EMERGING CITIES

OPTIMIZING MOBILITY

AN INNOVATIVE SOLUTION

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ABSTRACT AND CONCLUSION

A PREDICTION

We start with a simple prediction: demand for mobility in emerging cities will continue to rise with economic growth and the rural exodus. This means that, in the absence of preventive measures and with the growth in the numbers of that particular object of desire – the automobile – these cities are condemned, as were the cities of the West:

- First, to potentially chronic traffic congestion,
- Second, to massive investment in road infrastructures and car parks.

THREE OBSERVATIONS

In the light of this, 3 observations can be made:

- Observation 1: Once parking restrictions and, in particular, parking fees, rise beyond a certain level, most drivers stop using their cars and thereby adding to traffic levels.
- Observation 2: In urban areas and given equal passenger flows, urban freeways and car parks are several times less efficient than mass transit infrastructures, in terms both of investment costs and environmental quality. The savings can be estimated at more than US$4 billion per million inhabitants.
- Observation 3: In cities where car use is still low, most people aspire to own cars, a source of freedom to "come and go" and of social status. However, this non-car owning majority will clearly not have developed the habit of automobile use and is therefore unaffected by rises in parking charges.

A SOLUTION

In the light of these observations, there is one clear solution: as of now, before this inevitable explosion in car use occurs in emerging cities:

1. Parking charges should be set at a level that will provide a measured disincentive for certain uses of the car;
2. Cities should at the same time develop public transportation, along with other efficient alternative modes, depending on conditions, e.g. car sharing, bicycles and motorbikes, etc., in order to avoid the construction of urban freeways.

This solution has the major advantage of being politically acceptable. This is because:

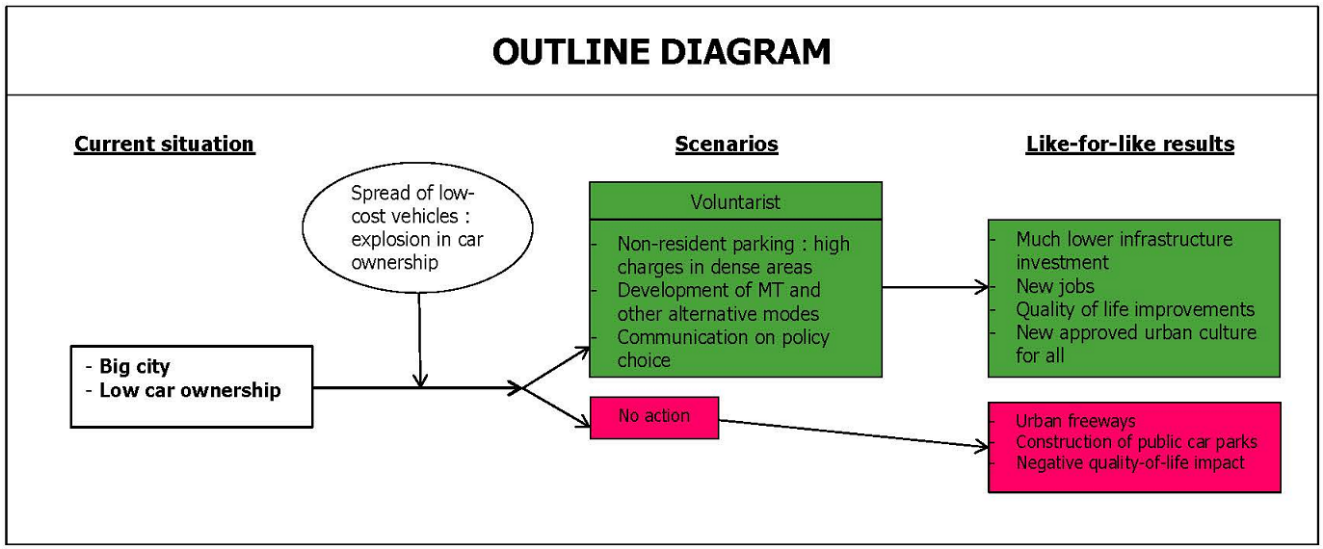
- It in no way affects the very powerful aspiration for car ownership, since it does not seek to increase the cost of car acquisition.
- Car use is not affected where appropriate, i.e. in low-density areas.
- Its introduction is not sudden: in fact, it can be very gradual both in terms of the rate of geographical expansion in pay parking areas and the pace of tariff increases.
- Finally, the advantages of such a policy are very easy to communicate:
  - The money saved on investment can be allocated to other, more important amenities: universities, hospitals…,

* It is only existing car owners, i.e. the most well-off, who will feel the effect.
* The majority of people will see rapid improvements in the quality of public transportation.
* The development of mass transit systems and the spread of roadside parking charges in central areas will generate significant employment, which is always popular: we can estimate some 3000 parking attendants per 100,000 pay spaces, and 8000 jobs per million inhabitants on public transit systems.
* It also offers an opportunity for highly effective public communication on environmental improvements and quality-of-life benefits.

In short, the message and approach need to be as follows:

"In view of the future explosion in car ownership, optimizing the economics and ecology of mobility in an emerging city urgently requires the enactment of a proactive policy of charges for parking in central areas, alongside the development of public transport. This will prevent massive waste in investment and significant environmental damage."

The next step is to begin experiments to test and refine this innovative approach.



1. INTRODUCTION

1.1. Foreword

Urban mobility has been a problem ever since cities have existed. In the course of time, solutions have been sought through a variety of approaches, in particular:

- In urban planning, there have been attempts to bring the workplace and housing closer together; the density of the urban fabric has also been increased to reduce travel distances, particularly around mass transit hubs. In the last few decades, many urban environments have been redesigned to encourage walking.
- Transportation methods themselves have become more diverse, and increasingly fast and efficient.
- Intermodal solutions have emerged and multimodal hubs with park-and-ride facilities have been created to accompany them.
- Finally, more and more measures to restrict car use are emerging: urban tolls, a cap on car parking capacity in private buildings…

The results have been spectacular: since Boileau's satire on the "Embarras de Paris", travel distances and speeds have exploded, whilst "time budgets" have remained relatively stable.

The innovation described below falls into the category of disincentives to private car use. It has a certain distinctiveness that directly reflects the nature of our design bureau: created 35 years ago, SARECO now employs around fifteen engineers, essentially working on the topic of "parking and mobility".

