. Once performance differences across an industry are understood then each participating organisation has the potential to integrate best practices within the scope of its own operations in order to attain measurable performance improvements.

Successful Benchmarking =
Self Analysis + Identify Best Practices + Analyse Performance Differences + Implement Findings
Result = Narrowed Performance Gaps & Tangible Performance Improvements

The benchmarking process is usually centred upon performance indicators, which operate as a means of self analysis and help to identify key differences between participating organisations. The participants of a benchmarking exercise will collect data for these indicators in order to establish best practices in a particular field. Site visits or case studies are often used to showcase best practices, because this helps participants to understand more fully how the best practices have been developed and how they work on a daily basis.

Once benchmarks have been established it is the responsibility of individual participants to return to their respective organisations and implement the process changes that should improve performance levels. This requires a commitment from participants that the organisation is willing to co-operate not just in the process of benchmarking, but in following up the recommendations in order to implement change. This is not simply a case of "following the leader", but of constructively integrating the best practices that leading organisations have established into existing procedures.

In the case of the Urban Transport Benchmarking Initiative the actors participating in the benchmarking exercise have been urban transport stakeholders. This included a range of organisations such as municipal authorities, public transport operators, and regional authorities. It is intended that the organisations representing each of the participating cities will disseminate results relevant to their city to other local transport stakeholders.

1.3 Review of previous benchmarking initiatives

The Urban Transport Benchmarking Initiative has built upon the experience of the two previous Citizen's Network Benchmarking Initiatives which together ran from 1998 until 2002. There have been many other transport benchmarking projects and this section briefly details the most relevant initiatives, providing links to websites where possible. The Urban Transport Benchmarking Initiative sought to learn from the experiences of previous transport benchmarking projects. A more exhaustive review of previous initiatives is detailed in Annex A1.2.

Benchmarking European Sustainable Transport (BEST)[1]

BEST is a thematic network which has been reviewing benchmarking practices in a number of transport sectors. The six BEST conferences have been aimed at raising the profile of benchmarking for the transport sector via the use of presentations and reports from various contributors who have experience of the benchmarking process. Until its commencement in October 2000 there had been little research into how benchmarking could work for the transport sector. In particular the BEST project aimed to explore the potential for benchmarking techniques to be adapted to assist in the future implementation of sustainable transport policies across the EU. The three main objectives of the initiative are:

- To produce specific recommendations on the development of benchmarking as a practical tool to assist the European Commission, Member States and Accession Countries in effectively implementing sustainable transport policies in Europe.
- To create an innovative dynamic of exchange of experience between the different transport sectors and sub-sectors.
- To build consensus, at a European level, on the key requirements for a successful benchmarking process, and the benefits of applying benchmarking in the transport sector

The indicators reviewed by BEST represent the recommendations which emanated from the BEST conferences, most notably conference 3, which aimed to highlight the most effective and practicable criteria for successful transport benchmarking. The findings of the BEST project were very useful in establishing the indicators and processes for the Urban Transport Benchmarking Initiative.

Citizen's Network Benchmarking Initiative[2]

This project forms the basis for the current European Commission benchmarking exercise and it is therefore important to avoid repeating what has already been achieved by the Citizen's Network. The Citizen's Network initiative was actually two projects; an initial pilot project which ran from 1998 to 1999, the success of which prompted the European Commission to fund an expanded initiative in 2001. The three main questions which the indicators were seeking to answer are:

- How do people travel? What transport services do people prefer and how well is the system meeting these requirements?
- How accessible is the transport system? How congested are the roads? What information is available to motorist and transport users?
- What are the costs of transport? What is the impact of transport on the environment? How safe is it to travel?

The majority of the indicators collected by the Urban Transport Benchmarking Initiative have been based upon those collected by the Citizen's Network Benchmarking Initiative in order to allow comparisons to be drawn between the two schemes.

[1] BEST web reference: http://www.bestransport.org
[2] Citizen's Network Web reference: http://www.eltis.org/benchmarking/

CoMET & NOVA – Benchmarking of global Metro Systems[3]

CoMET and NOVA are two different, but related, projects which aim to compare the urban transport systems of various cities from around the world. This involved using insight taken from other metro systems in order to attempt to improve internal working cultures and more specifically to improve on service levels. The initial step of these studies began in 1982 as a trilateral study between Paris, Hamburg and London. The CoMET benchmarking group began in earnest in 1994 and while the NOVA group has spun-off from the CoMET benchmarking group and is currently comparing medium sized metro systems. The CoMET and NOVA schemes have attracted cities from all over the world, not just in Europe and include the three global cities of London, New York and Tokyo.

The CoMET/NOVA projects are based around a set of core Key Performance Indicators (KPIs) from which best practices are established and then transferred among the group in the form of case studies. The indicators used in the CoMET / NOVA projects are focused mainly upon issues central to collective passenger transport. In addition the recommendations made in Adeney and Self's (2001) presentation for the 2nd BEST conference for the successful exchange of best practices have also been very useful.

EMTA Barometer[4]

The European Metropolitan Transport Authorities (EMTA) Barometer involves 15 of the 26 metropolitan areas which are currently members of the association. The Barometer was designed to provide information on the public transport systems of the participant cities, therefore enabling comparisons to be made. The data refers to the year 2000, although it is stated that future versions of the Barometer study will use updated data and be harmonised in future versions.

The EMTA Barometer is based around three main areas:

- Basic facts of each metropolitan area (population, surface area etc)
- Public transport system data (supply, demand and quality)
- Financial data related to fares, revenues, expenditures, coverage and investments.

The main indicators used in the Barometer study provided useful guidance to the Urban Transport Benchmarking Initiative's selection of both common and thematic indicators.

Millennium Cities Database[5]

The Millennium Cities project involved the compilation of a database of data from 100 cities in order to compare their transport systems. The project was completed by UITP in conjunction with Murdoch University, Australia and focused particularly upon the issues of sustainability and public transport and therefore is highly relevant to the new EC benchmarking initiative. Data was collected for over 200 indicators for the cities and was for the year 1995. The indicators covered a range of the working group themes and are likely to provide useful common indicators as well being relevant to collective passenger transport, emissions and energy and demand management.

[3] CoMET/NOVA web reference: http://155.198.91.3/rtsc/html/projectsCurrent/pts.htm NB: This site under construction. See also the BEST website, particularly the section on conference 2, for William Adeney and John Self's presentation notes at: http://www.bestransport.org/conference02/Adeney2.pdf
[4] EMTA web reference: http://www.emta.com/
[5] UITP web reference available at http://www.uitp.com/project/index4.htm

The Millennium Cities database is now being extended by UITP and is being developed into the "Mobility in Cities Database".

Scandinavian BEST[6]

BEST, the Scandinavian Benchmarking Survey has been running since 1999 and was set up by the Stockholm public transport authority "SL". It initially involved the four Nordic capitals of Oslo, Stockholm, Copenhagen and Helsinki and took the form of a survey of 36 questions based on 10 categories carried out in spring 2000. The idea was that for each of the 10 categories the city which displayed the best results would present a success story at a seminar. The initial problem with this approach was that the only "winning" cities were Helsinki and Copenhagen. All the cities did give presentations though and as a result four Common Interest Groups were chosen and each city is responsible for one of them. They are listed below:

- Integrated Public Transport and City Planning – Copenhagen
- Information at Traffic Disruptions - Helsinki
- Complaint Management - Oslo
- Systematic Branding - Stockholm

The second "round" of Scandinavian BEST included Turin, Munich, Barcelona and Vienna who were found through the UITP network. The project was not overtly quantitative in its approach and sought to provide the involved public transport authorities with a cost effective, usable benchmark forum which was task-oriented. The weaknesses of the project arose from differences in the expectations of stakeholders and varying company attitudes towards secrecy. Some worthwhile recommendations stemming from the project are that an agreement should be made concerning a press policy and that "less is more" when it comes to the number indicators and of participating cities.

1.4 Learning from the Citizens' Network Benchmarking Initiative

The Urban Transport Benchmarking Initiative has been able to refer back to the achievements of the Citizens' Network Benchmarking Initiative reports in order to try and further refine the process of benchmarking urban transport and to learn from previous experience. The aim of the Urban Transport Benchmarking Initiative has been to try and continue the work of the Citizens' Network project, rather than repeat what has already been achieved and this reflection upon previous work was an important initial stage of the project undertaken by TTR.

Where relevant in this report, comparisons have been drawn between the findings of the Citizens' Network Benchmarking Initiative and the results of this project. As the Urban Transport Benchmarking Initiative progresses it is intended that further comparisons between the two datasets will be made. The comparability of the two sets of data is ensured through the compatibility of the common indicators used in the two projects.

1.5 Purpose and context of this report

This report is Annex A1 of the Urban Transport Benchmarking Initiative's final report and describes the process of collecting and analysing data for the set of common indicators.

[6] Scandinavian BEST web reference: http://best2005.net/

The remainder of the report consists of an overview of the cities and regions that participated in the Urban Transport Benchmarking Initiative (section 2). Section 3 of the report outlines the methodology used to define the common indicators and explains the barriers to the collection and analysis of the common indicator data. Section 4 of the report contains the analysis of the common indicators and the fifth section of the report outlines the key trends identified from the analysis of the common indicators. The final section of the report outlines the conclusions from the analysed common indicators and makes suggestions for further refinements to the dataset and indicator definitions. These suggestions will feed into year two of the Urban Transport Benchmarking Initiative.

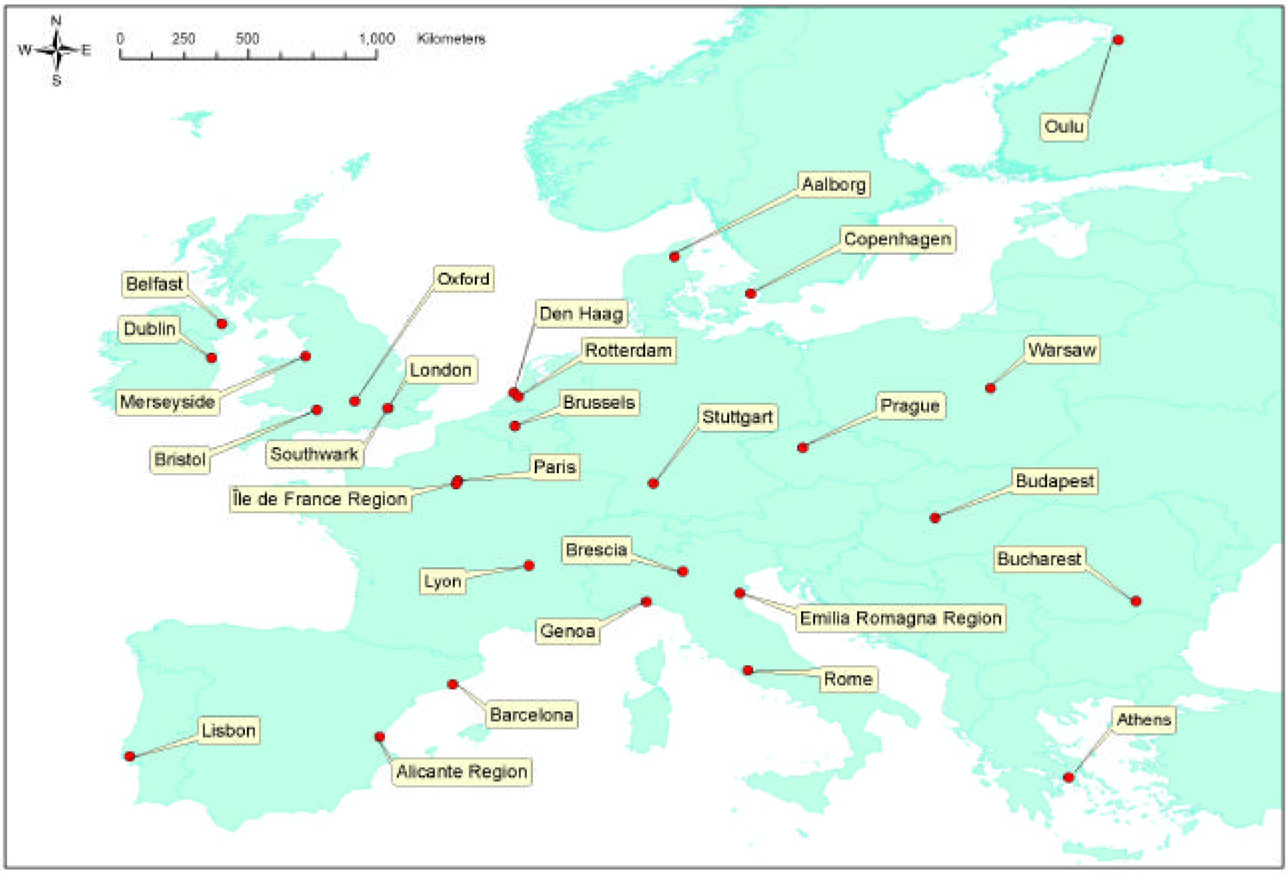
2. PROJECT PARTICIPANTS

2.1 Overview of participants

In total 26 different cities collected common indicator data for the Urban Transport Benchmarking Initiative and these cities represent a diverse range of geographical, social-economic and environmental conditions. This is very beneficial to help achieve the aims of the benchmarking initiative, because it is logical to assume that cities from a wide range of regions and circumstances will display more diverse practices in the field of urban transport. Comparing cities from the same country or a narrowly defined region of Europe would probably lead to a greater degree of homogeneity within the results.

The map illustrated in Figure 2.1 shows the large geographic spread of participants involved in the Urban Transport Benchmarking Initiative.

Figure 2.1: Cities participating in the Urban Transport Benchmarking Initiative



3. DEFINITION OF COMMON INDICATORS

In this section of the report the role of the common indicators and the processes of defining and analysing the collected data are explained.

3.1 Aims of the common indicators

The process of data analysis adopted by the Citizens' Network Initiative has greatly influenced the approach to this project. The aims of the Urban Transport Benchmarking project data analysis were clearly defined at the outset and these remain unchanged now:

- To look for best practices and try to establish reasons for variations between indicators that data are collected for.
- To encourage all participants to take part in this process in order that we end up with a set of findings that are supported by reasoned analysis rather than a collection of statistics.

The term "best practice" has been heavily debated over the course of previous benchmarking projects. The major problem is that there is no all-encompassing definition which clearly defines a "best practice". In the case of this benchmarking initiative the term "best practice" is applied more loosely to include interesting practices that are displayed in the participating cities.

From the outset it has not been the goal of the Urban Transport Benchmarking Initiative to create a competitive atmosphere among the participants and at the launch conference it was clearly stated that this is not a competition with "winners" and "losers". Promoting interesting practices, through the use of benchmarking, so that a wide audience of cities, operators and local authorities may benefit from them is a fantastic concept with huge potential. Creating a set of "winners" and "losers" does not help to achieve this, because it may dishearten those perceived to have "bad practices", yet these groups of participants probably have the most to gain from this type of project.

The aim of the common indicators has therefore been to try and offer the participants the chance to get the most out of the project by presenting a set of general findings that will interest all of the participants. Disseminating a range of interesting practices is also likely to be of wider interest to urban transport stakeholders that have not been participating in the project.

3.2 Methodology for indicator definition

The main consideration for the definition of the common indicators was that there was a degree of commonality with those used in the Citizens' Network Benchmarking Initiative. The aim of this was to enable backwards comparisons to be made with the data collected by the Citizens' Network project. These comparisons are likely to become more important at the end of year two of the Urban Transport Benchmarking Initiative, because at this stage the opportunity to compare data from three different study years (2000, 2002 and 2003) will emerge.

The common indicators were drawn up based upon the state of the art review undertaken by TTR in August 2003 and participants were invited to comment upon the indicators before they were finalised in January 2004. Because of the need to try and limit the number of common indicators to approximately 20, it was not possible to include every suggestion for another common indicator. The experiences of year one of the initiative will enable a re-evaluation of the common indicators prior to the commencement of year two and as a result of this it is possible that changes will be made to the existing set of common indicators in readiness for year two.

