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The cost of journeys is reduced to a minimum, when the metro is the dominant mode of transport for high density use

# Density of urban activity and journey costs

*The cost of mobility to the community varies according to the different types of urban area and the means of transport used. In areas where population and employment densities are medium to high, public transport is always cheaper than the car. The combination of high density and a vigorous public transport system with dedicated lanes constitutes the most efficient form of urban*

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## THE COST OF TRANSPORT TO THE COMMUNITY AND POPULATION AND EMPLOYMENT DENSITY

The work carried out by Peter Newman and Jeffrey Kenworthy has highlighted the relation that exists between fuel consumption for urban journeys and population density in towns. This study clearly reveals the very high cost in energy terms of dispersed urban development patterns that are founded on the quasi-exclusive use of the motor car. The concept of "sustainable development", defended by international organisations such as the UN, OECD and the European Union, and the law on air and the rational use of energy in France, start out from the same premise. This embraces other effects of excessive car use in towns, air pollution, and the climate dangers due to the Greenhouse Effect caused by emissions of carbon gases. By analysing the case of the Ile-de-

France region, the intention is to compare the efficiency of urban development patterns in terms of the cost to the community of daily journeys. The region is divided into four zones of differing density: central Paris, the inner suburbs close to central Paris, the inner suburbs further away from the centre, and the outer suburbs.

In order for a city to be able to function smoothly, each city-dweller must be able to access his or her place of work or education and all administrative, medical, commercial or leisure amenities necessary for their daily activities and well-being. **The method put forward therefore takes as its starting point the journey needs of Ile-de-France residents, as is understood using the concept of accessibility.** The region's working population must be able to access in reasonable time a labour market that is sufficient for them to find a suitable job without having to endure overly long home-work journeys.

The higher the immediate density, the shorter the distance city-dwellers have to travel from their place of residence in order to reach jobs that interest them. "Access zone" radii have been calculated for the four study zones determined earlier. For each of the zones studied, it is possible to calculate the cost to the community of journeys corresponding to a return journey, of a length equal to twice the radius of the "access zone" (whose circumference is centred on the place of residence and contains a given number of jobs).

These estimates of the cost to the community have been made for home/work journeys and home/shopping journeys made by car and by public transport. They allow these costs by various transport modes in each of the zones to be compared and the efficiency of urban development patterns, depending on density of activity (measured as the sum of the population and the number of jobs per hectare), to be assessed.

The cost to the community is calculated before taxes. It includes operational expenses, capital expenditure and the cost of transport's externalities: consumption of urban space, noise, pollution and traffic accidents. The cost of transport time is integrated in the journey cost on the basis of a time value of 40 francs/hour, which is representative of how the "average traveller" behaves (this value allows traffic flows on the Ile-de-France's transport networks to be reconstructed using simulation models).

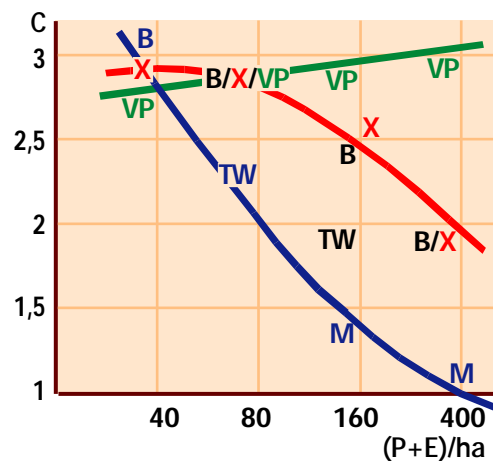
**Built-up urban development patterns that are well served by public transport running on exclusive rights-of-way are the most efficient; apart from the outer suburbs, the car is always less efficient than public transport running on exclusive right-of-way (cf. diagram)**

For public transport, it is noticeable that the cost to the community of the most efficient mode -- metro in built-up zones, tramway running on exclusive, surface right-of-way in moderately built-up zones, and buses in dispersed zones -- increases three-fold when the density is divided by 10. It is three times higher in the outer suburbs than in central Paris. On the other hand, the cost to the community of the motor car varies inversely but far less dramatically: falling by around 20% when the density decreases from 400 to 40 inhabitants + jobs per hectare and remaining very much higher than the cost of public transport in built-up zones.