1.2. Genesis of the idea

The purpose of this paper is to outline a conviction that has been gradually acquired over the course of some twenty assessments, parking studies or research trips conducted by SARECO over the last dozen years. These took place in cities with low levels of car use, with populations of between 1 and 25 million.

Despite varying conditions, there were certain regular common denominators:

- Financial constraints on parking are low:
    - In many cases, roadside parking charges are a recent phenomenon: 2007 in Beirut, 2010 in Marrakesh, around 2005 in Shanghai (see photo),

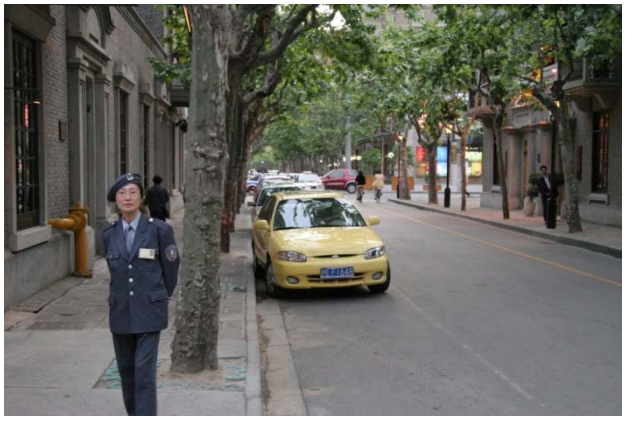


Photo 1 - In Shanghai, parking fees have been in existence since 2005

* In many cases, cities are still at the stage of informal "surveillance" by parking attendants who receive payments that are akin to a mix of tips and piece-time wages. This is true, for example, of Belém in Brazil (apart from 200 official pay spaces), and was also the case in Fez and Marrakesh in Morocco until the end of 2009…
* Parking charges are low relative to the cost of buying a running a private car, for example:
  - 5 or 10 Yuan per hour in Shanghai in 2011 (€0.6/h or €1.2/h, i.e. US$0.7 or US$1.5 per hour),
  - 1.5 Real per hour in Belém in 2009 (€0.6 or US$0.7 per hour),
  - a one-off payment of 5 to 15 Dirhams (€0.5 to €1.5, or US$0.6 to US$1.8) for a day's parking near Jama Lafna Square in Marrakesh.

- It is almost invariably assumed, by municipal authorities and users alike, that public car parks need to be built.
- Travel demand is on the rise, along with both population size and purchasing power.
- Road congestion is common and set to deteriorate in the future.
- The investment needed to meet spontaneous demand for private car journeys is enormous.

In response to these observations, an innovative solution for improving travel conditions in cities with low car use has gradually emerged, focusing on the reorganization of car parking arrangements and the development of public transportation. This solution will need to be accompanied by a change in the local mobility culture.

This new approach, presented below, is not a ready-made solution: there is much still to be refined or added.

In the rest of this paper, we successively set out:

- The principles of the recommended innovation
- A description of the main measures required
- An analysis of the possible political impact of these measures, in terms of public response.

2. ESSENTIALS OF THE INNOVATION

The urban travel solution described below has emerged gradually over the last few years, through the observation of 3 realities relating to:

- The respective efficiencies of the infrastructures required for private cars and for public transportation,
- The factors that influence the modal choice of car owners,
- The foundations of the aspiration to private car ownership.

2.1. Comparison of public transit and the private car

SARECO carried out research on the comparative costs of building mass automobile infrastructures and mass transit infrastructures. The findings of this research, which are given in the appendix, can be summarized as follows:

2.1.1. In investment terms

An analysis of the costs of infrastructure construction in France shows that, to transport the same number of people at peak times, the cost of 1 km of freeway is more than 7 times greater than that of 1 km of mass transit network, i.e. Regional Express Railway (RER), Subway, Tramway, BRT (bus rapid transit) (see appendix 1.2).

In consequence, in order to tackle structural growth in transport demand, the decision to focus on building public transportation networks accompanied by appropriate park-and-ride facilities, rather than freeways, generates very significant financial savings.

By way of example, the savings generated in Île-de-France were estimated by analysing an alternative scenario in which additional public transportation capacity was built to retain the same overall transport supply whilst eliminating 300 km of freeway. The resulting savings are in excess of €38 billion, i.e. more than €3.5 billion per million inhabitants (see appendix 1).[1]

The two scenarios considered are presented in the table below:

[1] US$4.25 billion at July 2012 values, or 250 million hours at France's minimum wage, including national insurance contributions.

Item	Current situation in Île de France	Alternative scenario that would have been possible (fewer freeways)
Length of the freeway network	454 km	154 km *additional mass-transit lines to offset 300 km of unbuilt freeways*
Daily journeys (in million km per day		
Public transportation	60 M km /d (38%)	70 M km /d (44%)
Car	100 M km /d (62%)	90 M km /d (56%) - *car parks not built in central zones* - *park-and-ride facilities created near mass transit stations*

This example in Île-de-France raises a number of points:

- The decision to retain a third of the freeways in the alternative scenario takes account of:
  - The necessity to provide for vehicles needing fast access to central zones: firefighters, ambulances, deliveries and other work-related travel…
  - A low level of demand from motorists whose choice of travel mode is not influenced by parking fees at their destination. This applies to destinations outside city centers and hubs: urban woodland, rural areas…
  - The need to provide for through traffic and to preserve an image of modernity, which would be undermined by a total absence of freeways.
- In the alternative scenario, the resulting reduction in car use remains broadly relative: the elimination of 300 km of freeway seems marginal given that 150 km of freeways, 330 km of national highways and 37,000 km of other roads remain (see para 1.3.1 in the appendix). This arises from the fact that there is a large non-freeway road network.

  As a result, it would seem that the potential benefit is directly linked with the density of the existing road network (in kilometers per million inhabitants), which constitutes a sort of reserve capacity for the development of both car and bus travel.
- In addition, urban density (the number of inhabitants per square kilometer) is a significant contributory factor in the efficiency of public transport, because it permits more "massive" and faster infrastructures.

On this question, it may be noted that average population density in Île-de-France is comparable to Beijing at close to 1000 people per square kilometer, and is fairly uniform:

- 20,000 people per square kilometer in Paris (pop. 2.2 million), comparable to Mumbai;
- 5000 to 8000 people per square kilometer in the inner suburbs (pop. 4.3 million);
- 500 people per square kilometer in the outer suburbs (pop. 5 million).