Figures 3.1 to 3.7 provide a summary of the common indicators that were collected by participants in the Urban Transport Benchmarking Initiative:

Figure 3.1: Region and city common indicators

Indicator	Description	Unit
1.1 Area of region	Size of regional administrative area	Km^2
1.2 Area of city	Size of urban administrative area	Km^2
1.3 Population of region	Number of residents of the regional administrative area	Persons
1.4 Population of city	Number of residents of the urban administrative area	Persons
1.5 Geography	Description of key geographical features influencing transport	Description

Figure 3.2: Transport network common indicators

Indicator	Description	Unit
2.1 Cycle paths	Length of segregated, dedicated cycle paths in the administrative area	Km
2.2 Public transport network	Length of network by mode (bus/train/metro/tram)	Km by mode
2.3 Roads	Length of road network	Km
2.4 Public transport priority	Length of bus lanes and segregated right of way for trams	Km

Figure 3.3: Fleet composition common indicators

Indicator	Description	Unit
3.1 Car ownership	Number of cars registered in the administrative area	Cars
3.2 Public transport fleet	Number of vehicles (by mode) operating in the administrative area	Vehicles by mode
3.3 Accessibility	% of public transport vehicles with low floors, by mode	% by mode

Figure 3.4: Travel characteristics common indicators

Indicator	Description	Unit
4.1 Average speed (private transport)	Average speed of cars/motorcycles in peak hour	Km/h
4.2 Average speed (public transport)	Average speed of buses/trains/metro vehicles/trams in peak hour	Km/h
4.3 Service intervals	Typical service intervals of buses/trains/metro vehicles/trams in peak hour	Minutes
4.4 Modal split	Total number of daily one-way journeys by mode in the administrative area	Person trips per day by mode
4.5 Vehicle occupancy	Average vehicle occupancy by mode (car/bus/train/metro/tram) in peak hour	Passenger km/Place km by mode

Figure 3.5: The economy common indicators

Indicator	Description	Unit
5.1 Cost of car use	Average cost to user of car use	Fixed & Variable costs per annum (€);
5.2 Cost of public transport	Average cost to user of public transport by mode	Typical single urban trip & season ticket price per annum (€);
5.3 Investment in public transport	Capital expenditure on public transport, by mode, averaged over the last 5 years	€ per annum by mode
5.4 Investment in roads	Capital expenditure on roads, averaged over the last 5 years	€ per annum
5.5 Gross Domestic Product	GDP per head of population	€ per capita
5.6 Employment	% of resident population currently employed	%

Figure 3.6: Road safety common indicators

Indicator	Description	Unit
6.1 Traffic accidents	Number of injuries and deaths on the road network, per annum	Number of persons injured and killed per annum

Figure 3.7: The environment common indicators

Indicator	Description	Unit
7.1 Air quality	Air quality by pollutant (NO2, SO2, NOx, VOC, particulates) per annum	Milligrams per cubic metre

3.3 Data collection and analysis

3.3.1 Data collection

Data collection was undertaken by the cities participating in the initiative between January and June 2004. This task was aided through the production of a common indicator handbook, which defined each of the indicators in full, and a data entry form, designed to enable all the cities to submit data in a comparable format. The collection of common indicator data was supported through update meetings held throughout the course of the three working group site visits, which were attended by a representative from each participating city / organisation. The participants were encouraged to raise any questions concerning the common indicators with their rapporteur and the project team, which was contactable through the helpdesk facility (benchmarking@ttr-ltd.com).

3.3.2 Data analysis

In order to successfully make comparisons using the data collected by the Urban Transport Benchmarking Initiative participants it was important to display an awareness of geographical, political and administrative differences that exist between the participating cities. In addition it was necessary to accept that the issues of data comparability highlighted by the Citizens' Network initiative were also likely to be an issue for the Urban Transport Benchmarking Initiative. These barriers are discussed in the next section of this report.

The overall aim of the data analysis process was to identify interesting practices and to examine the reasons for the differences in the data collected. This means that the cities participating in the initiative have been involved in order that the analysis of data was not undertaken from a "Top-Down" perspective. The local knowledge of each of the city representatives has proved invaluable when trying to undertake a reasoned analysis of the data.

Feedback from the participating cities indicated that they were keen to benchmark their city against similarly sized cities. However, due to the small number of cities that had submitted data for the common indicators (25), statistical analysis was only really relevant if the full data set was used.

The following statistical techniques were applied using the SPSS statistical software package in order to try and find the extent of correlation between some sets of variables.

Scatterplots

The scatterplot was widely used in the analysis of the common indicators and was particularly useful; because where good correlation was visually evident the scatterplot was then developed into regression analysis or rank data analysis.

Correlation Co-efficient

This test is a logical continuation of the scatterplots and enables a precise numerical figure to be generated for data that display a reasonable degree of correlation. This test could be performed using SPSS and it has been used to back up visually presented data.

Although relatively straightforward statistical techniques, these tests have provided enough output to make simple comparisons between the urban transport systems in the each of the participating cities. Because of the simplicity of the tests the findings from the data analysis are easy to interpret and therefore make the report more coherent than if an elaborate range of complex statistics had been applied to the data. In addition it is very straightforward for any city not involved in the benchmarking initiative to compare itself to the cities that have participated, because no complex statistics have to be computed. In the case of scatterplots only two items of data are required to make a comparison, so this is a further benefit and has the potential to be developed into an interactive facility delivered via the project website during the second year of the project.

3.4 Data limitations and barriers to data collection

As described above, the project has experienced similar limitations and barriers to data collection to the Citizens' Network Benchmarking Initiative. The data collected for the Urban Transport Benchmarking Initiative was not immediately comparable due to the following issues

- **Differences in data definitions**. These may have been due to different statistical definitions (e.g. walking not being considered as a mode of transport, non-fatal accidents may not defined consistently) or simply due to confusion (e.g. "modal split" referring to different scales of geographical area and / or times of day – it is important to be specific).

- **Differences in the way that data are collected**. In many cases the participating cities collect the same data in different ways (e.g. a 100% census of households will produce different results compared to a sample survey conducted in the street)

- **Differences in data reliability and consistency**. The quality of data varied according to changes in administrative structure or boundaries. The variable availability of time-series data also made the analysis of trends a difficult task.

- **Time pressures upon participants**. The relatively short timescale available for data collection and the varying pressures upon their resources meant that the data collected by the participants were also likely to vary greatly. Some organisations were fortunate to be able to invest greater time and resources in the Urban Transport Benchmarking Initiative than others, which had a direct impact upon the quality and quantity of data that could be collected and analysed for the initiative.

To try and minimise the impact of these inevitable differences, and ensure a degree of comparability between submitted data, the following actions were taken:

- When making comparisons using the data indicators it was essential to consider the **descriptions of key geographical features** given for indicator 1.5. In some cases local features such as climate or topography are highly influential and explain a certain type of modal split (e.g. lack of cycling in very hilly cities) or a lack of car ownership (Venice can be used as an example of this).

- **Knowing specifically what area the data refers to** was also of paramount importance, because this often confirmed whether comparisons being made were relevant or not. There tended to be several levels of measurement (e.g. metropolitan area, administrative area, public transport zones etc) in each city. It was therefore important to confirm with the people who submitted the data exactly what geographical areas the figures related to.

- **Displaying an awareness of the data limitations** involved when trying to make comparisons using the indicators. It was necessary to look beyond the figures that were produced as outputs of the analysis process in order to ascertain whether there were logical reasons for apparent variations in the data. It was therefore very important that any potential findings which arose from the process of statistical analysis were circulated to the representatives from participating cities. This way any potentially erroneous results (e.g. due to data irregularity or statistical error) were checked through a process of mutual consensus about whether the findings were valid or not.

The findings of the common indicator report and the data annex (A2.1) which complements it, were subjected to a process of critical appraisal and re-drafting by both the project team and the participants of the Urban Transport Benchmarking Initiative.

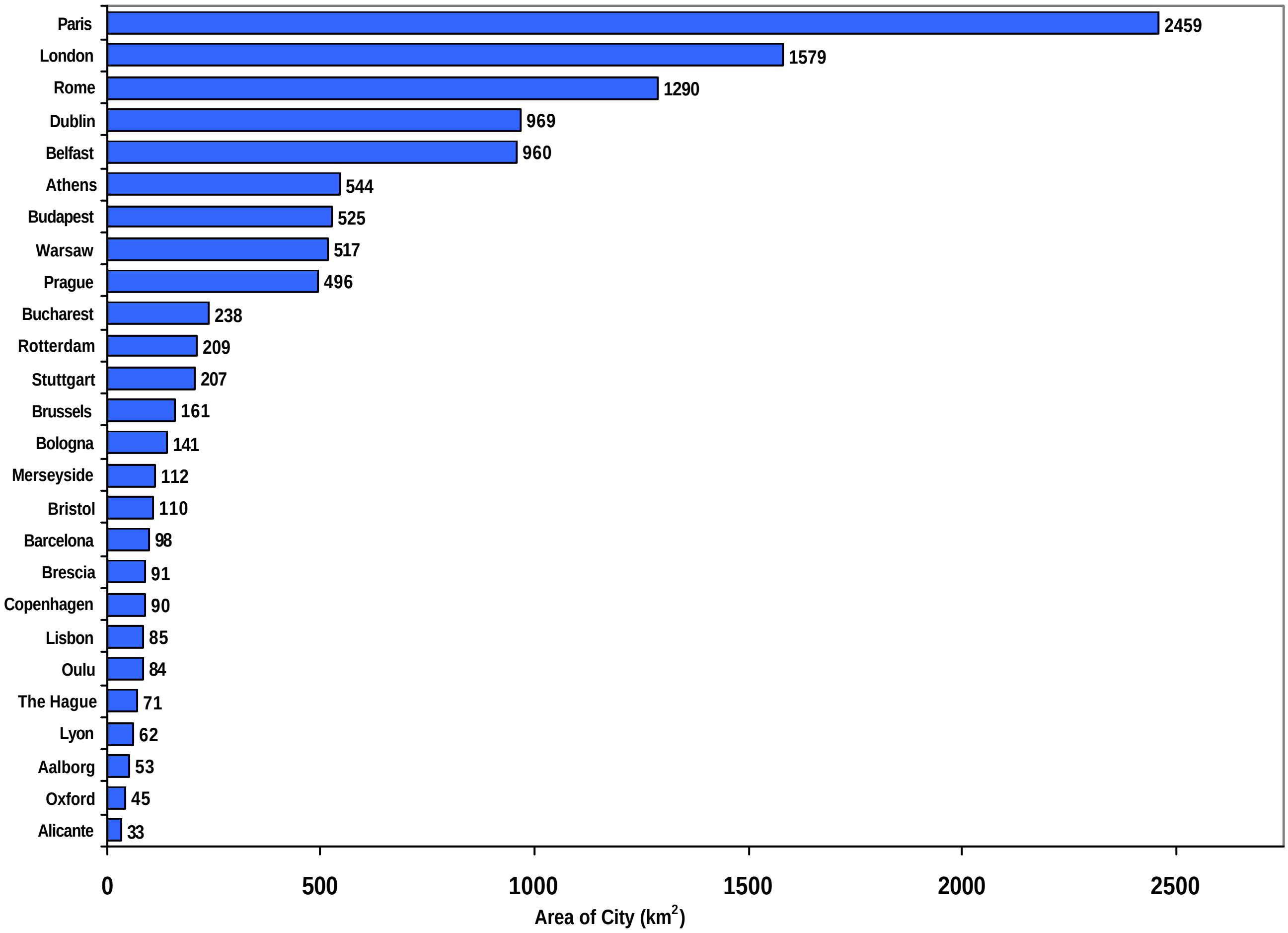
4. ANALYSIS OF FINDINGS FROM THE COMMON INDICATORS

4.1 Background data

This section of the analysis includes the data that provide a contextual overview of the participating cities and regions in the Urban Transport Benchmarking Initiative. This data has been displayed to cover background statistics, such as population, area, population density and GDP per capita, as well as general data which describe the urban transport network in each of the cities and regions.

Figures 4.1 to 4.5 provide five key statistics for each of the cities and regions that participated in the Urban Transport Benchmarking Initiative.

Figure 4.1: Surface area of cities



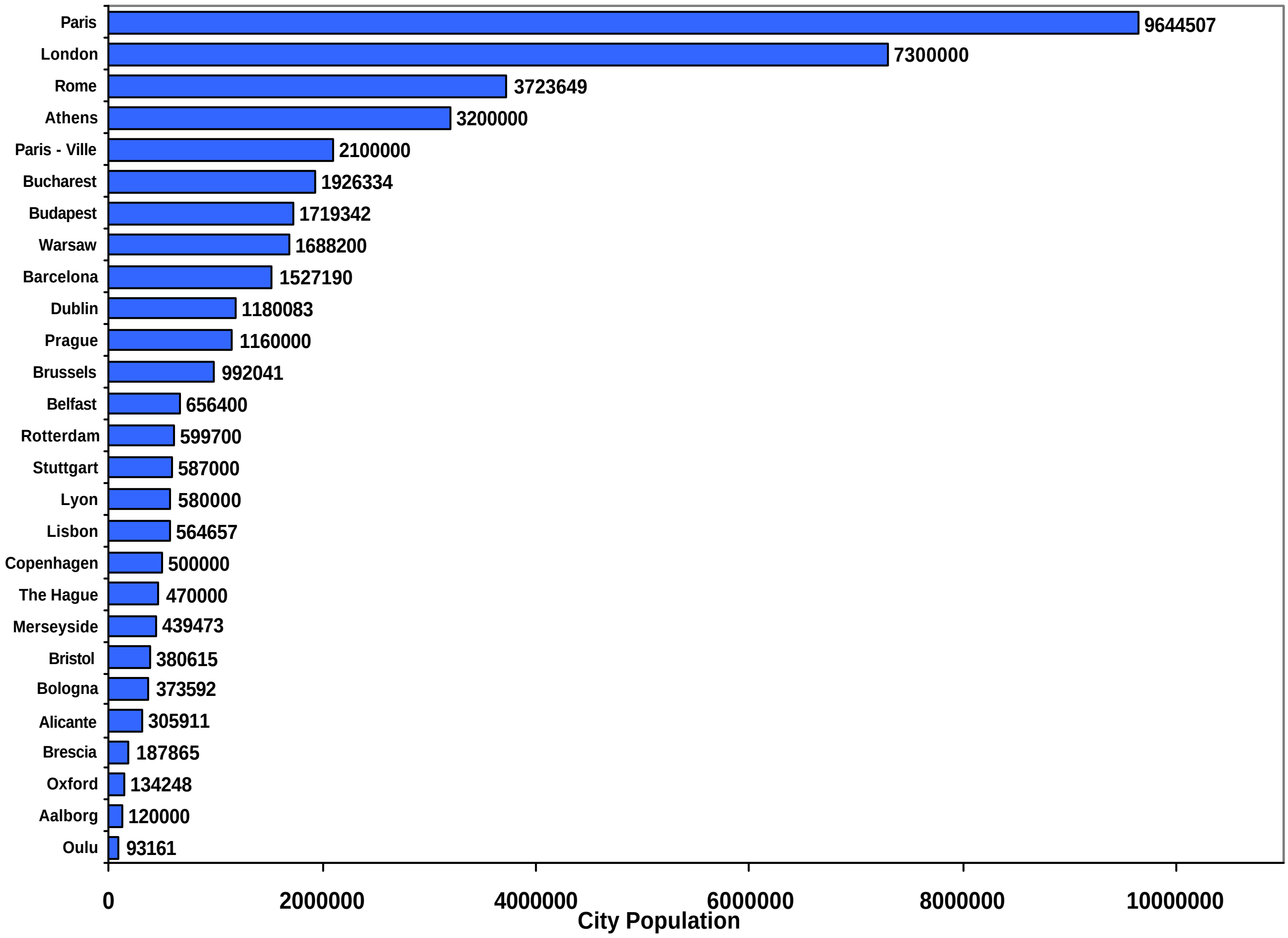
Key data issues:

- All data relates to 2002.
- Data for Rotterdam refers to the municipality of Rotterdam.
- Data for Paris refers to the built-up area and not the entire Ile de France region.
- Data for London relates to the Greater London area.
- Data for Rome refers to the built-up area and not the surrounding metropolitan area.
- Data for Dublin refers to the Dublin Metropolitan area.
- Data for Merseyside refers to the City of Liverpool.
- Data for Barcelona refers only to the city.

Figure 4.1 illustrates the variety of cities involved in the benchmarking initiative. The cities range in size from Alicante, the smallest city in the initiative with a surface area of 33km^2, to Paris which covers an area of 2,459km^2. Paris is the largest city participating in the Urban Transport Benchmarking Initiative and, along with Greater London and Rome, is one of only 3 cities participating in the initiative with a built-up area which exceeds 1000 km^2. The average size of cities participating in the benchmarking initiative is 448 km^2, although this declines to 264 km^2 if the values for Rome, Paris and Greater London are excluded from the calculation.

Paris also displays the largest population, with 9.64 million inhabitants, among the benchmarking cities (see Figure 4.2). London is the second most populous city with 7.3 million inhabitants followed by Rome and Athens. The smallest city in terms of size of population is Oulu, which has a population of just over 93,000. Figure 4.1 and 4.2 emphasise the wide range of cities that have participated in the Urban Transport Benchmarking Initiative.

