The millennium cities database: a tool for sustainable mobility

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1. SYNOPSIS

In producing the « Millennium Cities Database » and analysing the results obtained, UITP provides a set of arguments in favour of sustainable mobility and public transport.

2. ABSTRACT

UITP is concluding the compilation of a database concerning 100 of the world's cities, known as the « Millennium Cities Database »[1]. The collected data concerns population, the economy and urban structure, the number of road vehicles, taxis, the road network, parking, public transport networks (offer, usage and cost), individual mobility and choice of transport mode, transport system efficiency and environmental impact (duration and cost of transport, energy consumption, accidents, pollution, etc.). In total, 69 indicators (175 basic indicators) are being compiled for each city.

In producing this database and analysing the results obtained, UITP plans to draw up a set of arguments in favour of sustainable mobility and public transport and provide its members with information that will allow them to evaluate the performances of their cities and their own public transport networks and construct an argument adapted to their own particular situation.

The aim of the paper is to present the results of the comparison between the cities of the database, under several criteria, e.g.:

- Mobility, accessibility and transport spending
- Mobility and the environment
- Factors explaining modal choice and public transport's market share

On the basis of a world wide quantitative comparisons, the paper identifies the key factors in sustainable mobility and shows that public transport is the answer to the problems of urban congestion.

3. BACKGROUND

In recent decades, urban and suburban travel has undergone major changes in terms of both quality and quantity due to several factors:

- Urban sprawl, which has created a larger number of more widely spread cities with large populations. In the year 2000, about 2200 cities have more than 100,000 inhabitants while this number was 114 in the beginning of the twentieth century. Half of the world's population now lives in urban areas, and estimates are that by 2010 there will be some 50 megacities of over 10 million people. As housing has moved out of the city centre, so places of employment, leisure and shopping have all grown less concentrated;
- The sharp rise in trips from outskirts to suburbs and long trips from outskirts to the centre, a direct result of the spread of the urban area. This has caused travel distances to increase: in France, in terms of local mobility the average distance travelled per week rose by 30% between 1982 and 1994, to 23 km;

- The growth in household purchasing power and the democratisation of the private car have led to a rapid rise in car ownership levels, and in some countries to multiple-car families. There is also a noticeable trend for car owners to buy ever-more powerful cars with more features, especially air conditioning, which are therefore more energy-consuming;
- The creation of road systems to respond to the dispersion caused by town planning less suited to the radial structure of heavy public transport networks has encouraged private car use, which has also been at the expense of walking and cycling. Over the last 25 years, the motorway network of the European Union has more than tripled in size (+208%), whereas the rail network has shrunk by 8%. Between 1980 and 1995, the number of vehicles per kilometre travelled by cars grew by 50% in the OECD countries even though the population growth was only 13%;
- Changes in people's lifestyles have affected their mobility habits: they are doing an increasing amount of travel for leisure and shopping purposes, trips which do not lend themselves as readily to public transport;
- A look at patterns of behaviour related to vehicle use shows that car drivers do not always think logically. A study performed by INRETS (France), TÜV (Germany) and TRL (UK) shows that half the time Europeans use their car to go less than three kilometres, a quarter of the time to go less than 1 kilometre, and one time out of eight to go less than 500 m.

This evolution of urban mobility has in most cases resulted in worsening traffic conditions, leading to a growing number of traffic jams which cause polluting emissions to go up in urban areas. According to ADEME (France), individual urban travel represents 24% of the energy consumption of land transport. The private car accounts for 87% of the energy balance of urban mobility, whereas public transport consumes barely 7%. In Brussels, vehicles of the STIB/MIVB (buses, trams and metros) consume only 8% of the energy balance of urban mobility yet account for 30% of total urban travel.

Given these observations, it appears beyond dispute that public transport is the answer to the problems of urban congestion. It also contributes to the quality of urban life and the environment, and makes it possible to free up scarce urban space. The following figures support this line of reasoning:

- In the Paris region, for example, an RATP bus which is 25% full consumes 25 goe/passenger-km whereas a car carrying 1.25 people consumes 60 goe/passenger-km;
- In terms of greenhouse gases, a bus emits about a third as much CO_2 per passenger per kilometre carried than a private car;
- As to other pollutants, in terms of passengers per kilometre the same bus will emit 25 times less CO than a petrol-powered car and a fourth as many particles as a diesel-powered vehicle.