- In addition, there are urban concentrations in moderately dense areas which are particularly well suited to public transport. This is the case for very dense clusters (30 stories or more) around certain peripheral subway stations in Shanghai.

- Finally, it should be noted that the ratio of €3.5 billion[1] per million inhabitants will vary from one city to another, largely on account of labor costs, which have a major impact on infrastructure costs. However, the significance of this factor is only relative: the construction costs of other amenities (hospitals, universities…) and of construction in general will vary accordingly.

2.1.2. In operational terms

a) Comparative costs per passenger kilometer (pkm)

The cost per kilometer for a vehicle does not change in line with the number of travelers, so the price of the passenger kilometer (pkm) will depend directly on how many people are in the vehicle.

For private cars, the occupancy rate is fairly stable, which means that the price of the passenger kilometer is also stable. By contrast, for public transport, the occupancy rate and therefore the cost per passenger kilometer varies greatly between peak and off-peak times. An analysis of the costs of motor travel (excluding depreciation), set out in detail in the appendix (2.1), gave the following results:

- In Île-de-France, at peak times, the cost per passenger kilometer is lower for public transportation (€0.7 per pkm) than for private cars (€0.14).
- In Île-de-France, averaged over the year, the cost per passenger kilometer is higher for public transportation (€0.23) than for private cars (€0.14).
- In emerging countries, because of lower wages and a higher occupancy rate in public transportation, the situation is reversed with a cost of €0.14 per pkm for the car and around €0.11 per pkm for public transport.

  It seems likely that ultimately, in emerging countries, as living standards rise along with the expectations of mass transit users (greater frequency, less

[1] US$4.25 billion at July 2012 values, or 250 million hours at France's minimum wage, including national insurance.

overcrowding,…), the average unit cost of public transportation will catch up and overtake that of the private car, but the peak time cost will remain low.

b) The funding of mass transit operation

Traditionally, in France, mass transit operation is funded from passenger revenues, employers' contributions and public subsidies (financed from taxation).

In Île-de-France, the breakdown is: 40% from passenger revenues, 39% from the "transportation" levy on businesses and 21% from subsidies (source: Syndicat des transports de l'Île-de-France – S.T.I.F).

It can legitimately be hoped that with our innovative solution, public subsidies will be replaced by revenues from roadside parking charges, which will become very profitable through the use of incentive pricing measures (see appendix: section 2.2.2 – revenue from parking fees)

c) Other comparisons

The following points are noteworthy:

- No one disputes the environmental superiority of public transportation over the automobile.
- Firstly through the sharp reduction in the construction of freeways, despite their particular efficiency in terms of travel speed (70 km/h for optimum flow), and secondly through the creation of faster public transportation systems, it seems likely that the journey speeds of cars and public transportation will remain comparable, whereas in Île-de-France the car is faster than public transit.

  NB: It may be recalled that one of the stated objectives of the introduction of bus lanes in Paris in the 2000s was to increase the speed of buses to the detriment of car speeds.

- In terms of travel comfort, it must be acknowledged that the car is likely to remain more efficient: everyone is seated and overcrowding less frequent. This is consistent with the natural tendency of motorists to choose their cars (see 2.1.2 above).

  On the other hand, congestion and traffic jams, which have much less impact on public transit, remain an inconvenience that motorists intensely dislike, causing frustration and uncertainty about journey times.

2.1.3. Conclusion

It would seem that public transportation is financially more efficient, particularly in investment terms, since it removes the need to construct urban freeways, but also in terms of operation. The other comparative factors are broadly in balance.

2.2. The decision to travel by private car

2.2.1. Spontaneous choice

In principle, anyone with access to a car will almost always automatically use it for any journey they consider too long for walking. This behavior is largely emotional and reflects a number of attitudes – comfort, pleasure, efficiency – of which the user may be largely unaware. The remarks below illustrate and explain the why this spontaneous choice is made:

- When people get into their car at the end of a day's work, they already have a sense of being partly home;
- The car is more comfortable (there is always a seat) and faster than public transport, particularly on fast-moving urban freeways;
- The car is a powerful object that docilely obeys the driver's orders, in a world where people lead increasingly harassed and restrictive social and professional lives: it becomes a compensatory object.
- These factors lead motorists to systematically underestimate the time a car journey will take, which exacerbates the frustrations caused by congestion, breakdowns, the behavior of other drivers…
- These factors also lead them to ignore or underrate the costs associated with owning and using a car: purchase price, insurance, tires, oil change, repairs.
- Finally, a rise in car ownership initially causes a significant reduction in foot travel.

This leads to situations of the following kind:

- On the edges of the downtown areas of French provincial towns, even large ones (e.g. Bordeaux before the tram), in areas where parking is free and traffic not too much of a problem (30 minutes' journey or less), almost 85% of people drive to work: only those without a car or driving license use other means.
- In the Paris area, despite the quality of public transit, which can be more efficient than the car, levels of spontaneous car commuting can be as high as 70%.
- In a study conducted in Tunis in 1997, the "cultural" definition of the parking "needs" of an office building was the number of car-owning employees in that building.

2.2.2. The potential role of parking charges

On the other hand, above certain thresholds, in particular for parking fees, motorists stop using their cars:

Example 1: SARECO undertook research in the City of Westminster in London, where the official policy is to monitor roadside parking carefully and to raise charges until 15% of parking spaces remain unoccupied. Field trips showed that these targets for empty parking spaces were actually met.

The hourly parking charges associated with these targets can be as high as £4.40.

In parallel, the monthly cost of a rented parking space is around £700.

Example 2: The towers of La Défense in Paris cover some 80 ha, so this sector can be seen as fairly homogeneous in terms of public transit provision.

A survey conducted in each tower (minimum 25,000 m²), comprising a total of 650,000 m² of office floor space, reveals that employee parking demand varied by a factor of 5 between the tower with the lowest demand (4.8 subscribed spaces per 1000 m²) and the tower with the highest demand (26.1 subscribed spaces per 1000 m²), a difference largely explained by the availability or not of free staff parking.

Today, the rate of car use amongst workers at la Défense is below 15%. To rent a parking space costs €90 per month and the car parks are not full.

Example 3: In Paris, in the 1990s, levels of commuting by car were as follows:

- *In a high-status office building (10,000 m²) in the 7th arrondissement. This building had a private garage that was not fully used, and offered free parking for all personnel:* ***70 % of employees.***
- *Around this building, a district of ministries with few garages but numerous free roadside parking spaces:* ***21 % of employees.***
- *In the heart of Paris (arrondissements 1; 2; 3; 4), with roadside parking fees beyond the means of staff:* ***less than 5 % of employees.***

2.2.3. Conclusion

The examples cited above show that parking fees and restrictions are an extremely effective tool for limiting car travel to areas where they are applied.