Figure 4.2: Population of cities

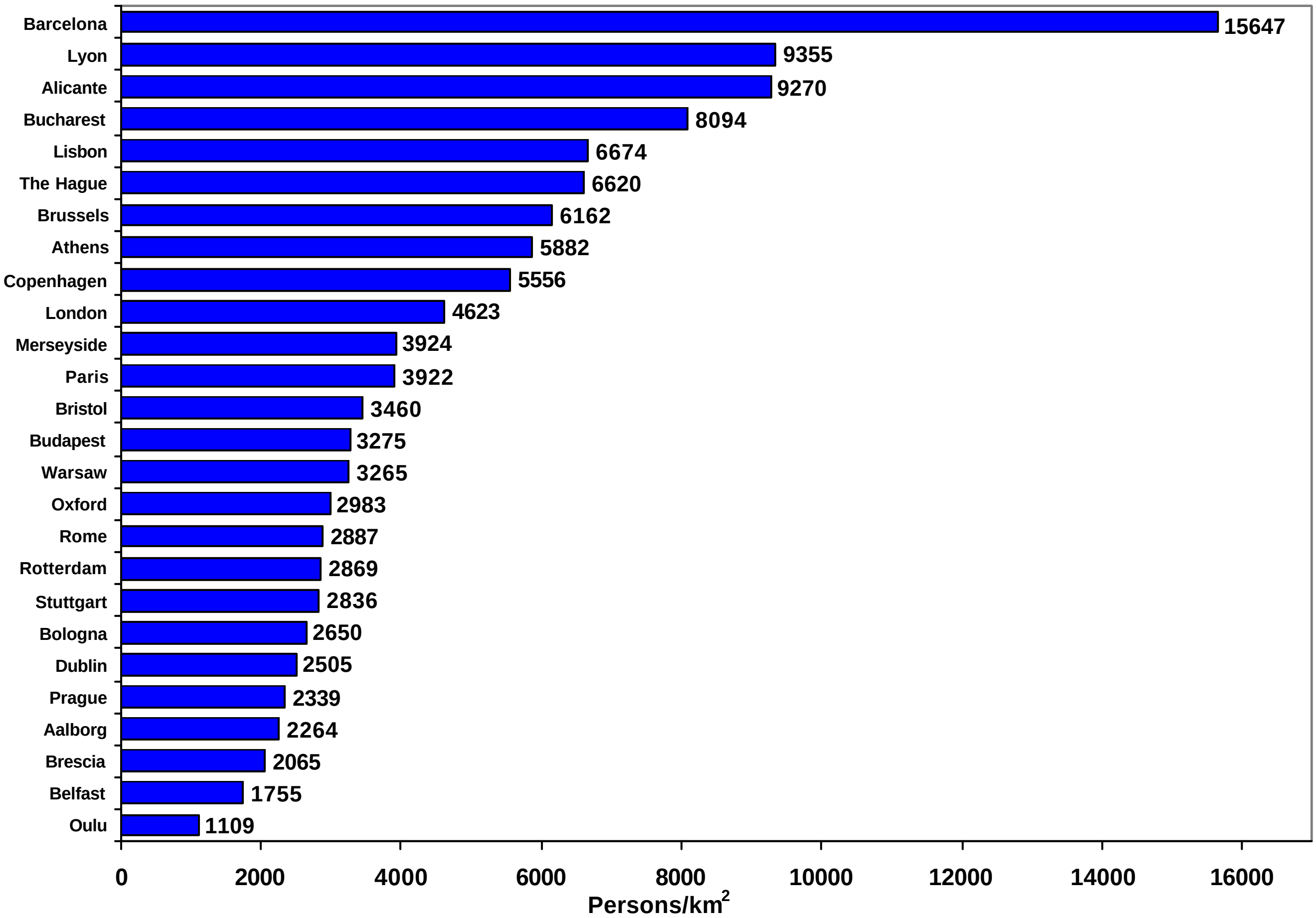


Key Data Issues:

- All data refers to 2002, except for Belfast (2000) and Athens, Bristol, Lisbon, Merseyside and Oxford (2001).
- Data for Rotterdam refers to the municipality of Rotterdam.
- Data for Paris refers to the built-up area and not the entire Ile de France region.
- Data for London relates to the Greater London area.
- Data for Rome refers to the built-up area and not the surrounding metropolitan area.
- Data for Dublin refers to the Dublin Metropolitan area.

- Data for Merseyside refers to the City of Liverpool.
- Data for Barcelona refers only to the city.

Figure 4.3: Population density of cities and regions



Key Data Issues:

- All data refers to 2002, except for Belfast (2000) and Athens, Bristol, Budapest, Lisbon, Merseyside and Oxford (2001).
- Data for Rotterdam refers to the municipality of Rotterdam.
- Data for Paris refers to the built-up area and not the entire Ile de France region. In Paris Ville (the urban centre of the city) the population density exceeds 24,000 people / km^2.
- Data for London relates to the Greater London area.
- Data for Rome refers to the built-up area and not the surrounding metropolitan area.
- Data for Dublin relates to the urbanised area of Dublin's District Electoral Divisions (DEDs). The built up aspect of these covers an area of 433 km^2 and are home to 1.084 million inhabitants. The Dublin Metropolitan area has a population density of 1219 people per km^2
- Data for Merseyside refers to the City of Liverpool.
- Data for Barcelona refers only to the city, which is completely urbanised.

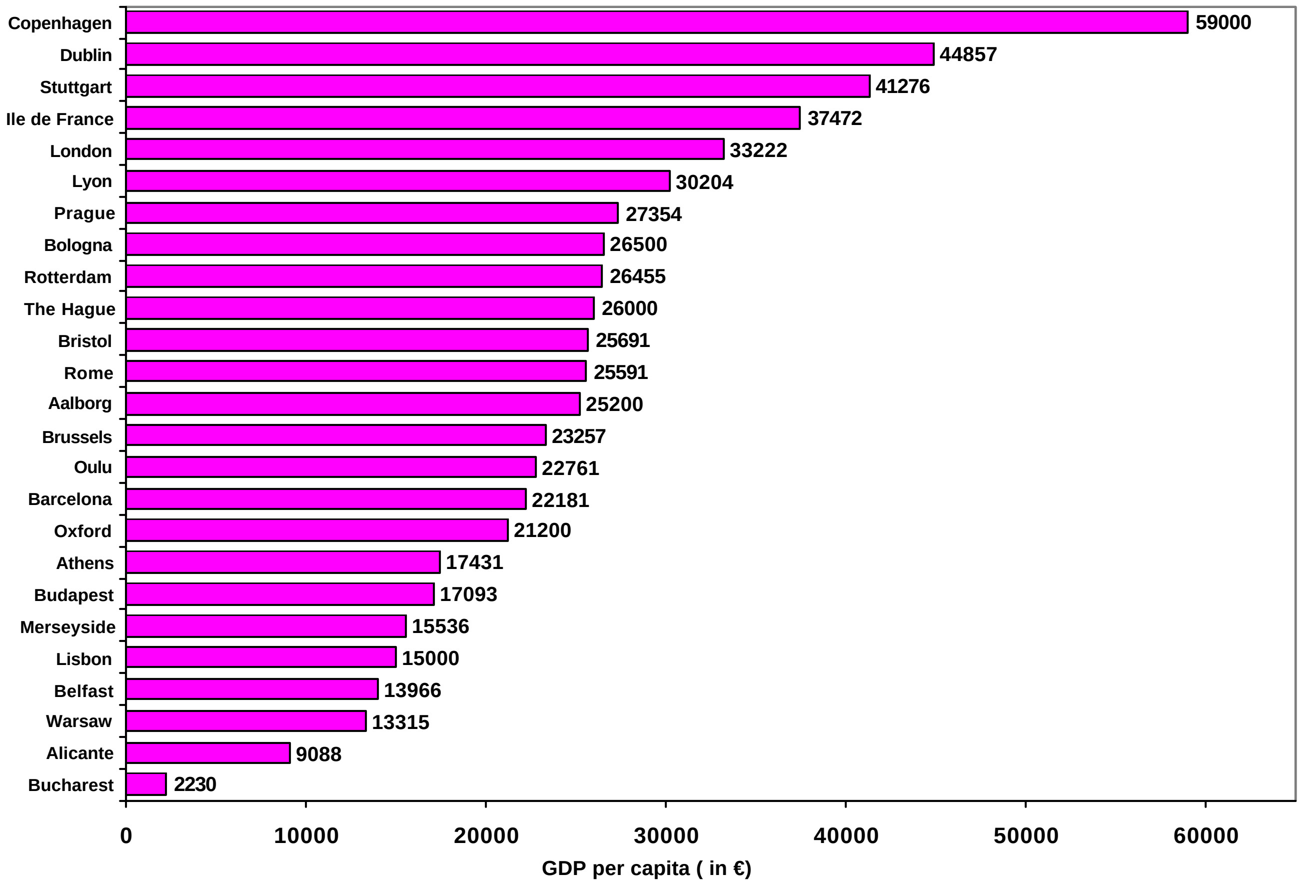
Figure 4.3 shows the population densities of the benchmarking cities, expressed as the number of persons per square kilometre. The least densely populated city is Oulu, with just 1,109 people / km^2. Barcelona is the most densely populated city which, with 15,647 people per km^2, is almost four times denser than the average population density for all other cities (4,275 people/km^2). The figures for Barcelona are so large, because the data submitted accounts only for the central area of the city and the population of this area.

The central area of Paris is very dense (approximately 24,500 people / km^2) which differs greatly from the figure of 3,922 people per km^2 for the urbanised area and even more so from the whole Ile de France region which has a population density of 918 people per km^2. In the case of Rotterdam the population of the RET public transport area is 909,000 and the surface area is 31.1 km2, which is equivalent to a population density of 29,228 people per square kilometre. This is also a much higher figure than that for the municipality of Rotterdam (2,869 people/km^2), which is displayed in Figure 4.3.

These examples demonstrate how difficult it is to de-limit city area in order to make salient comparisons, particularly with very large cities such as Paris, London, Rome and Barcelona. As a result it is difficult to use population density as the basis for any accurate analyses

Figure 4.4 displays the GDP per capita values for the cities taking part in the Benchmarking initiative. Large differences exist in the levels of GDP per capita, most notably between Copenhagen, the city with the largest GDP per capita (€59,000), and Bucharest, the city with the smallest (€2,230). The average GDP per capita of all of the cities participating in the Urban Transport Benchmarking Initiative is €25,425.

Figure 4.4: GDP per capita of cities and regions



Key Data Issues:

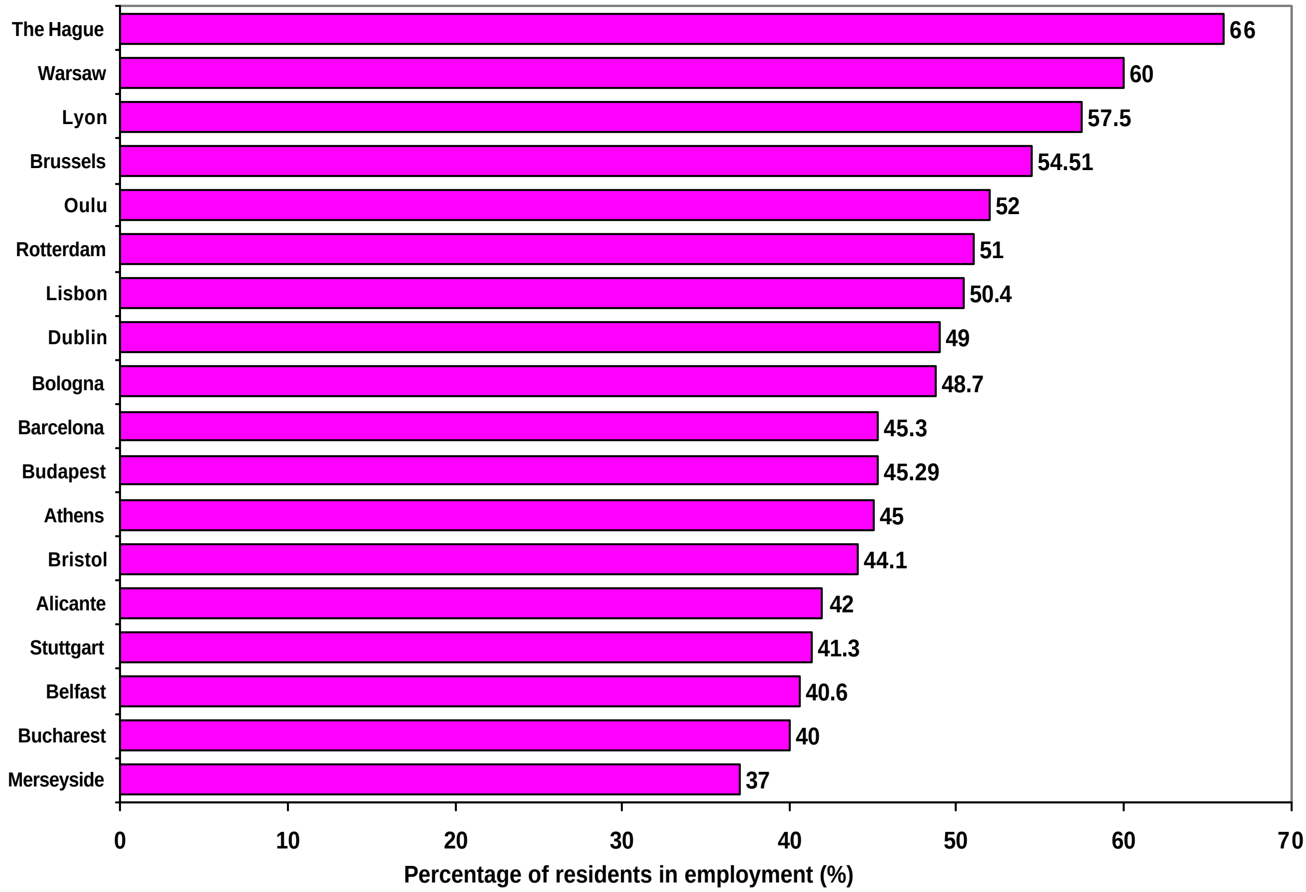
- All data refers to 2002, except for Belfast (1997), Lisbon & Brussels (2000) and Barcelona, Bologna, Budapest, Copenhagen, Merseyside, Oxford and Rotterdam (2001).

- Data for Lyon refers to the Rhone region.
- No data was supplied by Brescia.

Figure 4.5 illustrates the different levels of employment among resident populations in each of the urban administrative areas. Not all cities have been able to provide these figures due to differences in statistical collection of data, so some cities which displayed very high proportions of employment (Prague, Aalborg, the Ile de France region and Copenhagen) are not displayed in Figure 4.5.

The Hague (66%) and Warsaw (60%) display the highest levels of residential employment of the cities that have participated in the Urban Transport Benchmarking Initiative. Merseyside has the lowest figure, with 37% of the total resident population in employment. Employment is an important factor in the generation of urban transport flows and these variations in the level of employment among residents may impact upon the modal shares of public transport and car use in the urban areas being considered.

Figure 4.5: Employment in the urban administrative areas



Key Data Issues:

- All data refers to 2002.
- Data displayed relates to the proportion of people living in the urban administrative area that are in employment.
- Additional data supplied by Prague, Aalborg, Ile de France region, Oxford, Copenhagen and London have not been displayed. These data related to the percentage of the local labour force in employment and are therefore not comparable with the other employment statistics submitted. No data was supplied by Brescia.

The large variations in the size and population of the cities and regions displayed in Figures 4.1 to 4.5 illustrate the challenge that detailed statistical analysis of the common indicators presents. No two cities are the same and therefore the aim of the common indicator analysis has been to try and identify trends in the urban transport systems present in each of the participating cities and regions.

4.2 The urban transport situation in the participating cities and regions

Table 4.1 and Figures 4.6 to 4.11 have been incorporated to illustrate the differences in the urban transport systems of each of the participating cities and regions. The aim is to present as clearly as possible the differences between the cities and regions urban transport systems so that they can be compared. Where data relate to different years, or it has not been possible for a city or region to provide data this has been footnoted.

Table 4.1 shows the range of public transport modes available in each of the benchmarking cities. It reveals that buses and trains form the core modes of urban public transport networks, both of which are present in nearly all of the benchmarking cities. The Trolleybus is the least represented mode of public transport among the benchmarking cities, with only Athens, Bucharest and Lyon having trolleybus networks. In total 15 of the 25 benchmarking cities have tram networks and 14 have metro networks. Interestingly, the cities that have metro networks all have tram networks, with the exception of Copenhagen. Stuttgart and The Hague are the only two cities that have tram systems, but no metro network. The city of Barcelona opened its tram system in 2004, but because the project study year relates to 2002, there are no corresponding modal split figures. Larger cities appear to have the widest range of public transport modes, reflecting their greater need for urban transport services. In the case of tram systems some cities have maintained historic networks (Warsaw, Bucharest & Lisbon) while others (London, Paris, and Barcelona) have been reintroducing them.