#### COST OF JOURNEYS ACCORDING TO DENSITY AND MODE

##### Cost to the community

(relative value in relation to the cost of the "Paris - metro" pairing)



VP = motor car  
B = bus running on ordinary roads  
TW = tramways running on separate surface rights-of-way  
M = metro

Blue: optimal public transport mode

X = average weighted by current modal split

The Cost of the "optimal" public transport mode (metro in densely built-up zones, tramway running on its own surface right-of-way in zones with average density, and buses in lower-density zones) increases three-fold when the density is divided by 10. The cost of the motor car varies inversely, but far less significantly (roughly a 20% fall whenever the density decreases from 400 to 40 (P+E)/ha). It remains well above that of public transport in densely built-up areas. Development of public transport running on separate rights-of-way (metro in the densely built-up primary inner ring; tramway in the secondary inner ring) would enable a reduction in transport costs to the community.

The conjunction between high density and a rapid, interlinked public transport network produces the lowest transport cost to the community. Indeed, central Paris is where access to jobs is obtained, courtesy of the metro and the RER, under conditions of minimal cost. On the other hand, car use in *Paris* is inefficient since it costs two to three times more than the metro.

**The built-up inner suburbs close to central Paris** would be almost as efficient if they had a system of light rail or tramway running entirely on exclusive right-of-way. The performances of road transport modes are markedly inferior: buses and motor cars are more or less level-pegging but lag behind light rail. The built-up suburbs can only claim to achieve a high level of efficiency, measured in terms of access to the largest number of desired destinations at the least transport cost, on the condition that they have an interlinked public transport network running entirely on exclusive right-of-way. **The inner suburbs further away from the city of Paris are**, it transpires, more efficient than more built-up zones. Having said that, the most effective transport modes in this sector are tramways or buses with exclusive surface right-of-way which outperform motor cars or buses running on ordinary roads. Hence the urgency of undertaking the building of a

public transport network with exclusive right-of-way to serve Paris's inner suburbs.

**The dispersed urban development patterns of the outer suburbs are two to three times more costly to serve than the Paris conurbation's centre**, whatever the transport mode: public or individual. The scattering of populations and business activities in the outer suburbs is a handicap to buses, which are only able to offer infrequent services on dispersed networks. The motor car, with its speed and the near door-to-door journeys it can provide when parking costs are not prohibitive, is more efficient than the bus but does not provide compensation for the negative impact of spatial scattering during urbanisation.

#### ACCESSIBILITY TO URBAN ACTIVITIES AND POPULATION AND EMPLOYMENT DENSITY

The benefits are equally apparent of supplementing the study of economic efficiency with an assessment of how "socially efficient" urban development patterns are when measured in terms of the accessibility offered to inhabitants depending on whether or not they have access to the use of a car. In the case of the four zones being studied, diagram 3 shows the number of jobs accessible in less than 30 min (duration of a single home/work journey), depending on the transport mode (public



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The main assets of the Paris metro in the town centre and inner suburbs are accessibility, efficiency and urban integration

or individual). This supplementary analysis enables measurement of the handicap endured by individuals without the possibility of getting around by car, depending on the employment density in the sector they live in.

### **In dispersed urban zones, only the motor car offers sufficient accessibility**

Inhabitants living in the outer suburbs, who are unable to use a motor car, are particularly hard-hit: by bus, their world of opportunity in terms of destinations is very much reduced: 30 000 to 70 000 jobs accessible in less than 30 min instead of 550 000 by car. The handicap endured by people who rely on public transport is again very appreciable in the inner suburbs when the only public transport mode available to them is buses running on ordinary roads. The consequence for working people reliant on public transport and who, like all working people, are not necessarily able to find a job close to where they live, is an extension of home-work journey times

to well beyond 30 minutes. In terms of the accessibility offered to city-dwellers, public transport only matches or outperforms the motor car in central Paris and the built-up inner suburbs served by the metro or RER. Reliance on public transport is therefore not an impediment in Paris itself: moreover, more than half of Parisian households do not own a car. If the intention is to avoid high levels of

rents, forcing less-well-off households to move to parts of the suburbs where accessibility to urban activities requires ownership of a car, or even two, as is the case of large families with two working members, then the benefits of retaining a sufficient proportion of social housing in central Paris could not be shown more clearly.