It seems likely that in emerging countries, charges of €1.5 to €2 an hour will generate a very significant fall in private car use.

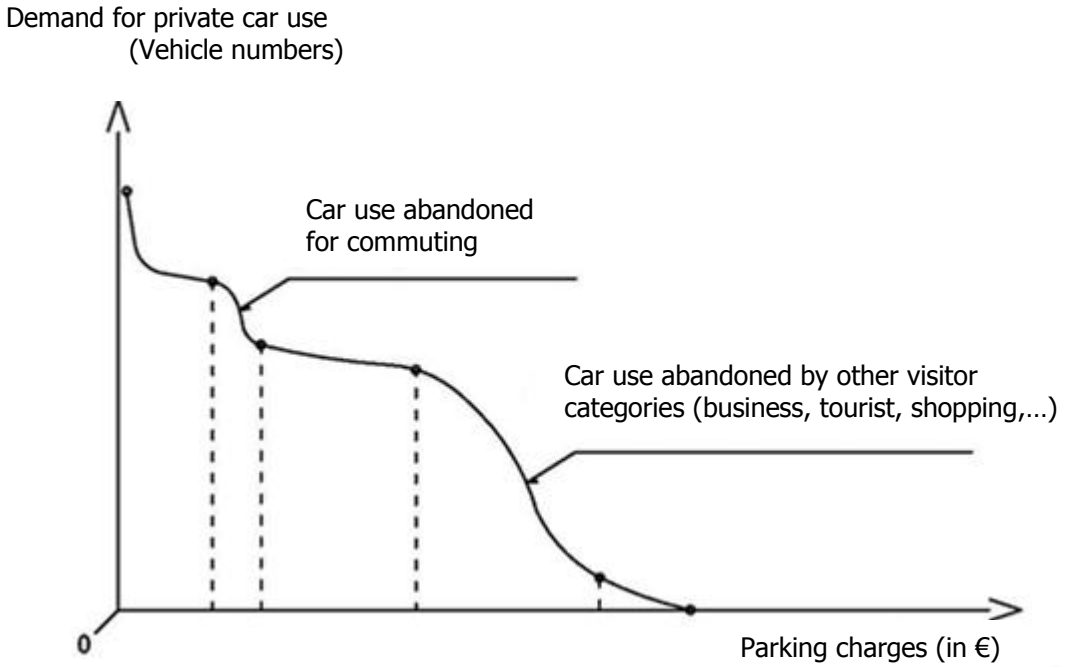
By way of example, the inset below shows a graph representing changes in car use in response to the introduction of parking fees.[1] This graph clearly demonstrates the critical influence of parking charges.

[1] NB: These graphs were established on the basis of research carried out in 1994 by SARECO for DRAST (the Infrastructure Ministry's Research and Scientific and Technical Affairs Department), on user responses to tariff changes. The link between travel demand and parking charges is analyzed more closely in the appendix (see appendix: 2.3-d).

USER SENSITIVITY TO PARKING CHARGES

Impact of parking charges on demand for private car use

(in a conurbation)



This graph suggests that parking fees operate in thresholds. There are relatively flat sections where users are largely indifferent to the fee, and steep sections where certain categories disappear.

Commuters are the most sensitive category: in France, they are prepared to pay up to €3 a day, and start to draw the line when the charge goes above that level.

The users who accept the highest charges are people traveling for "business". In France, these fees can be up to €30 a day in TGV station or airport car parks.

In certain places, such fees can be very high: $14 per hour in Chicago in 2008.

2.3. The decision to buy a car

The decision to buy a car is governed partly by the desire for freedom, and partly by the quest for identity and social status.

2.3.1. The freedom to come and go

Owning a car means having the freedom to use it for any journey at any time; this is particularly important at times when public transportation is poor (at night…). The

association with "freedom" (to come and go) instantly places a very high value on the aspiration for car ownership.

2.3.2. Social status and identity

- Owning a car or – even better – "a nice car", is frequently a factor of social status, especially in urban contexts where car ownership is low:the privileged few…
- Owners often lavish special attention on their cars, buying accessories, regular washing, minor maintenance,…

2.3.3. Consequences

People who are not yet car owners have no culture of car use: this means that they are unaware of the behavioral factors outlined above, which govern the decision to use the car, and **in particular of parking charges** (which they are likely not to know). However, they still aspire to own a car. This has the following consequences:

- First, it is politically much easier to increase parking charges when only a minority of the population is affected, especially when these charges (€1.5 per hour…) remain consistent with the often high price of car purchase.
- And second, there is no reason why an increase in parking charges should affect car purchase, since the aspirations that drive potential buyers belonging to a different emotive register.

2.4. Conclusion

We previously noted that:

- Constructing efficient public transportation instead of urban freeways to meet growing travel demand within a **conurbation, produces very significant gains in investment (more than €3.5 billion per million inhabitants),[1] as well in operating costs.**
- Parking tariffs are a very effective tool for converting demand for car travel into demand for public transportation.
- Politically, the immediate introduction of stringent parking charges will have a minimal effect on the population and will not disrupt the demand for ownership of private cars.

Given these facts, there are very obvious benefits in the immediate introduction of strict parking policies in emerging cities, accompanied by a program to develop public transit systems.

[1] US$4.25 billion at July 2012 values, or 250 million hours at France's minimum wage, including national insurance.

3. PROPOSED SOLUTION

There are 3 elements to the action plan for introducing this solution:

- Development of alternative modes,
- Management of private car use,
- Communication.

3.1. Development of alternative modes

3.1.1. Public transportation

The aim here is to develop an efficient "mass transit" network: BRT, Tramway, Subway, Regional Express Railway (RER). A particularly effective starting point is to introduce dedicated bus lanes on roads used by cars (for parking or travel), which is both consistent with the goal of restricting car use and very inexpensive. Similarly, in cities that are already highly congested, the development of dedicated bus lanes on urban freeways should quickly improve traffic flows.

This measure comes first because it is the priority. It constitutes the base level of motorized transportation needed to tackle the growth in structural demand for mobility within the city, whilst controlling car use, in order to restrict the construction of urban freeways. However, it is not part of our remit to propose ways of optimizing the design of a city's public transit network.