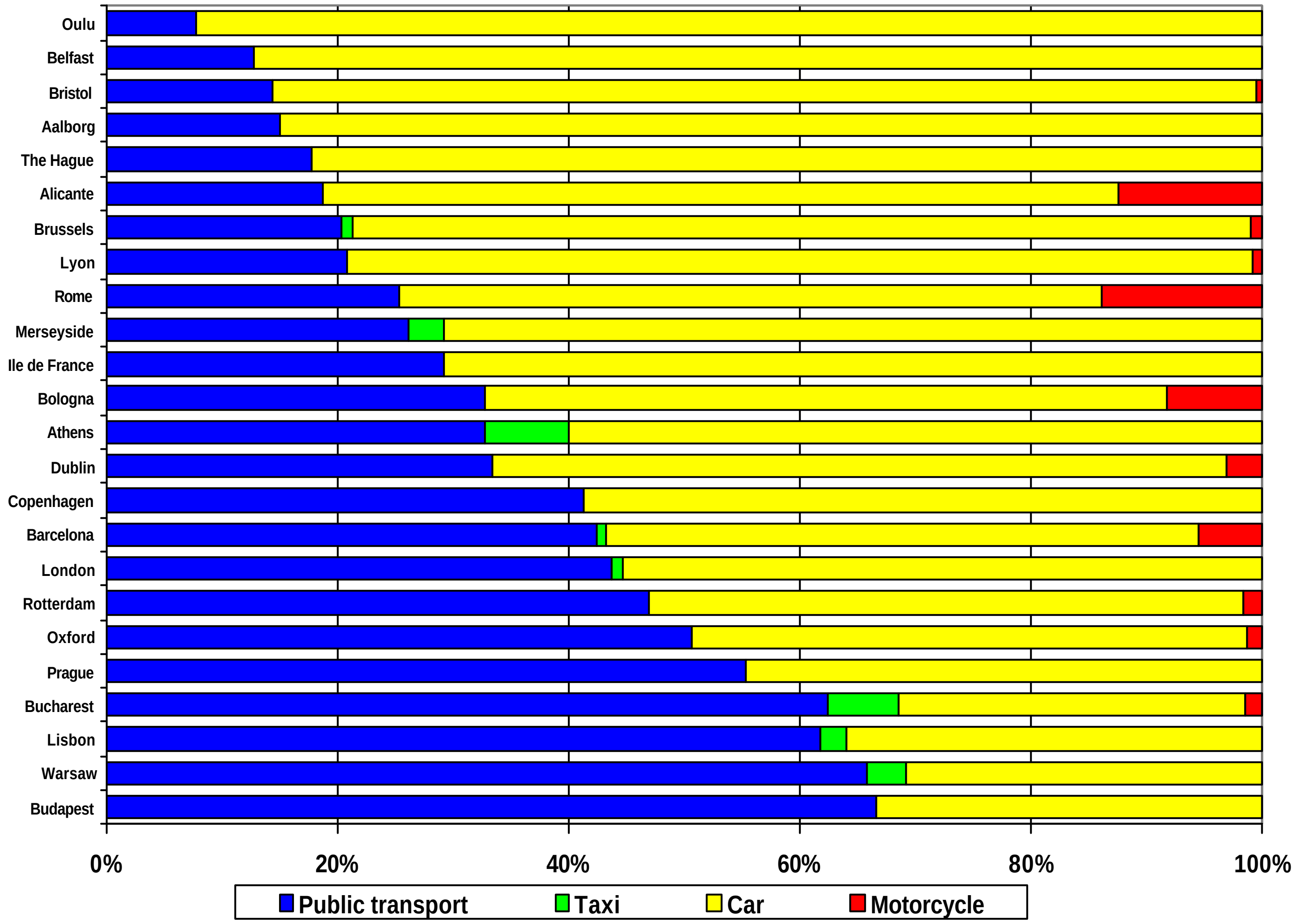
Table 4.1: Typology of public transport modes present in each city/region

	Bus	Train	Trolley	Tram	Metro
Aalborg	✓	✓			
Alicante	✓				
Athens	✓	✓	✓	✓	✓
Barcelona	✓	✓		✓	✓
Belfast	✓	✓			
Bologna	✓				
Brescia	✓				
Bristol	✓	✓			
Brussels	✓	✓		✓	✓
Bucharest	✓		✓	✓	✓
Budapest	✓	✓	✓	✓	✓
Copenhagen	✓	✓			✓
Dublin	✓	✓			
Ile de France	✓	✓		✓	✓
Lisbon	✓	✓		✓	✓
London	✓	✓		✓	✓
Lyon	✓		✓	✓	✓
Merseyside	✓	✓			
Oulu	✓	✓			
Oxford	✓				
Prague	✓	✓		✓	✓
Rome	✓	✓		✓	✓
Rotterdam	✓			✓	✓
Stuttgart	✓	✓		✓	
The Hague	✓			✓	
Warsaw	✓	✓		✓	✓

Figure 4.6 and Figure 4.7 display the proportions of journeys made by each mode. Figure 4.6 illustrates the percentage of trips made using motorised transport, discounting the figures for cycling and walking which have been provided by some cities and which are frequently based upon estimates. The full modal split is displayed in Figure 4.7 although this is less accurate than Figure 4.6 which does not include the figures for walking and cycling. Explanations about the modal split data have been given in bullet points after Figure 4.7.

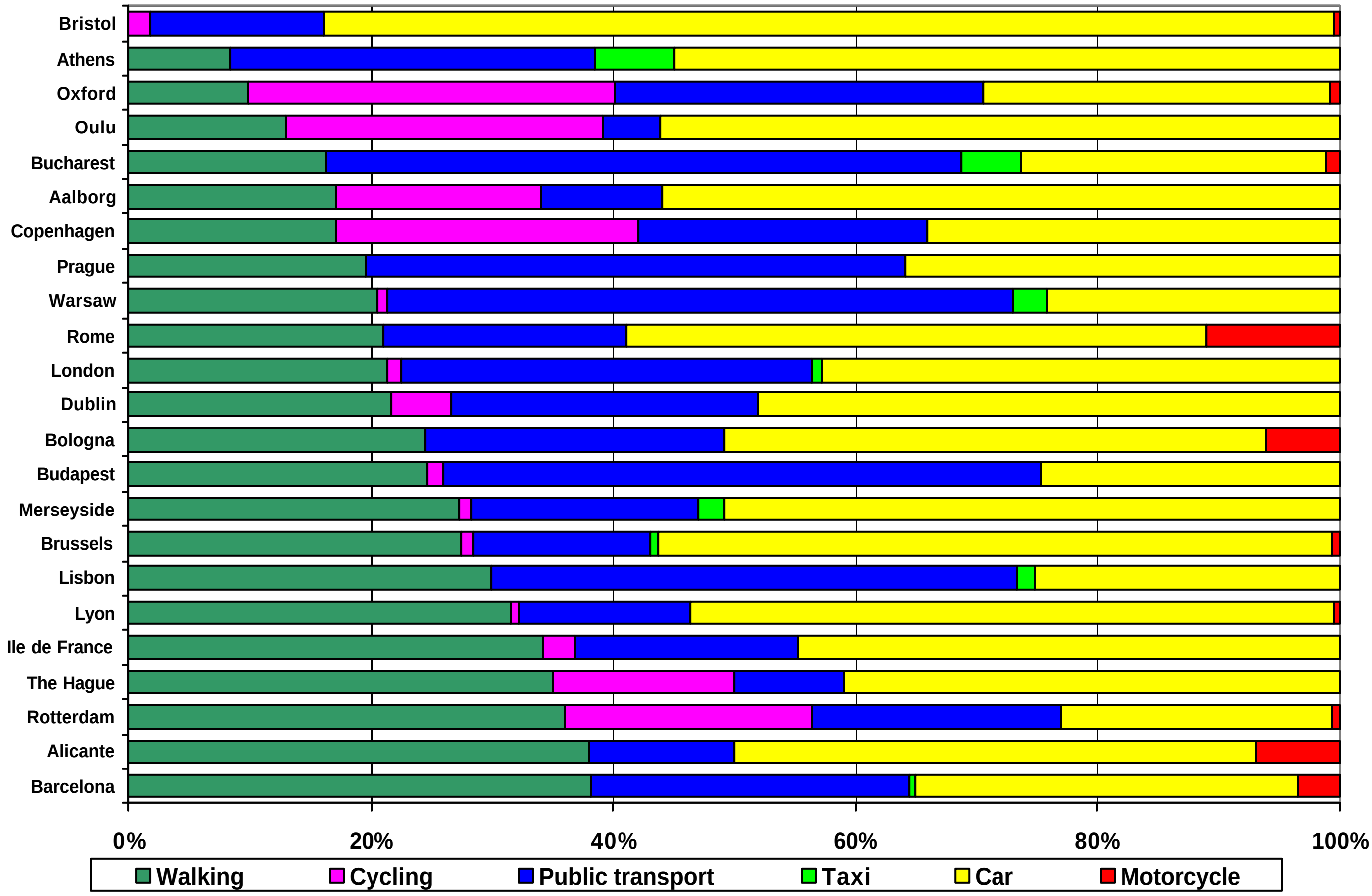
Figure 4.6 displays the modal split of motorised trips in the benchmarking cities and the figures have been ranked so that the cities with the largest public transport modal shares are displayed at the bottom of the chart. Oulu has the smallest proportion of public transport trips per day and more than 90% of total daily trips are made by car. This is much greater than in Bucharest, where only 29% of all trips are made by car. The city of Budapest has the highest percentage of public transport trips per day, at just over 65%. A number of other cities display significant proportions of journeys that are made using other forms of transport. Both Rome (13.9%) and Alicante (12.5%) display large proportions of journeys made by motorcycles and in Bucharest, 4.9% of journeys are made by goods vehicles. It is difficult to draw meaningful conclusions from these other modes of transport, because few cities were able to disaggregate their data completely.

Figure 4.6: Modal split of daily motorised trips in urban administrative areas



Please note that footnotes for Figure 4.6 are displayed beneath Figure 4.7 (overleaf).

Figure 4.7: Modal split of daily motorised and non-motorised trips in urban administrative areas



Key Data Issues for Modal Split Data in Figure 4.6 and 4.7

- The data displayed relates to the study year of 2002 except for: Bologna (1991), Budapest (1994), Lyon (1995), Aalborg (1997), Lisbon & Warsaw (1998), Athens, Bucharest & Rome (1999), Alicante (2000) and Rotterdam (2001).
- Walking and cycling data was unavailable for Belfast.
- Data for Bologna relates only to systematic journeys and the figures for walking and cycling are combined.
- The data for Prague, Barcelona and Alicante in Figure 4.7 are the combined modal shares of walking and cycling.
- Data for Dublin reflects <u>all</u> the daily trips that are made to places of work, school and university only (irrespective of start time) do not therefore reflect the total level of daily trips. The figures are therefore of more non-car based modes, because the majority of these types of trips take place during the peak daily transport hours.
- Please note that 4% of all urban transport trips in Bucharest were attributed to Lorries. This figure has been removed from Figure 4.6 and 4.7 for improved comparability.

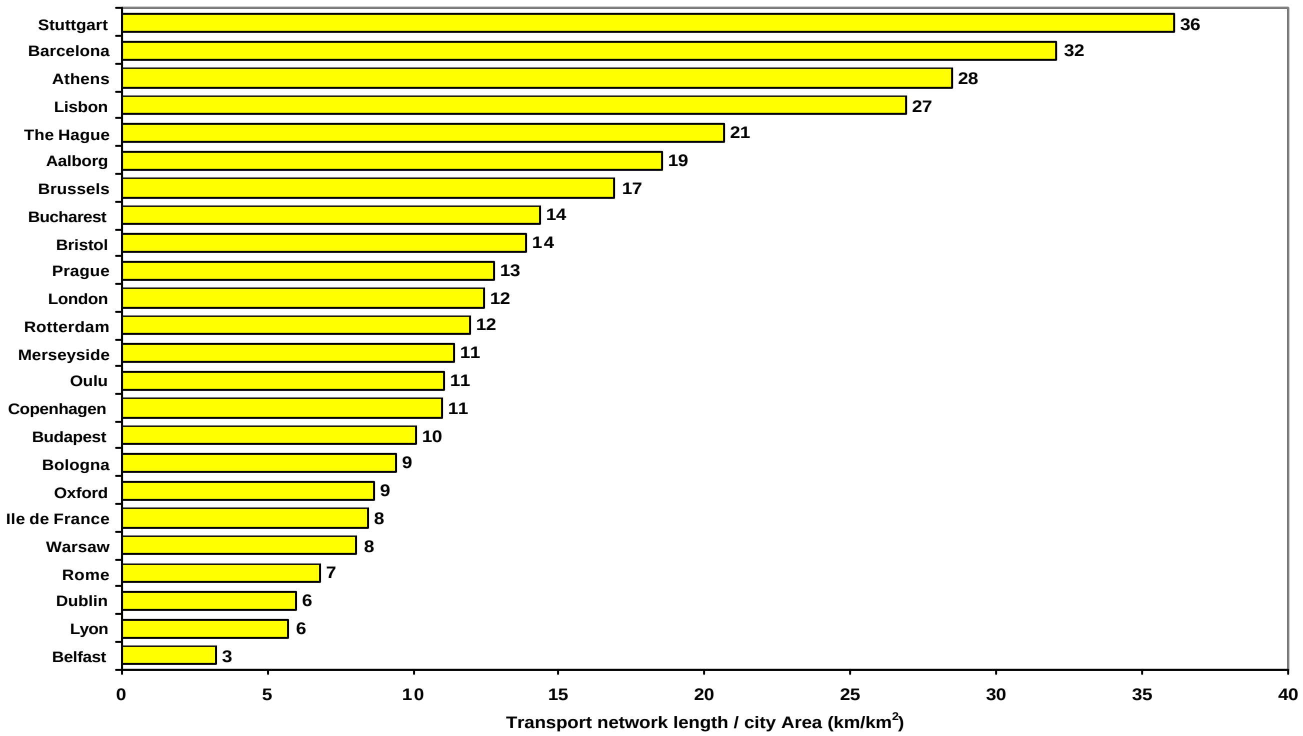
Figure 4.7 shows the modal split figures including the submitted data for walking and cycling trips. This chart displays the cities in rank order of modal share for walking. It is important to consider that the data the participants have provided for walking and cycling modal share does not always differentiate between the two modes. As already stated these figures are often based upon estimates, rather than site surveys and traffic counts and so the reliability of the walking and cycling data for statistical analysis is questionable. Nonetheless the data is sufficiently robust for the straightforward comparisons made in this section and the simple analysis outlined in section 5.2 of this report.

Athens has the lowest share of walking trips of those cities that were able to provide data and is also an unpopular location for cycling. It is possible that the warm climate in Athens could explain the low levels of walking and cycling in the city. The city with the highest genuine percentage of walking trips is Rotterdam, where 36% of all journeys are made by people walking and a further 20% of all daily trips are accounted for by cycling. The Hague, another Dutch city, also performs well in terms of sustainable mobility with 50% of all daily trips being accounted for by walking and cycling.

The Netherlands therefore appears to be at the forefront of environmentally sustainable urban transport. It is well documented that cycling is a popular mode of transport in the Netherlands, aided by the country's suitable terrain and "cycling culture", but the practices these cities have adopted to promote sustainable mobility could still be considered as potential case studies from which other cities can learn. This is a potential area of further research during the second year of the Urban Transport Benchmarking Initiative. In addition, the cities of Copenhagen, Aalborg and Oxford display large cycling modal shares which could also be points of further enquiry in the second year of the project.

Figure 4.8 illustrates the density of all urban transport networks in each of the benchmarking cities. These figures include the length of roads as well as all modes of public transport. The chart displays the length of urban transport networks in each of the cities divided by the area of the city. Stuttgart displays the densest public transport network, with an average of 36 kilometres of public transport network per square kilometre. The Ile de France figure of 8 kilometres of public transport network per kilometre of surface area refers to data from the region as a whole and therefore does not reflect the density of urban transport in urban Paris. Half of the benchmarking cities display urban transport network densities of between 9 and 14 kilometres per square kilometre of surface area.

Figure 4.8: Length of all urban transport networks in relation to surface area

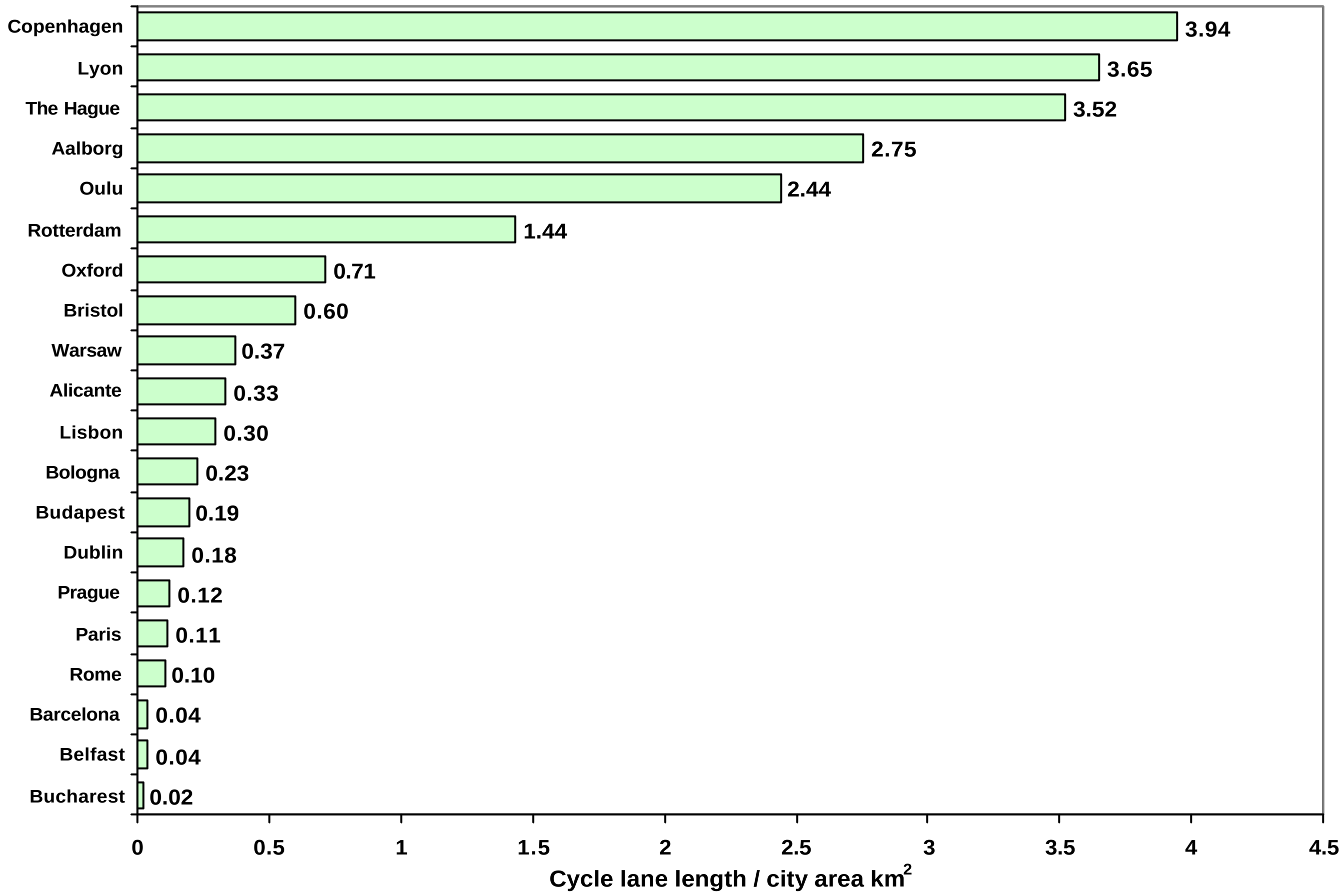


Key Data Issues

- Figure 4.8 displays the total length of urban transport network (all public transport modes added to the length of the road network) per kilometre of surface area.
- The data relates to a range of years between 1997 and 2003. In many cases the year the data has been collected for varies by mode.
- Bus & Trolleybus network data is for 2002 except for: Bristol (2000), Dublin, Lisbon & Warsaw (2003) and Oxford (2004).
- Tram network data refers to the study year of 2002, except for Lisbon (2003) and Athens, Barcelona and Warsaw (2004).
- Train network figures are from 2002 except: Rome and Warsaw (1999), Lisbon, (2003) and Athens (2004).
- Metro network date relates to 2002 except for Bucharest (2001) and Lisbon and Warsaw (2003).
- Road network data relates to 2002, except for Athens (1997), Bristol & Rome (2000), Rotterdam (2001), Warsaw (2003).
- Data for Dublin refers to the Dublin Metropolitan Area.