Obviously, these ratios would be even more unfavourable to the private car during rush hour, since the bus would be close to 100% full.

4. THE MILLENNIUM CITIES DATABASE

To support these findings and provide arguments in favour of public transport, UITP is concluding the compilation of a database concerning 100 of the world’s cities, known as the « Millennium Cities Database »[2]. The collected data concerns population, the economy and urban structure, the number of road vehicles, taxis, the road network, parking, public transport networks (offer, usage and cost), individual mobility and choice of transport mode, transport system efficiency and environmental impact (duration and cost of transport, energy consumption, accidents, pollution, etc.). In total, 69 indicators (175 basic indicators) are being compiled for each city.

In producing this database and analysing the results obtained, UITP plans to draw up a set of arguments in favour of sustainable mobility and public transport and provide its members with information that will allow them to evaluate the performances of their cities and their own public transport networks and construct an argument adapted to their own particular situation. Hereafter a thematic analysis of the results obtained from the exploitation of the database.

5. MOBILITY, ACCESSIBILITY AND TRANSPORT SPENDING

Mobility is not an end in itself. As transport modes, the automobile and public transport should be in the service of the city and its inhabitants. The important thing is accessibility, that is to say the possibility for all citizens to reach their places of work as well as the businesses and amenities they need in a reasonable space of time. The automobile offers remarkable flexibility of use for those who own one, but the lengthening of distances travelled and mounting congestion are forever undermining its performances. Moreover, public transport has an irreplaceable role to play in ensuring that every citizen, whether they have a car or not, has access to jobs, businesses, services and leisure amenities. Economic dynamism and social cohesion are at stake here.

Politicians and economic representatives know very well that the transport system's performances have a decisive bearing on whether their cities will expand or go into decline against a background of globalisation and competition between cities. Having said that, transport systems come at a price, which we need to try and limit while, at the same time, ensuring the best possible accessibility for individuals and for companies and businesses.

Transport spending, including investment and transport operations (both individual and collective modes), varies in developed countries from 4 to 18% of a conurbation's GDP. Sprawling American cities, which have virtually no public transport, are the most expensive owing to massive automobile use, whereas the best results are obtained by cities such as Munich, where journeys are spread equally between walking, public transport and the automobile, or by compact cities like Hong Kong and Singapore, whose public transport systems are highly developed (Table 1). A comparison between Singapore and Houston, which are cities with similar populations and wealth, reveals that Singapore spends ten billion US dollars less per year than Houston in order to transport its inhabitants (i.e. $US 3,000 per inhabitant) while offering them better accessibility.

Table 1. Density, modal choice and cost of urban transport

Cities	Density (inhab/ha)	Modal split (walking +cycling +PT)	Cost of urban transport (% GDP)
Houston	9	4.5 %	14.0 %
New York	18	25 %	9.4 %
Paris	48	56 %	6.8 %
Munich	56	60 %	5.8 %
Singapore	94	47 %	4.7 %
Hong Kong	320	82 %	5.0 %

(Source : Millennium Cities Database ; UITP - Murdoch University)

It is plain to see that the rush to invest in roads does not provide any kind of sustainable response to the mounting needs of urban mobility. Public transport running on its own right-of-way significantly outperforms expressways: for the same amount of spending on investment, a RER line is able to carry 60,000 passengers per hour and direction compared to 7,500 in the case of a three-lane highway.

Before investing in additional transport capacity, usage of our existing roads needs to be optimised. Again, public transport's superiority in this field is obvious: during peak periods, two to four times more passengers can be transported if travelling by tram or bus rather than by car. In city centres, which are home to activities with high value added as well as places of culture and exchange, space is a rare and prized commodity that must not be wasted on car parks and expressways.