Nonetheless, it is worth emphasizing the importance of establishing appropriate park-and-ride facilities to optimize the use of the public transportation network. One example is Île-de-France, with its 100,000 park-and-ride spaces, compared with the stations on the regional rail network.

NB: It should also be pointed out that park-and-ride facilities can generate urban sprawl. SARECO is currently studying this issue in collaboration with PREDIT. One of the ideas for preventing residential development around cities is to provide preferential pricing in certain park-and-ride centers for people who live less than a certain distance from the station.

3.1.2. Other transportation modes

These include pedal bikes and motorcycles, car sharing, carpools, communal taxi schemes… In quantitative terms, they currently play a minor role, but their advantage is that their image has greater public appeal than public transport. In our view, they should be explored on a case-by-case basis, with reference to the local culture, which can vary from one continent to another. For example:

- Bicycle use in the Far East is exploding and "family" ownership of a car, a form of car sharing, seems to be a culturally acceptable practice.

  Example: Hangzhou in China has an extensive network of self-service pedal cycles: 50,000 bicycles, 2000 docking stations (see photos).

Photo 2 – Self-service bicycles in Hangzhou, China

- In Africa, the development of communal taxis augurs well for the future of "carpools".
- Eastern Europe has a very well-developed "tram" and "subway" culture, and "other mode" solutions could be pursued for access to the mass-transit stations. More generally, in all cities where car use is low, there will be benefits in promoting other modes (given the "absence" of cars) of access to the mass-transit hubs in order to optimize the network.
- Walking is still a significant means of short distance travel and undoubtedly needs to be encouraged.

In any case, the potential of these "other modes" should not be underestimated, because they have one enormous advantage over the car, in a context where the aim is to limit car use: the measures used to develop them involve incentives rather than restrictions.

3.2. Management of car use

Our experience leads us to believe that parking fees are particularly effective in limiting private car use. There are also other measures that could further improve the system.

3.2.1. A pattern-changing parking policy

The main components of such a policy are as follows:

a) Parking fees for roadside parking

- Urban areas concerned

  Ultimately, it may be that roadside parking charges will be imposed in all busy areas – shopping streets, business centers, dense zones – within a city. In addition, there should be a degree of parking control around such areas, with measures such as resident-only parking, long-stay parking with charges by the day…, so that no one travelling to the area by car can escape paying.

  However, this policy will be introduced gradually by steadily expanding the pay areas on the basis of results (see section d) below: travel surveys). In fact, it is the effectiveness of the balance between the size of the pay zones, traffic congestion

and public transit development that will determine the efficacy of the system, preventing:

- The construction of unnecessary freeways,
- The construction of non-essential public transportation to meet travel demand. This could occur if excessive parking fees generate reserve parking capacity in the street network as people abandon car use.

- Setting the right tariff levels
  - First of all, given that the behavior of car users varies depending on their reasons for travel,[1] there will need to be different tariffs for different user categories:
  - Hourly fees for visitors in major shopping streets,
  - Daily rates for commuters,
  - Low preferential rates for residents or else streets with resident-only parking. Residents should not be dissuaded from buying a car because they find it impossible to park near where they live. Moreover, excessively high roadside parking fees for residents encourages people to drive to work in order to avoid the parking fee, thereby increasing car use.
  - Otherwise, the goal should be to start with parking charges that are as high as possible while still acceptable to motorists. Communication campaigns (see para 3.3 below) will have an important role to play in this respect. Subsequently, these rates will need to rise faster than inflation to reach a satisfactory level, e.g. €1 or €2 (US$1.2 or US$2.5) per hour.

  NB: The target of achieving an inoccupancy rate for parking spaces of at least 15%, as in central London, seems technically appropriate: this will eliminate additional congestion caused by drivers looking for a parking space.

  - Finally, the charging periods will need to cover the morning and evening peak travel times, but will depend very largely on local conditions.

    <u>Example</u>: parking up to 11 pm, seven days a week, for outdoor car parks serving the areas around Jamal Lafna Square in Marrakesh: this square is particularly busy in the evenings, since numerous food outlets set up at around 5 pm every day, catering to around 1000 people.

- Parking controls

  Parking attendants constitute a particularly good solution for many emerging cities:

[1] In an emerging city, no worker will pay €0.5 per hour to park for 12 hours a day, whereas €0.5 per hour is generally acceptable for a visitor.

- This method of control is already very widespread: we have seen it in Morocco and Sub-Saharan Africa, in Brazil (Belém), in Shanghai in China…
- It generates jobs: 600 to 800 jobs per 10,000 short-stay parking spaces and 200 to 300 jobs for 10,000 long-stay parking spaces.
- It provides a better service and commands a very high level of compliance: this minimizes enforcement measures, which are always unpopular.

  As regards enforcement, the Denver boot (wheel-clamping) has proved an effective solution in cities as various as Tunis, Marrakesh, Amsterdam and London.

b) Off-road public car parks

In an emerging city, off-road public car parks serving the local district will only be needed if available roadside parking is occupied, despite strict charging. In principle, given the low level of car ownership in such cities, this should be very infrequent. This remark does not apply to shopping center car parks, which are actually "private" garages provided for customers (see below c): "private garages").

NB: In France, hundreds of off-road public car parks were built with capacity exceeding the demand from visitors to the district. This led to a policy of low parking fees for people working in the district which, by the law of unintended consequences, generated significant additional traffic.

Similar outcomes are found in emerging cities, e.g. the Kasbah car park in Tunis, or the Place du 7 Novembre car park in Marrakesh.

c) Private garages

These are garages built in apartment buildings built to provide parking for their occupants. It is essential to control this trend through regulation, by prescribing minimum and <u>maximum</u> thresholds for parking capacity in future buildings.

The aim of these should be, in particular:

- For residential buildings: To ensure that their capacity is consistent with the predicted rate of car ownership amongst their residents.
- For office buildings: To set standards that put a ceiling on the level of automobile use for commuting; the existence of garages in office buildings encourages commuting by car.

  <u>Example</u>: In the 7th arrondissement of Paris, the proportion of car commuting was 70% for employees in an office building with a large private garage, as compared with 20% on average for workers in the area around.
- For shopping centers: Provide capacity that is consistent with the predicted number of paying customers. In emerging cities, we find well-used shopping center car parks where users pay to park:
  - In the center of Cairo (H.S.I. district),

* In Belém: the downtown Iguatemi shopping center. It should also be noted (see photo), that this shopping center can also be accessed by public transportation.