Figure 4.9 illustrates the length of cycle lanes per square kilometre of the city area for each of the cities participating in the initiative. The cities of Rotterdam, Oulu, Aalborg, The Hague, Lyon and Copenhagen are the only cities which have more than one kilometre of cycle paths per square kilometre of surface area. Despite the large cycling modal share figures displayed in Figure 4.7, the city of Oxford displays quite a small density of cycle lanes in relation to its surface area.

Figure 4.9: Cycle paths in relation to surface area



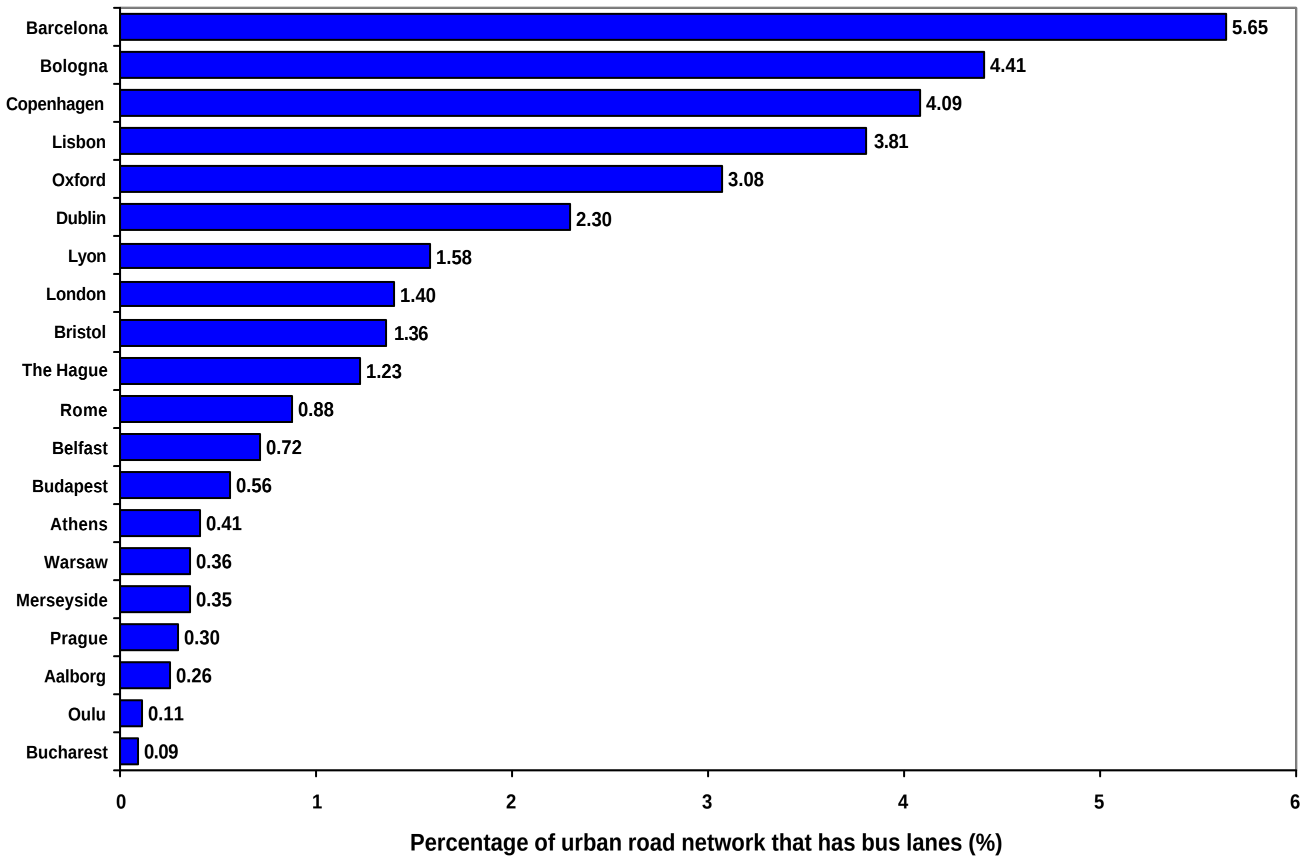
Key data issues

- All data relates to 2002, except for: Rotterdam and Rome (1999), Lisbon (2001) and Bristol & Warsaw (2003).
- Data for Dublin is based upon the estimated 2-way length of the strategic cycle network (both segregated and adjoining).
- Data for Rome relates to the regional area.

The benchmarking cities display a large range of cycle lane densities. Bucharest has just 20 metres (0.02km) of cycle lane per km^2, which is considerably smaller than the 3,940 metres (3.94 kilometres) of cycle lane per square kilometre in Copenhagen. Further analyses of cycle lanes and the impact of investment in cycling upon cycling modal share are presented in section 5.2 of this report.

Figure 4.10 shows that Barcelona (6%) has the highest percentage of road network attributed to bus lanes. A number of other cities have values over 3% including Bologna, Copenhagen, Lisbon, and Oxford. In Bucharest bus lanes make up a much smaller 0.09% of the total road network. Interestingly the other cities that display small percentages of road network given over to bus lanes are Aalborg and Oulu, which are also the two smallest cities in terms of population. This suggests that bus lanes are more prominent in larger cities where population and thus the number of cars are likely to be higher.

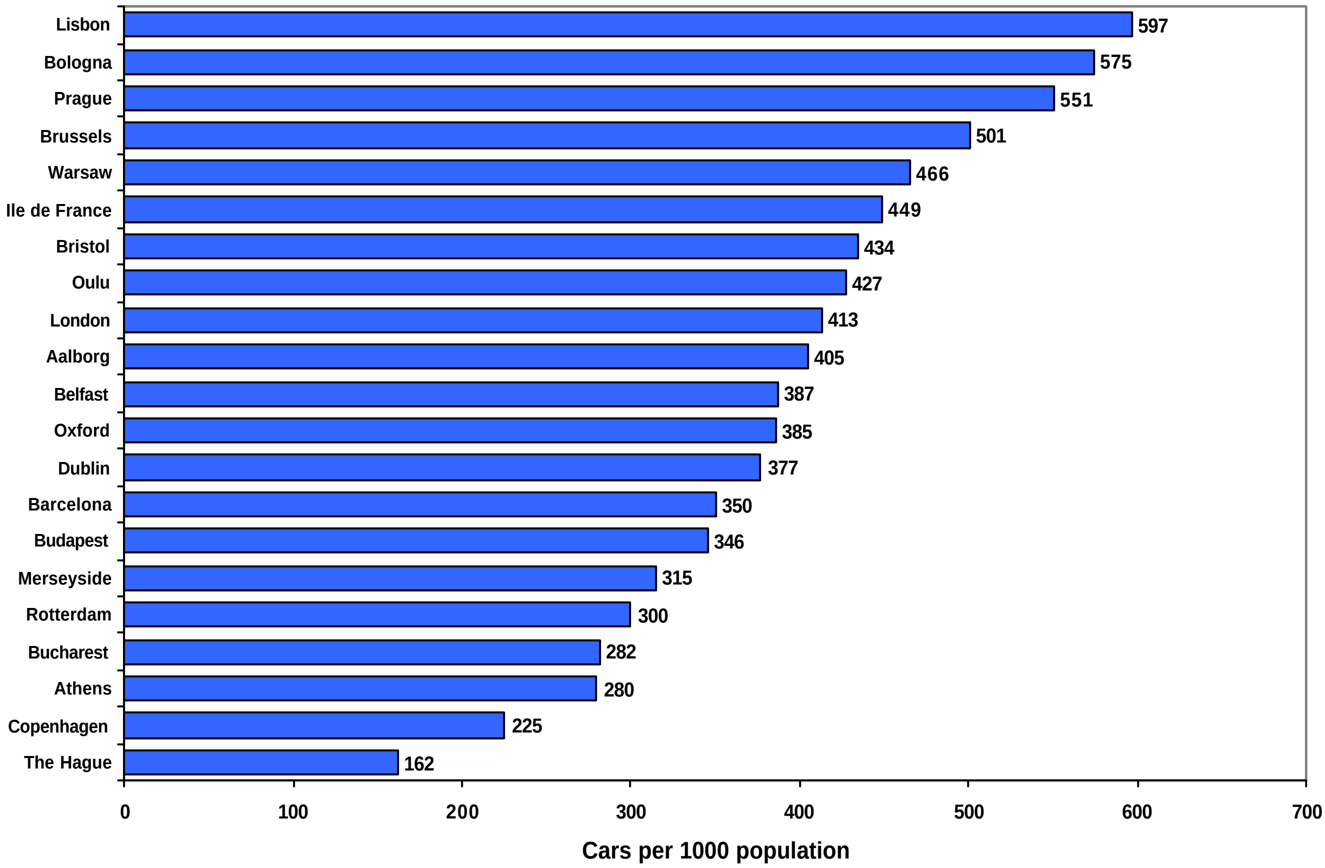
Figure 4.10: Bus lanes as a percentage of total road network



Key data issues

- All data relates to 2002, except for: Warsaw, Athens & Lisbon (2003), Merseyside, Bristol, Belfast and Copenhagen (2004).
- No data was available for the Ile de France region, Brussels, Stuttgart and Rotterdam.

Figure 4.11: Cars per 1000 population



Key data issues

- All data relates to 2002, except for: Barcelona & Ile de France (2000), Bologna, Dublin, Lisbon, Oxford & Stuttgart (2001) and Merseyside (2003).
- Data for Belfast includes both cars and vans.
- Data for London refers to the Greater London area.
- Data for the Ile de France, Merseyside and Barcelona relates to regional areas.
- Data for Lyon and Rome are not presented in Figure 4.11, because data submitted cannot be compared to a similar population.

Figure 4.11 displays car ownership in terms of the number of registered cars per 1,000 people. The city with the highest level of car ownership is Lisbon, with 597 cars per 1,000 people. Brussels, Prague and Bologna also display high levels of car ownership, with each city having more than 500 cars per 100 inhabitants. The Hague (162 cars per 1000 population) and Copenhagen (225 cars per 1000 population) display the lowest levels of car ownership among the benchmarking cities. The average number of cars per 1000 population for all of the cities listed above is 457. Figures for car ownership are not displayed for all of the benchmarking cities. This is because some of the figures relate to regional area and not the urban administrative areas and are therefore not directly comparable.

5. URBAN TRANSPORT TRENDS IDENTIFIED

Statistical analyses of the common indicator data has identified apparent trends in the way urban transport is provided in the cities and regions compared in the benchmarking initiative. This section of the analysis focuses upon these trends by illustrating patterns observed in the collected data and highlighting the outliers. These outliers are significant, because where trends are strongly pronounced it is often possible that cities or regions that appear to contravene the accepted wisdom, or standard patterns of urban transport through the implementation of alternative practices.

5.1 The influence of GDP per capita upon urban transport modal share

Affluent cities have greater levels of car use than less affluent cities. There is a negative statistical relationship between public transport modal share and GDP per capita, which suggests that as GDP per capita increases, people's propensity to use public transport decreases.

Figure 5.1 illustrates the medium strength negative relationship (correlation of -0.2) between GDP per capita and the modal share of public transport modes. The calculations for this example have excluded the data for walking and cycling modal share, because these figures are frequently based upon estimates which are not reliable enough for statistical analyses. The modal share of public transport thus represents the share of all trips not made by private motorised modes of transport.

In Figure 5.1 there is a degree of spread either side of the trend line, but the broad pattern is for modal share of public transport to decrease as the level of GDP per capita increases. The data points highlighted in red represent the main outliers to the trend identified. Copenhagen displays a much higher level of GDP per capita than all of the other cities while Bucharest has the lowest level of GDP per capita. The Ile de France region and Bucharest appear to be outliers, but do support the inverse trend between GDP per capita and public transport modal share. Belfast and Alicante are true outliers from the trend, because they both display comparatively low levels of GDP per capita with low levels of public transport modal share. Dublin and Copenhagen both display a high level of GDP per capita and reasonably high levels of public transport modal share. This could be the focus of further examination into year two of the initiative, in order to try and examine what these cities are doing differently and whether it has any impact upon public transport patronage.

In order to establish whether these findings are meaningful it is also important to consider the modal share of car and motorcycle trips in relation to GDP per capita. Figures 5.2 and 5.3 illustrate these relationships.

Figure 5.2 shows that the relationship between GDP per capita and the modal share of car trips is, as expected, the inverse of that shown in Figure 5.1. In cities with higher levels of GDP per capita the proportion of daily trips made using cars is higher than in cities with lower levels of GDP per capita. The statistical correlation for this relationship is 0.4, which is a medium strength positive relationship. As with Figure 5.1, the Ile de France region and Bucharest are again at polar ends of the scale and although they appear to be outliers from the main trend they are consistent. Bucharest has a low level of GDP per capita and one of the lowest car modal shares, while the Ile de France region has a high level of GDP per capita and it displays a car modal share of 80%. The red and blue circles indicate the expected location of any data points which are not consistent with the observed trend. The lack of data points clustered in the red circle indicates that there are no cities with high levels of GDP per capita that display a low level of car modal share. The cities of Belfast and Alicante do appear to contradict the trend by displaying comparatively low levels of GDP per capita and large proportions of daily trips by car.