6. MOBILITY AND THE ENVIRONMENT

Nowadays, the city is very often synonymous with multiple nuisances (pollution, noise, road congestion). In addition, the transport sector is the main cause of the greenhouse effect created by emissions of CO_2 and contributes to the inevitable depletion of fuel reserves. According to the World Health Organisation (WHO),

pollution causes 80,000 premature deaths in Europe. Each year, 45,000 European Union citizens lose their lives in traffic accidents. Danger on the roads is the main cause of death in Europe among the under-25s.

Fuel is a resource that will invariably run out and will therefore become ever more expensive. A decade of cheap petrol had caused us to lose sight of this. Henceforth, we shall have to put an end to fossil fuel wastage, particularly in the transport sector where the appetite for fuel is forever increasing despite the technical advances achieved by automobile constructors. Between 1973 and 1990, transport's energy consumption increased by 50%. On the basis of current trends, a 130% increase is set to occur between now and 2025, essentially because of increased car use. This prospect is unacceptable. We need to save fuel. This is an obligation for meeting the commitments made by governments at the United Nations' Kyoto and The Hague gatherings in order to reduce the climate dangers associated with the greenhouse effect.

The superior performance of urban mass transport over the automobile in terms of energy consumption, safety and pollution is well known. When it comes to protecting people's health and the environment, the cities where public transport, cycling and walking are used for the majority of journeys are the ones that produce the best results (Table 2).

Table 2. Modal choice, energy consumption, pollution, traffic accidents

Cities	Modal split (walking+cycling+PT)	Energy consumption (Mj/inhab/year)	Pollutant gas emissions (kg/inhab./year)	Annual number of people killed in road accidents (per million inhabitants)
Houston	4.5 %	86,000	330	130
New York	25 %	43,000	170	95
Paris	56 %	15,500	120	85
Munich	60 %	17,500	110	55
Singapore	47 %	12,000	75	80
Hong Kong	82 %	6,500	25	40

(Source : Millennium Cities Database ; UITP - Murdoch University)

7. FACTORS EXPLAINING MODAL CHOICE

Modal choice is the result of a combination of factors that differently affect each citizen. The database permits to analyse the influence of quantitative factors such as income growth, urban density, car ownership level, number of parking space, etc. on the modal choice.

It is commonly admitted that income growth leads to an increase of car ownership level. Nevertheless, income growth does not imply dependency vis-à-vis the automobile, as far as modal choice is concerned. It is difficult to refute this assertion when comparing the North American, European and Asian cities included in the database in which income per inhabitant is similar. Cities in North America and Oceania, which sprawl a great deal, are highly dependent on the automobile. In Europe, where density is higher and the level of car ownership moderate, walking, cycling and public transport account for half the journeys. Cities in Japan, Singapore and Hong Kong are heavily built-up and household car ownership is low in relation to household incomes. Public transport, which is highly efficient, is the dominant transport mode. Taxes on automobile purchases limit car ownership and automobile use, as in Singapore (115 automobiles per 1,000 inhabitants), Hong Kong (46) and Copenhagen (275). The inadequacy of public transport and absence of constraints vis-à-vis the automobile are favouring car ownership in developing cities: in Bangkok, there are 250 cars for every 1,000 inhabitants, the result of which is widespread congestion.

Table 3. Density, number of automobiles and road km per 1,000 inhabitants and modal choice

Region	Density (inhab./ha.)	Automobiles (/ 1,000 inhab.)	Road km (/ 1,000 inhab.)	Share of journeys on foot, by bicycle or on public transport
USA, Canada,	17.5	570	6.4	15.5%

Oceania				
Europe	45.5	380	3.3	53%
Asia (affluent cities)	134.0	220	2.45	61.5%

(Source : Millennium Cities Database ; UITP - Murdoch University)

As far mechanised journeys are concerned, it is interesting to analyse the influence of diverse factors on the market share of public transport. It comes as no surprise to note that the higher the level of car ownership, the more public transport use declines. This relation is shown clearly in Table 4. Having said this, it is worth emphasising that, at a given level of car ownership, public transport use becomes more intensive the more attractive the services on offer become. It is illustrated chiefly by the examples of Vienna, Munich and Frankfurt where high levels of car ownership do nothing to stop city-dwellers from using public transport on a frequent basis.