Photo 3 - In Belém, the Iguatemi shopping center is served by numerous bus lines

These shopping centers are often an important "driver" of urban development.

NB:

Studies by SARECO on the parking generated by shopping centers have shown that car use for shopping in these places diminished substantially:

- *If there was good public transit provision: e.g. several subway lines;*
- *In circumstances of high residential density: 30-story tower blocks.*

More generally, it is important to remember that urbanization policy strongly influences both the need for parking infrastructures and levels of car traffic. Constructing very dense urban hubs with extremely good public transit provision – 2 subway/express railway lines or more – is a very effective way of reducing car journeys/parking.

d) Travel and parking surveys

These kinds of survey are used to generate figures, using the same method each time to facilitate year-on-year comparison, which describe different aspects of transport use:

- Capacities, overloads and reserve capacity of traffic infrastructures, mass-transit systems and parking provision,
- Certain additional figures, in particular relating to parking: revenues, compliance with regulations, level of enforcement, time needed to find a free roadside parking space…

Such surveys have existed for many years, and experience shows that they are an indispensable tool for fine-tuning strategies such as achieving a balance between public transportation and car use, the topic of this article.

3.2.2. Other measures

In addition to reducing car use through rigorous parking policy, possible additional measures, depending on political context and likely public response, include:

- Increasing the cost of car use,
- Restricting ownership of private cars.

a) Increasing the cost of use

In our view, the most effective measures in this respect are:

- Raising the price of fuel. This measure is effective because it has an immediate impact on motorists, and in particular because it affects all car journeys, whether to employment hubs (the focus of this study) or other destinations.
- Taxing car insurance for "commuting" and perhaps removing tax on car insurance for "leisure" purposes. These measures have the advantage of being well targeted: they are a disincentive to car use for commuting and at the same time an incentive to car ownership.
- Urban tolls and automobile restrictions in certain zones are already widely practiced (London, Singapore, numerous Italian downtown zones…) and well proven. The disadvantage is that they are expensive to implement.

b) Restricting car ownership

This measure deserves mention, because it has been successfully applied, first in Singapore for more than 20 years with auctions for the right to buy a car, then more recently in Shanghai through car-plate auctions. It has just been introduced in Beijing through a lottery system.

These policies are in no way in contradiction with the measures to reduce car use outlined above. However, they are politically harder to sell, and run counter to the development of the automobile industry in the countries concerned.

NB: with sales tax on cars at 33% until the 1980s, France in fact placed (slight) restrictions on access to car ownership.

3.3. Communication

The measures outlined above need to be backed by communication at 2 levels:

3.3.1. Information on roadside parking rules

Insofar as this approach entails new roadside parking rules, with penalties for non-compliance, it is clear that motorists need to receive effective information on their rights and obligations. This is important but will not pose major problems:

- It is enough to provide effective signage both by and on the road,
- Parking attendants can be very helpful as information providers.

3.3.2. Communicating about the policy

Broadly speaking, nearly all parking policies suffer from poor communication with users and other stakeholders such as local politicians, shopkeepers, operational staff…

What is proposed here is an innovative travel policy that seeks to change the culture of car use and the spontaneous behavior of motorists. In these circumstances, it is essential to persuade users through effective communication. This will have two main goals:

- To explain the purpose of the measures taken. If they are to accept targeted charging for roadside parking, a space seen as costing nothing, users must not perceive the introduction of these charges as a way of "making money".
- To convince: No one has ever been overcome by the aesthetics of a transportation policy, but everyone can believe in a City Masterplan. It is **therefore important that this Plan should be effectively promoted through credible communication on the links between transportation policy and the City Masterplan**.

3.4. Expected results

3.4.1. General case

- First of all, there will be significant savings – more than €3.5 billion per million inhabitants – on the construction of transportation infrastructures,[1] and a reduction of perhaps some 20% in operating costs, for mass transit journeys as compared with car journeys (€0.11 pkm by public transportation, as against €0.14 pkm by car: see appendix, para 2.1.2).

Important remark: Emerging countries already have numerous big cities. Moreover, most of them are facing situations of intense urbanization arising from the rural exodus and also, in certain cases, from rapid population growth. This means that, for many countries, the financial benefit from the proposed solution will be measured in hundreds of billions of euros, which may be a far from negligible proportion of aggregates such as GDP.

[1] US$4.25 billion at July 2012 values, or 250 million hours at France's minimum wage, including national insurance.

- The policy will also generate large numbers of jobs. Ultimately, it will require some 8000 jobs per million inhabitants to run the public transit systems, and in the shorter term 3000 jobs per 100,000 pay parking spaces. In fact, the introduction of roadside parking charges will need to be quick to restrict the growth in demand for car traffic.

  The role of the public transportation system will then be to absorb, by gradually raising capacity, the structural increase in demand for transport associated with economic development and population growth.

- Finally, the following environmental benefits can be anticipated:
  - A reduction in greenhouse gas and dust emissions, with the associated impact on public comfort and health;
  - The elimination of obstructions to sidewalks, pedestrian crossings, etc. caused by parking in downtown areas;
  - A reduction in road traffic accidents;
  - Better transportation services.

3.4.2. Emerging cities with high levels of traffic congestion

In cities where traffic congestion already exists, the proposed solution will very quickly improve traffic flows by reducing the level of automobile use and the time needed to find a parking space.

These improved driving conditions will make life better for motorists but, because of the high cost of parking, will not increase their numbers.

3.4.3. Short implementation timescales

Where there is reserve capacity in public transportation systems, or the possibility of rapidly increasing mass-transit provision, for example by creating bus lanes on existing roads, charges for roadside parking can be introduced in under a year. The same is true for increases to parking charges.

4. A POLITICALLY ACCEPTABLE SOLUTION

There is no doubt that car owners are not going to welcome restrictions on car use.

Given that the governing classes in emerging cities are generally car owners, that does not bode well for the introduction of this solution, because they will be directly affected. In fact, we have encountered this personal reluctance amongst the urban leaders in the course of our research. This is the main obstacle to the introduction of the policy.

However, that is not a reason to abandon measures that hold out so much promise.