Figure 5.1: The relationship between GDP per capita and public transport modal share (excluding walking and cycling)

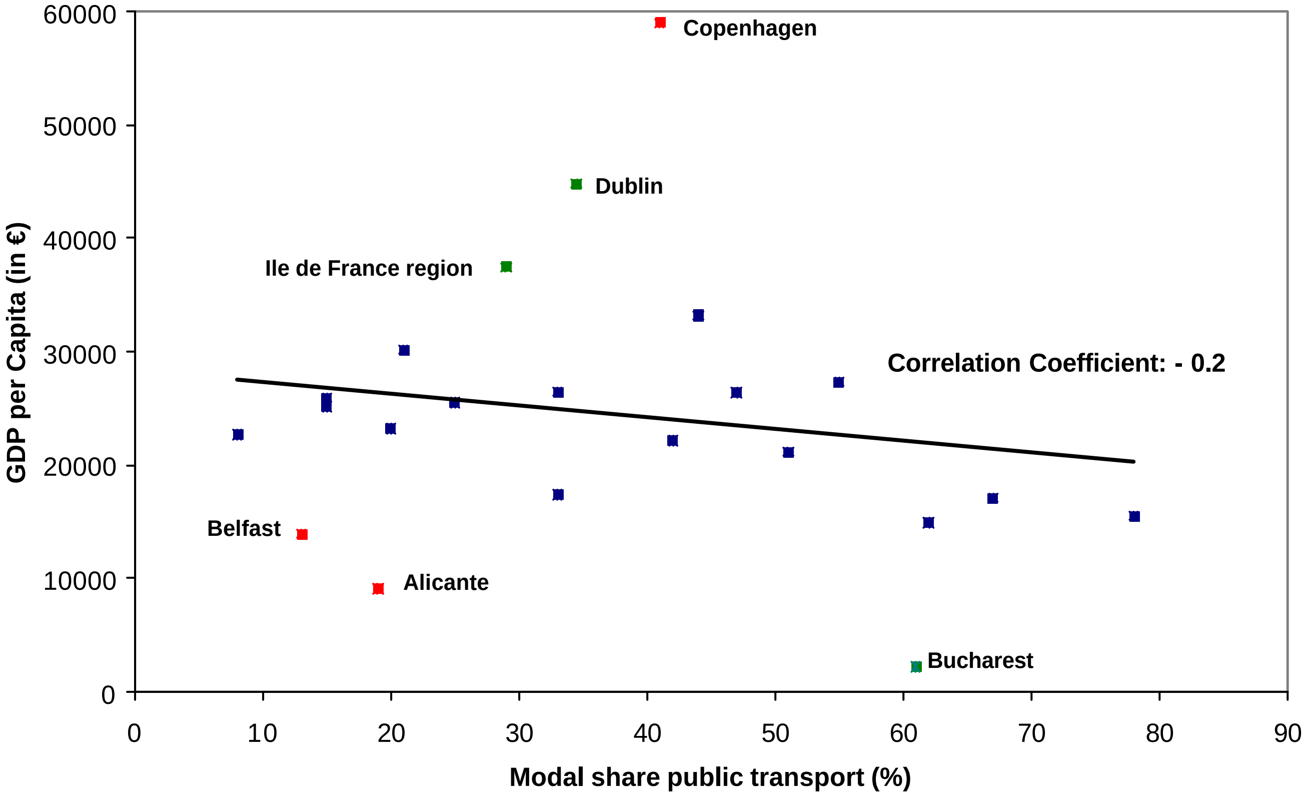


Figure 5.2: The relationship between GDP per capita and modal share of car trips (excluding walking and cycling)

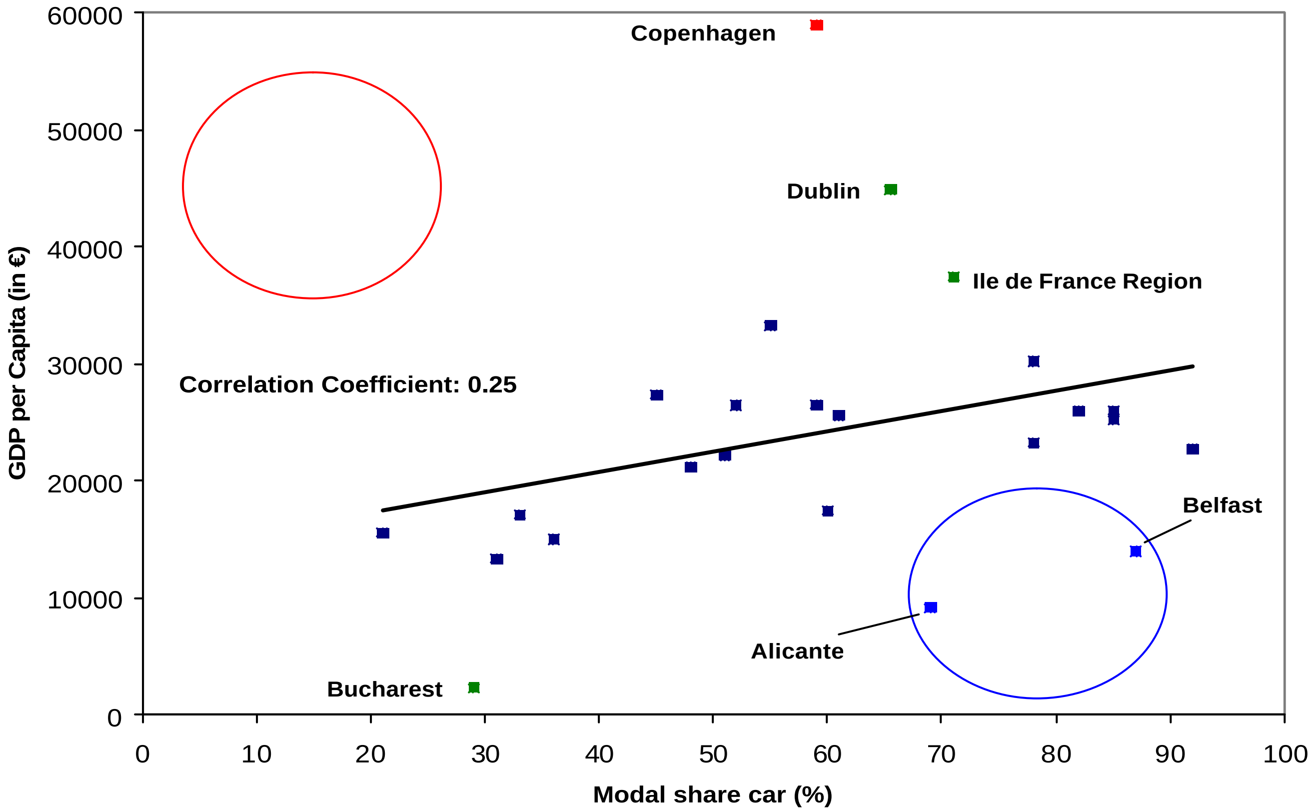
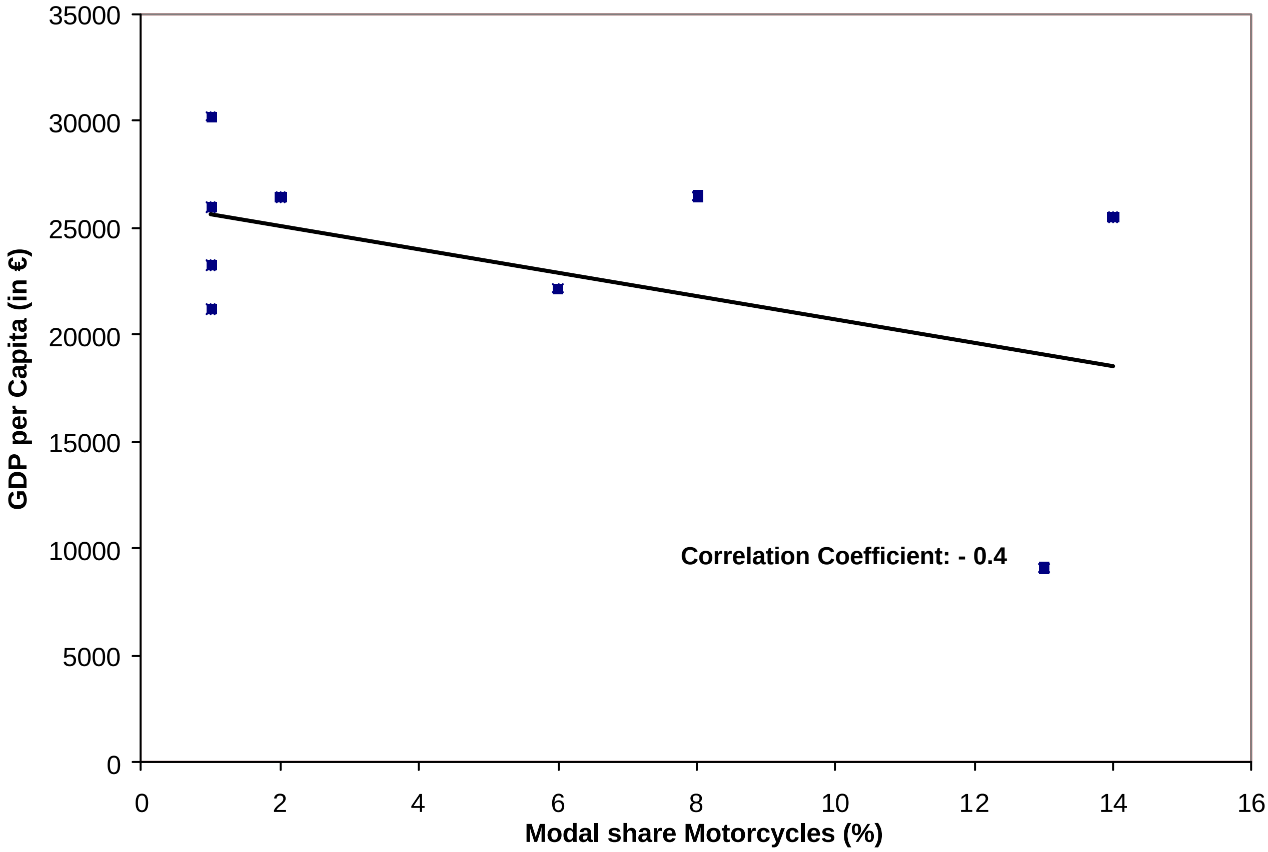


Figure 5.3 illustrates the relationship between GDP per capita and the modal share for motorcycles and mopeds. In total 10 cities were able to provide this data and the statistical correlation of -0.4 indicates a strong inverse relationship between GDP per capita and the modal share of trips made using motorcycles. This suggests that as GDP increases the modal share of motorcycle trips decreases, although it is difficult to draw any further conclusions, because with only 9 items of data this finding is not statistically significant.

Figure 5.3: The relationship between GDP per capita and the modal share of motorcycle trips (walking and cycling excluded)



5.2 Urban cycling

Wealthier cities are those most likely to have larger cycle path networks. Those cities with large cycle path networks in relation to the total road network are also likely to display a high level of cycling modal share.

Figure 5.4 demonstrates the relationship between the length of cycle paths in a city and GDP per capita. Statistically there is a reasonably strong relationship between the two indicators, with positive correlation of 0.5. More affluent cities are therefore more likely to have a larger cycle path network. The two points highlighted in red represent the cities of Dublin and Copenhagen which appear to have small cycle path networks in relation to the average level of income in the city. However, the large figures for Rome and the Ile de France region skew the data and have been removed in Figure 5.5. Data was unavailable for Brussels, London, Merseyside and Stuttgart, so these cities have not been included in this analysis.

Figure 5.4: Correlation between the length of cycle paths and GDP per capita

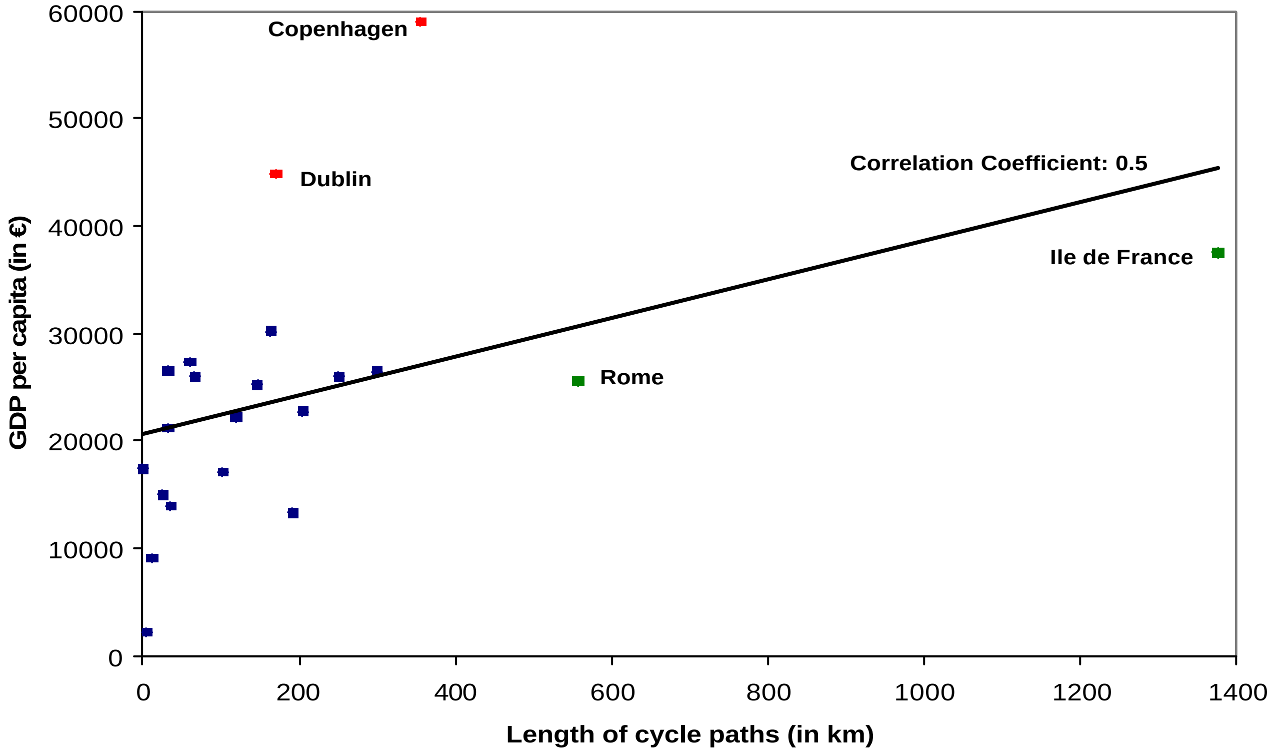
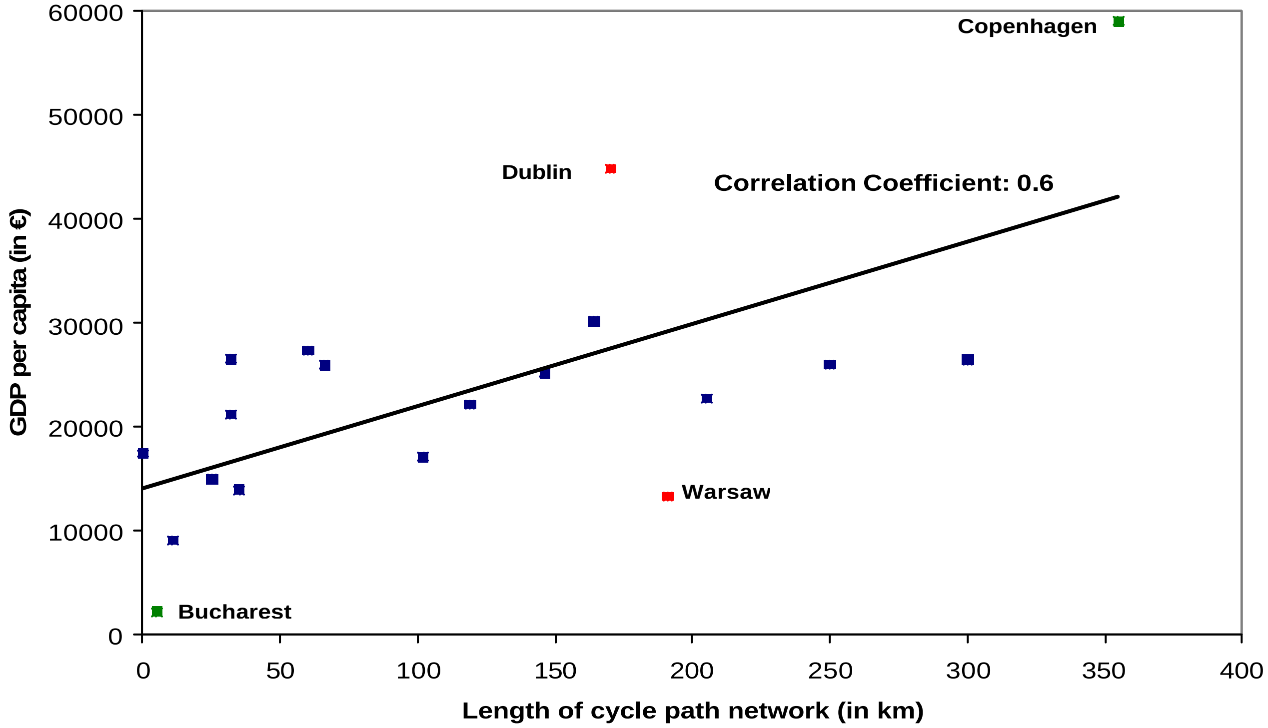


Figure 5.5 illustrates how the statistical correlation between GDP per capita and the length of cycle paths becomes stronger (increasing to 0.6) when the Ile de France region and Rome are discounted. The trend is more pronounced, with the larger cycle networks being found in cities with higher levels of GDP.

Figure 5.5: Correlation between the length of cycle paths and GDP per capita (outliers removed)



The two exceptions to this rule are the cities of Dublin and Warsaw, which are both outliers. Warsaw has 190 km of cycle paths and a comparatively low level of GDP per capita. Warsaw is a good example of a city encouraging sustainable modes of urban transport, although the modal share for cycling in the city is low (see Figure 4.7). Dublin has a much higher level of GDP in relation to the length of cycle paths in the city. Although Copenhagen and Bucharest appear to be outliers from the illustrated pattern they represent the extremes of the trend.

Figure 5.6 illustrates the relationship between GDP per capita and cycle paths in proportion to total road network. Those cities displaying a high level of cycling modal share in Figure 4.7 are highlighted green and labelled for clarity. Oxford, Aalborg, Oulu and Rotterdam all display broadly similar levels of GDP per capita and have different sized cycle path networks. Statistically the correlation is weaker (0.5) than the initial comparison between cycle paths and GDP per capita, but the comparison is more valid, because by displaying the length of cycle paths in proportion to the size of road network the size of the city is taken into account.

The most relevant finding highlighted by Figure 5.6 is that the 5 cities with the highest levels of cycling modal share (as shown in Figure 4.7) display the largest cycle path to road network proportions. This suggests that the relationship between cycle paths in proportion to total road network and cycling modal share will also be strong. It is important to note that the modal share of cycling and walking as modes of urban transport are difficult to measure and therefore it is common for this data to be estimated.