The attractiveness of public transport is partially attributable to qualitative elements or ones that are difficult to measure, like passenger information, the attitudes of operating staff, comfort and feelings of security (or insecurity). It clearly appears that the performances of networks in terms of commercial speed, in relation to the speed of automobile traffic, are crucially important for city-dwellers who are in a position to choose between the automobile and public transport. Another major factor is the availability of a parking space at the actual destination. The database has made it possible to assess the impact of these two factors using the following parameters: average speed ratios (automobile speed / public transport speed) and the availability of centrally located parking, measured in terms of the « the number of on-road parking spaces and spaces in public car parks / number of jobs » ratio.

Table 4. Modal choice, car ownership, modal speed and parking spaces

Region	Share of motorised journeys by public transport	Automobiles / 1,000 inhab.	Automobile speed / Public transport speed (1)	Number of parking spaces / Number of jobs
USA, Canada, Oceania	5.9%	570	1.75	0.54
Europe	29.4%	380	1.28	0.19
Asia (affluent cities)	42.2%	220	1.04	0.12
Asia (developing countries)	77.5%	75	1.45	0.08

(1) Terminal walking times are not taken into consideration in the calculations.

(Source : Millennium Cities Database ; UITP - Murdoch University)

At a given level of car ownership, public transport's market share becomes stronger the higher its speed. Public transport is not competitive with the car in the United States, Canada and Oceania (except in New York and Sydney). On the other hand, it is faster than the automobile in Tokyo and Osaka, where 90% of journeys on public transport are made by train or metro. The situation in Europe is halfway between the two : competitiveness is adequate in Munich, Frankfurt, Zurich, Vienna, London and Paris, where rail modes predominate. In cities in developing countries, however, the automobile is much faster than the bus, but is the preserve of a minority.

There is also a statistical correlation between parking capacity in central areas and the market share of public transport in the conurbation, and it is noticeable that cities with well-developed, heavily-used public transport offer few such central parking spaces.

It is fairly paradoxical to record that there is no apparent link between the volume of service offer (seats x annual km / inhabitant) and the percentage of motorised journeys made on public transport. Public transport's occupancy rate actually varies a great deal from city to city. In the United States, the offer is poor and under-used (except in New York). In Europe, the situation is extremely variable (occupancy rates are high in Athens and Budapest), whereas offer is strong and heavily used in Japan, Hong Kong and Singapore. In China, the occupancy rate is very high, but competition there is more between cycling and public transport.

The cost of an automobile for the passenger is always higher than that of public transport (1.5 to 40 times greater). That being said, it does not cause motorists to plump for public transport if the latter fails to produce

adequate performances. No relation whatsoever can be discerned between public transport's market share and what the automobile and public transport actually cost the passenger (measured by the average cost of a car journey, all taxes included, in relation to the cost of a journey by public transport). This observation can be explained by the fact that journey time and comfort are determining modal choice factors. One conclusion that might be drawn from this is that subsidised low fares, which are vital for ensuring urban accessibility for all, are ineffective when it comes to attracting motorists.

8. CONCLUSION

The analysis of data from the "Millennium Cities Database" confirms that the principal « choice » factor for public transport involves curbing automobile ownership and use. In this regard, taxes on purchasing a car, parking restrictions and urban tolls are effective instruments, as is illustrated by the examples of Hong Kong, Singapore, Japan and, to a lesser extent, certain European cities. Car use can be limited most effectively if the city is sufficiently built-up for it to be served by an efficient public transport network. Notwithstanding, cities such as Vancouver and Perth have shown that they can begin to achieve good results with public transport where there is an investment in speed and comfort-competitive rail services. This is especially true where there is also an effort to link high density development to the new rail stations. Finally, it should be emphasised that public transport speed and regularity are decisive in attracting motorists. Rail transit offers this determining advantage. If the available funding capacity precludes metro construction or the development of commuter railways, the solution is exclusive surface rights-of-way for bus or tramway. These exclusive rights-of-way should be arranged ideally before the roadway is invaded by motorised two-wheel forms and the automobile.

9. END NOTES

[1] The Millennium Cities Database is developed by UITP with the assistance of Murdoch University, Australia.

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