First of all, there are many examples of restrictive car policies that have actually been applied, with no particular negative effects. For instance:

- The city of London, already mentioned: parking fees of £4.40 an hour and urban tolls (congestion charging) for automobile access to the city.
- The city of Shanghai, which for the last 10 years or so has required people to pay for the right to own a car.
- The city of Kiev, where the roadside parking fee collected by parking attendants was 10 Hryvnia (€1.5) per hour in 2007, up from 4 Hryvnia (€0.6) per hour in 2003. In the same city, the charges at the downtown Arena car park were 20 UAH (€3) an hour.

Moreover, there are numerous arguments that can contribute to public acceptance.

4.1. No threat to car ownership

At no point has this paper suggested the need to discourage car ownership. On the contrary:

- It emphasizes the importance of preferential measures for residents, so that vehicle owners can easily park near where they live: reduced parking fees, resident-only parking,…
- Even measures to promote car ownership could remain consistent with restricting their use, e.g. reduced sales tax on the cheapest models or/and on insurance for "leisure" use.

4.2. A gradual solution

One of the advantages of roadside parking charges is that they can be introduced as gradually as one wants, both in terms of how quickly pay parking areas are expanded and and of the rate of increase in charges.

Travel surveys are an essential tool for optimizing this gradualist approach.

4.3. Limited restriction on use

The main goal is to reduce the construction of urban freeways by a factor of 3 or 4. If we look at the entire highway network within a city, the reduction in car journeys arising from the non-construction of freeways remains small relative to total demand.

For example: In the Île-de-France scenario outlined previously, 300 km of freeways are not built, but 150 km remain, along with 330 km of busy national highways and 37,000 km of other roads.

The proportion of automobile use remains high, but the culture of use changes: a shift to driving at evening and off-peak times, to public transit for access to downtown areas, possibly an intermodal transition from the car to mass transit via park-and-ride facilities.

4.4. Only a minority affected

By definition, our solution is designed for cities with low levels of car ownership. This means that only a minority of the population will be affected by the parking restrictions, whereas everyone will see the positive impact of improved public transit provisions.

In addition, it is the well-heeled minority that will be affected, the group most materially able to bear the restrictions.

Finally, to promote social equity, a dual-level charging system could be established when car ownership increases:

- The basic charge, already a disincentive (€1.5 to €2 per hour) will be retained for low-cost vehicles.
- A second, higher rate could be set for more expensive vehicles.

4.5. A politically acceptable solution

All the features of acceptability outlined above, along with the outcomes (expected then achieved) set out in para 3.4, can be effectively sold to the public, because they give a positive image of the measures.

Example: The introduction of separate women's and "mixed" cars on Rio de Janeiro's subway network at peak travel times is a measure that is easy to promote, since it demonstrates the desire for good service quality (see photo).

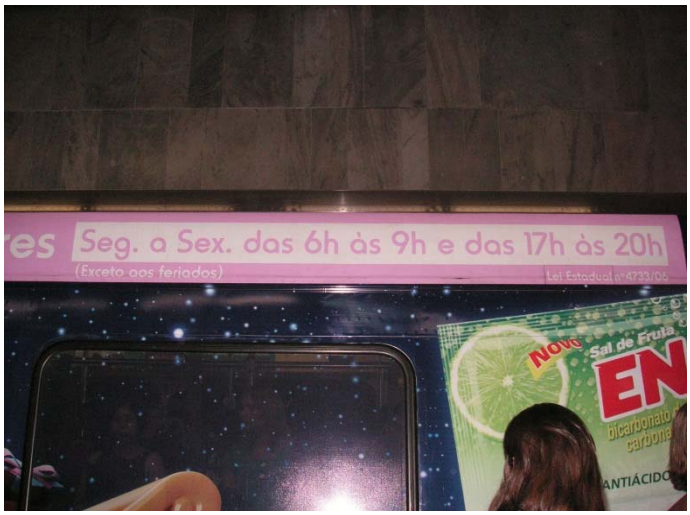


Photo 4 - During peak hours in Rio, passenger safety is enhanced by separate subway cars for men and women

The quality of these communication campaigns is a very important factor for a successful shift in mobility culture as advanced in this proposal.

APPENDIX

TRANSPORTATION INFRASTRUCTURES – RATIOS AND SCALES

1. INVESTMENT

1.1. Summary table

An idea of the scale of investment needed to provide peak time urban transportation for 1000 people per hour is given in the table below, for the different public transit modes employed.

Investment required to transport

1000 passengers per hour in each direction

Travel mode	Private vehicles – Four-lane freeway (2x2)	Tramway	Subway	Regional Express Railway
1: Peak flows in each direction (passengers per hour)	5,300	10,000	30,000	50,000
2: Investment per km (€ million)	108(1)	18.5(2)	55(2)	75 (2)
Source	Setra financial assessment of national assets in 2007 Île-de-France urban freeway	Sandrine DARCIS – Course at ENSTA (higher National School of advanced techniques) - 2009		
Result: Investment per km for one-way flows of 1000 passengers per hour (€ million)	20.3	1.85	1.83	1.5

1) This does not include the construction costs of the destination car parks required, since these are marginal though not insignificant (some 10% of freeway investment). The price of the vehicles has not been included, on the grounds that they are financed by motorists essentially to fulfill their aspirations for car ownership: see para 1.3 below.

2) Rolling stock has been included in the investment on the basis of operating speeds of 20 km/h for trams, 30 km/h for subways and 50 km/h for regional express railways.
Rolling stock capacity is based on the assumption of full capacity operation in both directions in central areas at peak times.

On the basis of the table above, we can conclude that the construction of a four-lane freeway costs from 10.8 – 12.3 times as much as that of a mass transit infrastructure.

The hourly cost per direction and per 1000 passengers of establishing a BRT (bus rapid transit) lane, which is not included above, should be much lower, since:

- They generally use existing roads (as do many trams),
- They do not require rails or a power supply.

BRT is a mass transit solution that is often a very effective starting point for emerging cities.

This means that if BRT is included in the comparison of construction costs between freeways and mass transit systems, the gap is likely to be even bigger, with a median point somewhere in the region of 12.

Finally, it should be acknowledged that the range of differences shown above is not very precise. This is because infrastructure costs vary very substantially from one place to another, both upward and downward:

Example 1*: The cost price per kilometer of the Paris Beltway (Boulevard périphérique), completed in 1974, was well below the €108 million (2007 values) estimated in the SETRA assessments, at around half, although it is difficult to set a precise figure (a gap of more than 30 years and 8 lanes – 4 in each direction – on most of the beltway).*

This price differential is explained, in particular, by the relatively small number of bridges and tunnels and by the road's location on the Paris fortifications, which simplified both the design and construction processes.