Figure 5.6: Correlation between the proportion of road network that is cycle paths and GDP per capita

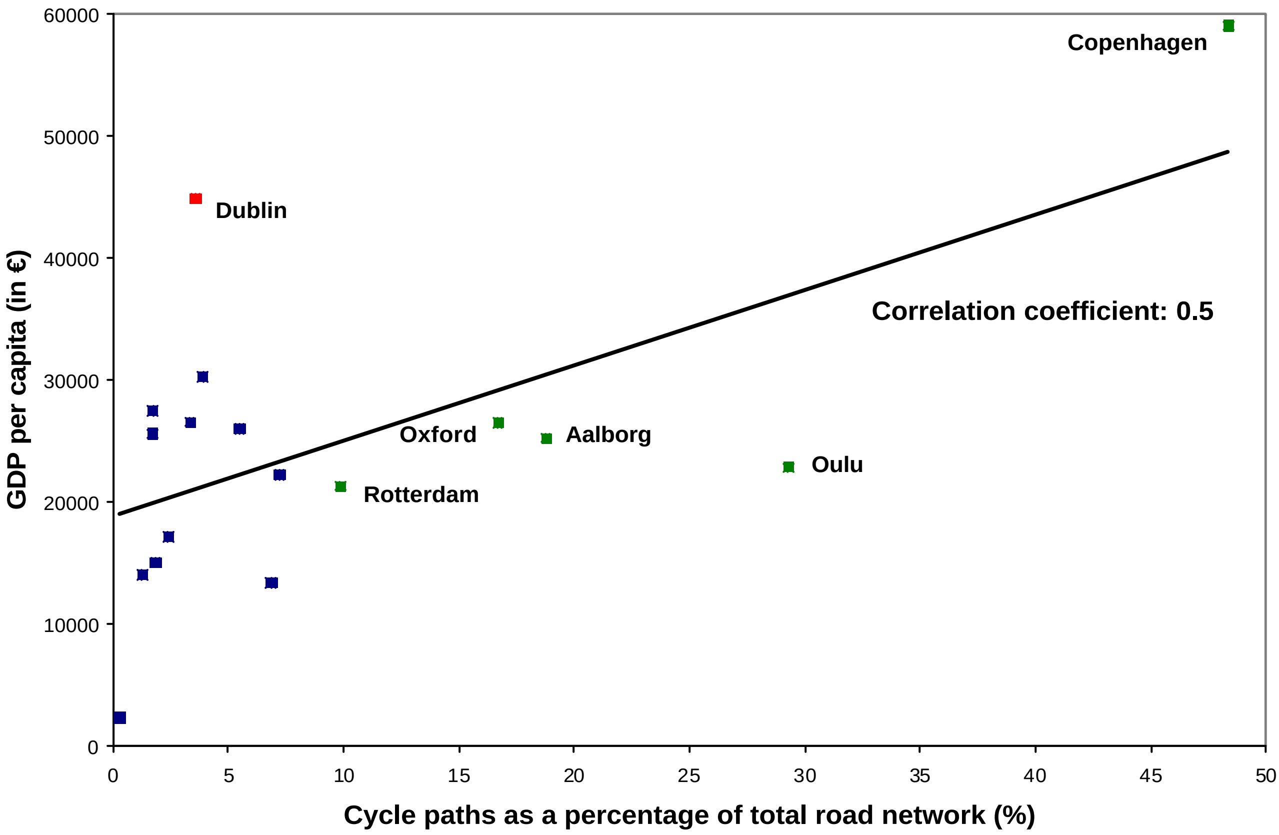
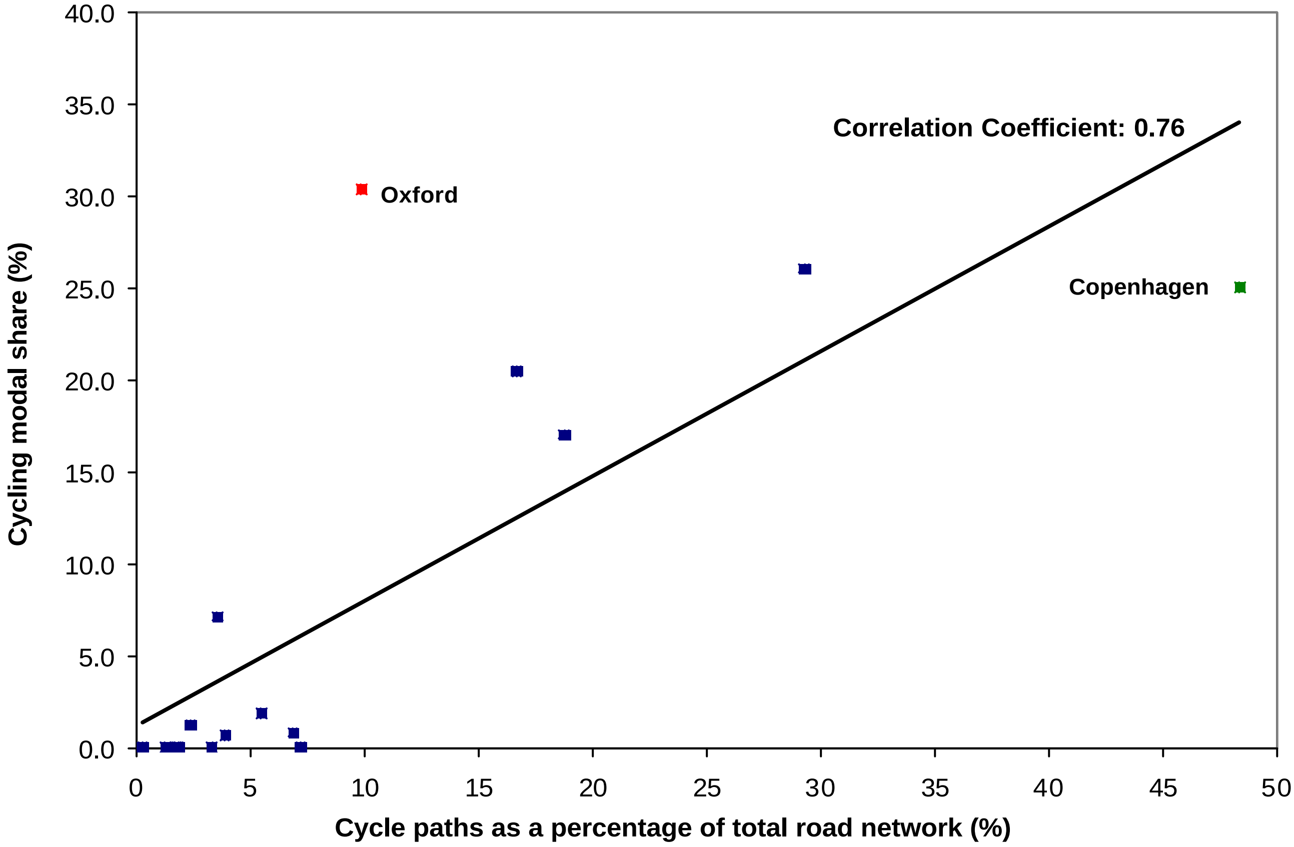


Figure 5.7 illustrates this relationship which has a very strong statistical correlation of 0.76. Although there are only approximately 10 data points which bear a comparison, the trend line does reveal that Oxford has a very high level of cycling modal share in relation to the size of the cycle network. This can therefore be cited as an example of good practice which could be partially attributed to the cycling culture developed by students in the city's two universities.

Figure 5.7: Relationship between cycling modal share and the proportion of road network that is cycle paths.



5.3 Urban road networks and car use

The most populous cities display the highest absolute numbers of cars registered. Smaller cities have marginally higher levels of car ownership (cars per 1000 people) than larger cities.

Figure 5.8 illustrates the very strong positive correlation (0.9) between the population of a city and the number of cars registered. This relationship is in line with what would be expected; in cities where there are more people there are more cars.

Figure 5.9 displays the negative statistical relationship between car ownership (the number of cars per 1000 population) and the surface area of the city. The statistical correlation is -0.1 which is a very weak relationship and indicates that in larger cities, where population densities are often higher, the level of car ownership is lower than in smaller cities. It is not possible to analyse this further, because the data for the Ile de France region and Barcelona (highlighted in the red circle in Figure 5.9) represent much larger areas than the other data and the trend is not particularly well pronounced.

Figure 5.8: The relationship between population and cars registered in a city

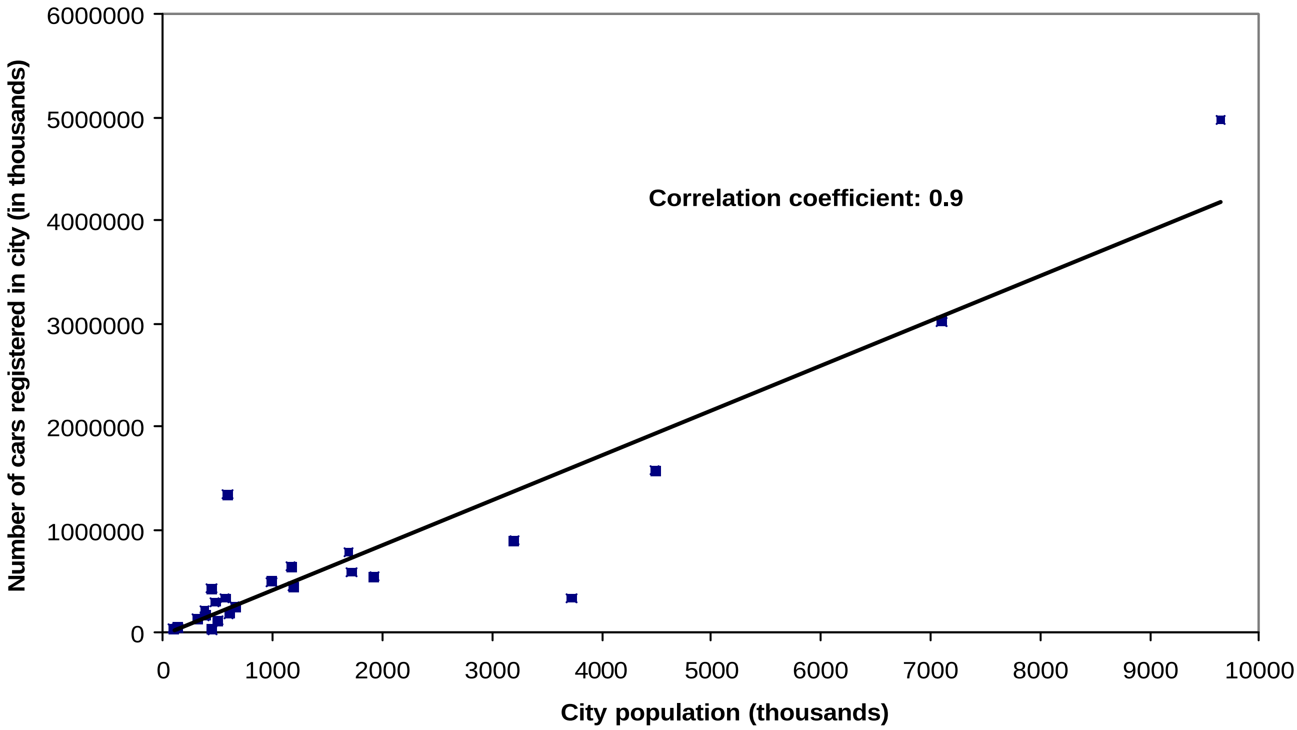
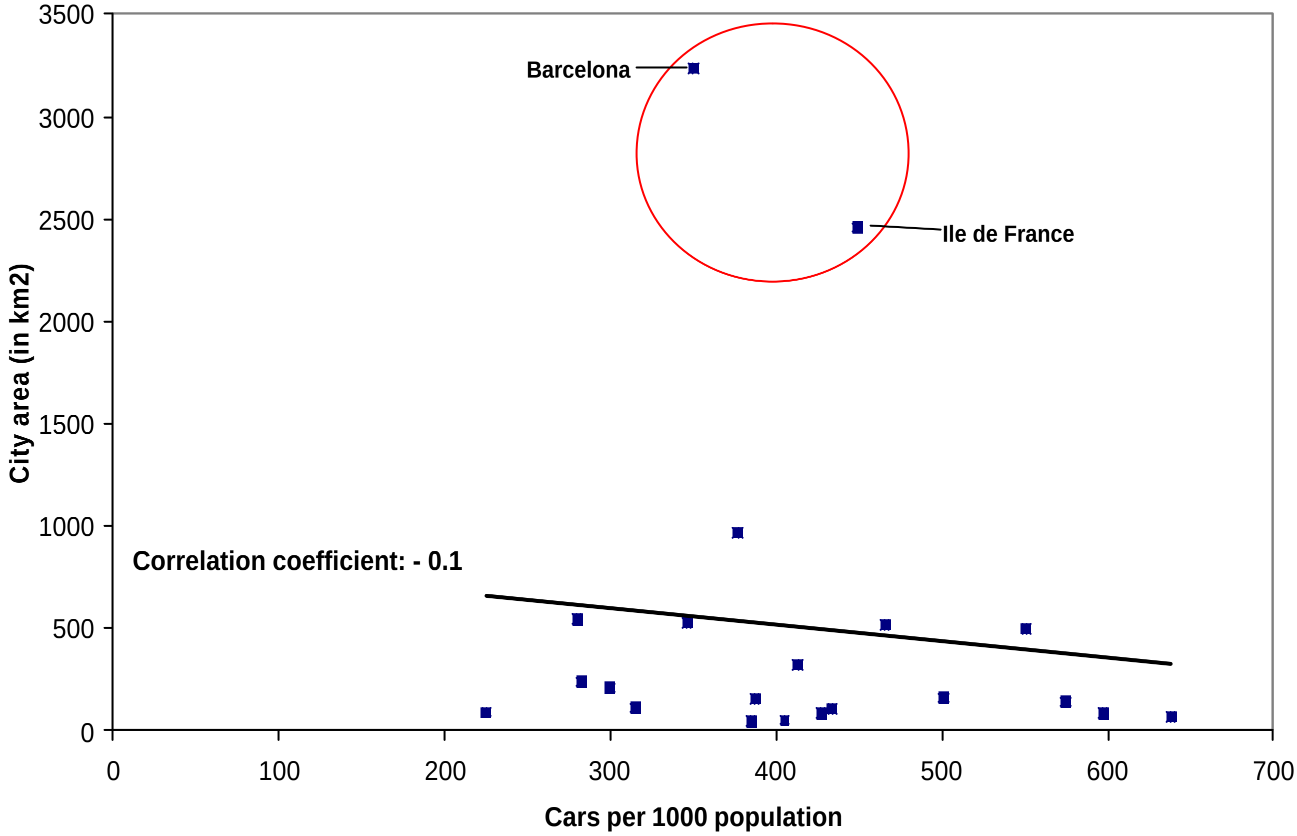


Figure 5.9: The relationship between car ownership and city size



5.4 Urban metro systems

Cities with large populations are those most likely to have extensive metro systems.

Table 5.1 displays data for the 13 metro-cities that have participated in the Urban Transport Benchmarking Initiative. The metro systems being compared cover a wide range of urban populations and surface areas, although 10 of the 13 metro cities have populations of approximately 1 million people or more.