The inadequacy of public transport services in certain residential suburbs and business zones in the suburbs is a very unfavourable factor when it comes to returning jobless people reliant on public transport to work. The de-localisation of employment, businesses and services within dispersed outlying areas with poor public transport services

contributes to marginalising the least well off members of the population, who are excluded from use of a car.

### **WHICH URBAN DEVELOPMENT MODEL FOR THE ÎLE-DE-FRANCE REGION?**

To ask such a question may appear somewhat naive, seeing as the future of the



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Car use in town results in traffic congestion and air pollution

**Number of jobs accessible within 30 min, depending on the place of residence and transport mode**

	Central Paris	Built-up inner suburbs close to central Paris	Inner suburbs further away from central Paris	Outer suburbs
<b>Average employment density per hectare</b>	200	60	25	10
<b>Number of jobs accessible by car in less than 30 min (1)</b>	> 1,5 millions	900.000	850.000	550.000
<b>Number of jobs accessible by public transport in less than 30 min (2)</b>	> 1,5 millions (metro)	from 120.000 à 230.000 (bus) > 1 million <i>light rail</i> (3)	from 100.000 to 190.000 (bus) <i>from 220.000 to 420.000 (tramway with exclusive surface right-of-way)</i> (3)	from 30.000 to 70.000 (bus)

(1) Where zero time is needed to find a parking space (space made available by employer)

(2) In view of the great sensitivity of the results to terminus journey times by public transport, these have been parametrised: the metro in central Paris (8 to 14 min); the bus in inner and outer suburbs and tramway on exclusive, surface right-of-way in the inner suburbs (6 to 12 min); and light rail in the built-up inner suburbs close to central Paris (8 to 18 min).

(3) Modes that are still not widely developed, or are at the planning stage, are shown in italics

region is the product of a multitude of individual decisions taken by each of the region's inhabitants and economic actors. Moreover, the centralised approach to planning, which allowed the creation of new towns and the international business centre at La Défense, is no longer on the agenda, particularly since the laws on decentralisation considerably increased the powers of local mayors.

Having said that, the dictates of the Master Plan, building new transport infrastructures and charges for urban transport, remain open to the French Government and the Regional Council as effective tools for orientating development. It is therefore reasonable to ask which development model should be used and to initiate debate on the relative merits of two contrasting scenarios: one founded on "gains in individual space"; the other on "sustainable development".

The perceptible trend today is that of "gains in individual space", which promotes dispersed forms of urbanisation in outlying areas and the creation of business zones and commercial centres served by roads. The results of this are longer journeys, increases in the pollution produced by cars, and the marginalisation of

people living in outlying areas who rely on public transport. On the other hand, households live in more spacious and quieter surroundings than they would in central Paris or its inner suburbs.

The "sustainable development" philosophy is intended to encourage more built-up and mixed forms of urban space occupancy and to consolidate public transport in order to reduce the pollution generated by car use in town. The downside, of course, of these higher population and employment concentrations is less space for private use and less tranquillity. Several countries in Western Europe have opted, in principle at least, for this type of development, which consumes less undeveloped space during urbanisation and pays more respect to the environment.

Previous estimates clarify the choice between these two options in terms of the cost to the community of daily journeys since they involve urban development patterns whose densities and dominant transport modes differ enormously. "Sustainable development", it transpires, is far more efficient than the Gains in Individual Space model, on the condition that at least half of all journeys are made using efficient forms of public transport. In

addition, the association of average or high density with efficient public transport presents the advantage of offering all city-dwellers potential access to urban activities, whereas dispersed conurbations with poor public transport services serve to heighten the exclusion phenomena that affect city-dwellers with no possibility of travelling by car.

*Translated from original French text, @UITP199*