Table 5.1: Metro-cities participating in the Urban Transport Benchmarking Initiative

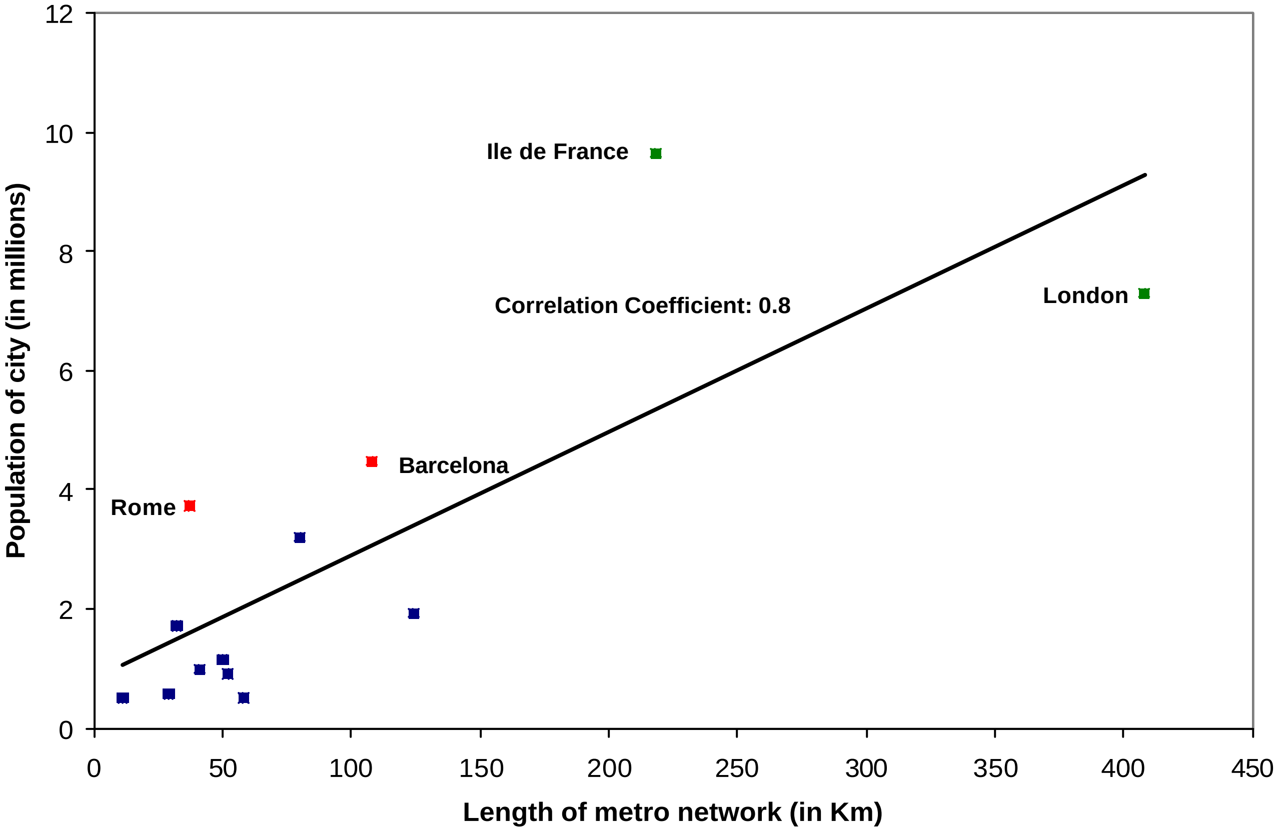
City	Length of metro network (km)	Population density of city (people per km^2)	Population of city	Surface Area of city (km^2)
Copenhagen	11	5,556	500,000	90
Lisbon	29	6,674	564,657	85
Budapest	32	3,275	1,719,342	525
Rome	37	2,887	3,723,649	1290
Brussels	41	6,162	992,041	161
Prague	50	2,339	1,160,000	496
Lyon	58	8,177	507,000	62
Athens	80	5,882	3,200,000	544
Barcelona[7]	108	1,385	4,482,623	3236
Bucharest	124	8,094	1,926,334	238
Rotterdam[8]	52	29,228	909,000	31.1
Ile de France/Paris	218	3,922	9,644,507	2459
London	408	4,629	7,300,000	322
Mean Average	**96**	**6,785**	**2,817,627**	**733**

Figure 5.10 demonstrates the relationship between the length of metro network in a city / region and the size of the population of a city.

[7] Data for Barcelona refers to the metropolitan area of Barcelona.
[8] Data for Rotterdam relates to the area and population covered by the RET public transport network

Statistically these two variables display a very strong positive relationship (correlation of 0.8) when all cities and regions participating in the initiative are considered. This direct relationship indicates that where the population of a city is high, the metro network is also large. In Figure 5.10, the points that are a considerable distance above the trend line appear to have small metro systems in relation to the population of the city. Those below the trend line represent cities which have extensive metro networks in relation to the size of the city. The two points highlighted in green (Ile de France / Paris and London) are the obvious outliers. London appears to follow the trend, although because the metro network is much larger than those displayed by other cities it skews the trend line. Ile de France / Paris has a relatively small metro network in relation to the size of its urban population, although the RER urban rail network supplements the metro system in Paris and this must be taken into account.

Figure 5.10: Correlation between the length of metro network and total urban population



The two data points highlighted red represent Barcelona and Rome which both appear to have small metro systems in relation to their respective urban populations. In each case the area covered by each of the cities is very large. It is possible that this reflects lower levels of investment in public transport evident across Southern Europe, although it is difficult to quantify and compare this using data from the common indicators. The commercially sensitive nature of this data meant that many of the participating cities were unable to submit information about the level of investment made in metro systems.

When the trend is re-drawn with the exceptionally large cases of Paris / Ile de France and London removed from the analysis (see Figure 5.11) the strength of the relationship becomes slightly weaker (correlation of 0.5). This is offset by the fact that the data points are more easily compared to the trend line and each other. Figure 5.11 reaffirms the finding that Rome and Barcelona both have small metro networks compared to the size of their populations. The chart also highlights four cities which have large metro systems in relation to the size of the populations they serve. These cities are:

- Bucharest, 1.9 million inhabitants, 124 km of metro network
- Lyon, 445,000 inhabitants, 48km of metro network.
- Lisbon, 565,000 inhabitants, 29km of metro network.
- Rotterdam, 909,000 inhabitants, 52km of metro network

Potential explanations for these cities having metro systems despite low populations could include: the size of the surrounding metropolitan or travel to work areas, protection of heritage sites by using sub-surface transport, high investment in metro systems and urban transport and large tourist flows. These potential explanations could be explored as the benchmarking initiative progresses into its second year.

Figure 5.11: The relationship between the length of metro network and total urban population (outlying data points removed)

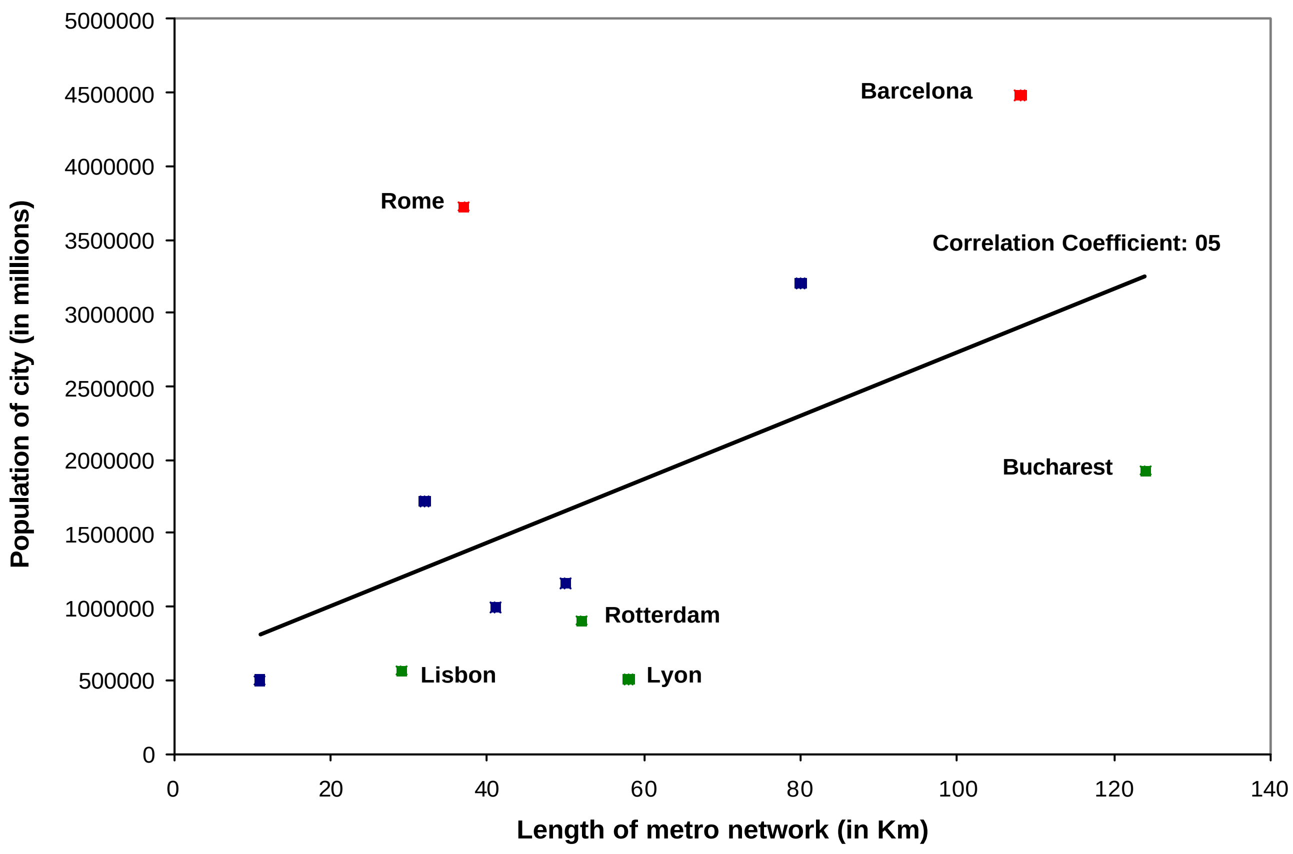
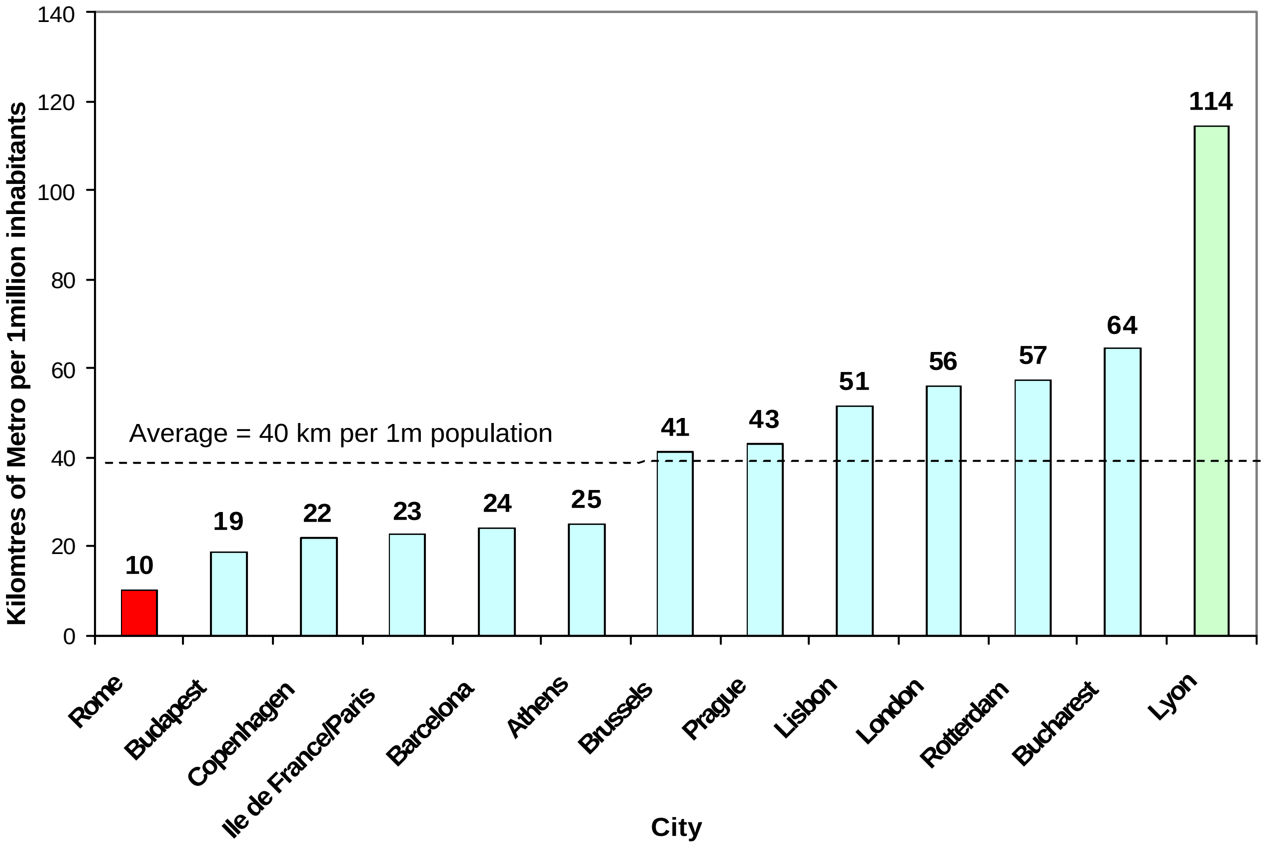


Figure 5.12: Comparison showing length of metro networks in relation to population



It is possible to suggest that the number of kilometres of metro network per million inhabitants as a way of comparing the utility of each city's metro system. Although this measure does not take geographical features such as surface area into account, Figure 5.12 reveals how large the metro networks of Lyon and Bucharest are in relation to the size of their urban population. In contrast Rome displays a very small metro network (10 km per million inhabitants).

By averaging the data shown in Figure 5.12 it is possible to suggest that approximately 40 km of metro network per 1 million inhabitants is a useful threshold for metro provision. Using this as a standard, the cities of Dublin and Warsaw could both be considered as potential metro cities based on the size of their populations.

6. CONCLUSIONS

6.1 Overview of findings

In summary, four key urban transport trends have been identified from the analysis of the common indicators collected for the Urban Transport Benchmarking Initiative. These are summarised below:

- **Average income levels have an impact upon public transport use and car use in cities**. Where GDP per capita was found to be high, the modal share of public transport was generally lower and the proportion of trips made by car was higher. This has obvious policy implications for both less affluent cities and wealthier cities, because it implies a clear preference for car travel. People who can afford to travel by car appear to do so unless traffic congestion, lack of parking or access restrictions associated with large, heavily urbanised cities prevent them from doing so (as in London or Rome). It also implies that people in less affluent cities would travel by car, if it were more affordable, but instead rely upon public transport.

- **Cycling was found to be popular where it had been encouraged by investment.** Cities that have larger cycle lane networks tended to be those with higher levels of GDP per capita. The cities that have large cycle lane networks in proportion to the size of the urban road network were also found to display the highest levels of cycling modal share. This sends a clear message to policy makers that are keen to develop a cycling culture in their cities. People are more likely to cycle where they are provided with the facilities that enable them to cycle safely and quickly.

- **Car ownership levels vary according to city size.** The cities that displayed the largest urban populations also displayed lower levels of car ownership (cars per 1000 inhabitants) in relation to the less populous cities that have participated in the Urban Transport Benchmarking Initiative. Although these large cities do generally contain more cars (in absolute terms) than smaller cities, the level of car ownership is lower and appears to be a particular feature of high density cities (Barcelona, London, Rome and Paris).

- **A critical mass of population is necessary to support a metro system.** The vast majority of cities with populations in excess of 1 million inhabitants were those that had metro systems. These metro networks were all supported by a wide range of other transport modes (bus, train and particularly tram) and were generally focused upon central urban areas (those in Paris and London are exceptions). Averaging the size of metro systems across the 13 metro cities revealed an average of approximately 40 km of metro per million inhabitants. Although this is only a rough threshold, which needs to be considered in relation to the other public transport modes available in each city, it does suggest that both Dublin and Warsaw are potential metro cities.

These findings can be further developed through the addition of new common indicators and further qualitative information derived on an individual city basis. Recommendations for developing the common indicators and next steps for the project team are outlined in the following sections of this conclusion.

6.2 Recommendations for developing the benchmarking initiative

In order to develop these findings, a range of further indicators could be considered in year two of the Urban Transport Benchmarking Initiative. These include:

- Refining the indicators that covered the cost of car use in order that accurate comparisons can be drawn between the participating cities. This would particularly help develop the finding about GDP per capita and its impact upon modal share by enabling comparisons between costs of car use. In addition this could provide a point of comparison for the cost of car use against the cost of public transport in each of the cities.

- Figures for investment in urban transport infrastructure over the last 5 years also proved difficult for the participants to collect, although this appears to be part of a larger issue of data sensitivity. A suggested alternative is that the developments or projects realised over the last 5 years and throughout the course of the project could be documented qualitatively by the participants. Rather than providing a quantitative indicator for the amount of investment in urban transport in recent years, this qualitative information could be used to rate each city in terms of the amount of development being achieved.

- A set of 5 to 10 core indicators could be drawn up based upon those that have been successful in year one of the initiative. This would enable new entrants to the project to submit data which is readily comparable and permit time series data to be collected by the existing participants in the project. Time series data would facilitate the identification of trends in urban transport, as well as help to unify the methods of data collection and measurement used in the cities involved in the initiative.

Further recommendations for year two of the Urban Transport Benchmarking Initiative include the development of international links which have been formatively established during year one of the project. A potential suggestion is that interested cities from other continents could participate remotely by submitting data for the benchmarking exercise to broaden the scope of data comparison. In addition links to other transport benchmarking projects will be renewed and, where relevant, there is potential for the sharing of data in order that the scope of the benchmarking exercise is widened.

Finally, a planned online benchmarking facility is another potential development of the benchmarking initiative. This would enable cities not participating to submit items of data on selected scatter-plots to see how their city measures up to those that have participated in the initiative. Accessible via the project website, this facility could be a valuable tool in attracting cities to the initiative, as well as aiding the dissemination of the project results.

6.3 Next steps and future intentions for Urban Transport Benchmarking

The immediate next steps for the Urban Transport Benchmarking Initiative are outlined below:

- Dissemination of year one results to urban transport stakeholders.
- Review of progress made by other transport benchmarking initiatives (to be conducted during the summer 2004).
- Review of common indicators to creation of a shortlist of core indicators to be collected for the duration of the project and some re-defined indicators that would improve the data set.

- Development of an online benchmarking facility.
- Prepare the "Year two Launch workshop" (taking place on September 28th 2004) to consider the development of themes for each of the working groups in order to improve the focus of the Urban Transport Benchmarking Initiative for year two of the project.