Example 2*: The final, 11 km, four-lane section of the A86 freeway, completed in 2010, cost much more, at €200 million per kilometer, largely because it is completely underground.*

In consequence, given the uncertainties about the accuracy of these cost estimates, we propose to reduce the estimated difference between freeways infrastructure costs and mass transit infrastructure costs **to a factor of 7**.

1.2. Estimate of possible investment savings

1.2.1. Background

Our baseline was the specific case of Île-de-France, taken from the following sources: EGT (global transport survey) 2001, STIF, DIRIF.

Île-de-France currently has a population of 11 million and a transport infrastructure comprising:

- 454 km of freeways,
- 336 km of national highways,
- 36,000 km of other roads and streets.

Motorized passenger transportation represents 60 million kilometers a day by public transit and 100 million kilometers a day by car (driver and passengers), i.e. 82 million vehicle kilometers with around 1.20 people per automobile.

Below, we assess the infrastructure cost savings in a scenario in which two-thirds of the 454 km of freeways are replaced by public transit infrastructures.

1.2.2. Estimated savings

Some of Île-de-France's freeways are four-lane highways (2 lanes in each direction), but many have six or eight lanes (beltway, A86 freeway, radial freeways,…). We therefore assume that the average freeway in Île-de-France has six lanes.

In consequence, the decision not to build 300 km of six-lane freeways can be seen as the equivalent, in terms of savings, of not constructing:

$$300 \text{ x } \frac{3\,\text{lanes}}{2\,\text{lanes}} \text{ x } 0.85 = 380\,\text{km of } 4\text{-lane freeways}$$

The coefficient of 0.85 is applied to reflect the economies of scale arising from the construction of a wider freeway.

Given the previously defined gain ratio of 7, and a cost of €108 million per kilometer at 2007 values for freeway infrastructures (see para 1.3 above), the reduction in investment in the Paris region for the non-construction of two-thirds of the freeway infrastructures and their replacement by mass transit infrastructures would have been:

$$108 \times 380 \times \frac{(7-1)}{7} \times 1.1 = €38.7 \text{ billion (2012)}$$

Cost of 1 km 4 lanes	Freeways not built (4 lanes)	Financial gain ratio	Inclusion of inflation 2007-2012

i.e.

$$\frac{38.7}{11} = €3.5 \text{ billion per million inhabitants at 2012 values. P}$$

This actually understates the real differences, given the use of a value of 7 for the gain ratio (rather than 12 as suggested by the chart), especially as it does not include savings on the building of car parks in central areas, which represent some 10% of the cost of the unbuilt freeways.

2. OPERATION

2.1. Comparison of the costs of a 1 km journey by automobile and by mass transit

2.1.1. Automobile

a) Sources and assumptions

Most of the results reproduced below come from a study carried out by Beauvais-Consultants in February 2012 on behalf of FNAUT (National Federation of Transport User Associations).

In the estimate of car costs below, the following items have not been included:

- TIPP (French tax on fuel products that represents 55% of the selling price), which is not a real cost since it generates government revenue.
- The cost to users of urban parking and tolls, because they generate revenue elsewhere. Conversely, potential revenues from parking are considered, since they may cover part of the costs of implementing transportation policy: see para 2.2.2 below.
- The purchase price of vehicles and any associated financial costs: this is consistent with the statement that patterns of vehicle use are relatively independent of the user's reasons for buying the vehicle (see main text paras 2.1 and 2.3).
- The part of the Beauvais-Consultants study used relates only to journeys of less than 80 km, in order to be properly representative of urban transport.

  This study is based on 2009 statistics, a period when a liter of gas cost €1 for diesel and €1.21 for Super 95. As a result, the fuel budget (excluding TIPP) set out below has been raised by a factor of 1.25, given that it is unlikely that gas prices will fall in the future.

b) Results

The 2009 budget corresponding to private car journeys of less than 80 km is as follows:

Fuel (revalued), (excluding TIPP)	€14,680 million
Non-marginal variable costs: (lubricants, parts and accessories, maintenance, repairs…)	€41,742 million
Fixed costs: insurance	€4,473 million
	€60,895 million

Millions of passenger kilometers, including passengers, corresponding to this budget: 438,183 million pkm

Cost per passenger kilometer: €0.14

This figure does not include direct personnel costs (chauffeur driven vehicles are not included) and is therefore valid for emerging countries.

2.1.2. Public transit

The costs below are taken from the annual statistics of the RATP (independent Parisian transportation board) for 2008. The data are as follows:

- Operating cost in € million, including €2,283 million in personnel costs: €3,491 million

- Annual traffic in millions of passenger kilometers (pkm): 15,347 million

  Subway: 7,318 million pkm

  RER (regional express rail) A + B : 5,020 million pkm

  Surface transportation: 3,009 million pkm

- Available provision: 62.5 million pkm

  Base: 4 people per square meter

  Breakdown between subway, RER and surface transportation, similar to passenger traffic.

This gives the following figures:

- Cost per passenger kilometer at peak times:

  On the assumption that mass-transit vehicles are 80% full at peak times (95% in central areas and 65% in the outskirts), the cost at these times will be:

$$\frac{\text{Annual operating cost}}{\text{Annual provision x } 0.8} = \frac{€3{,}491 \text{ million}}{(62{,}500 \text{ million pkm}) \text{ x } 0.8}$$

  i.e. €0.07 per pkm

- Average cost per passenger kilometer:

  In the case of the RATP, we have:

$$\text{Average cost} = \frac{€3{,}491 \text{ million}}{€15{,}347 \text{ million pkm}} = €0.227 \text{ per pkm}$$

  NB: The cost per pkm provided by the RATP is significantly higher than the costs found in other European transportation companies. This reinforces our comparison between the car and mass-transit, since the cost per kilometer in a car remains relatively stable.

In the case of many emerging countries, personnel costs can reasonably be divided by 5, giving:

$$\text{Average cost} = \frac{€3{,}491 \text{ million} - 4/5\ (€2{,}283 \text{ million})}{€15{,}347 \text{ million pkm}} = €0.11 \text{ per pkm}$$

Obviously, this figure will vary from one country to another, depending on living standards. Indeed, in practice, the cost of mass-transit in emerging cities should be significantly below this, because their use of capacity in off-peak times is much higher than for the RATP.

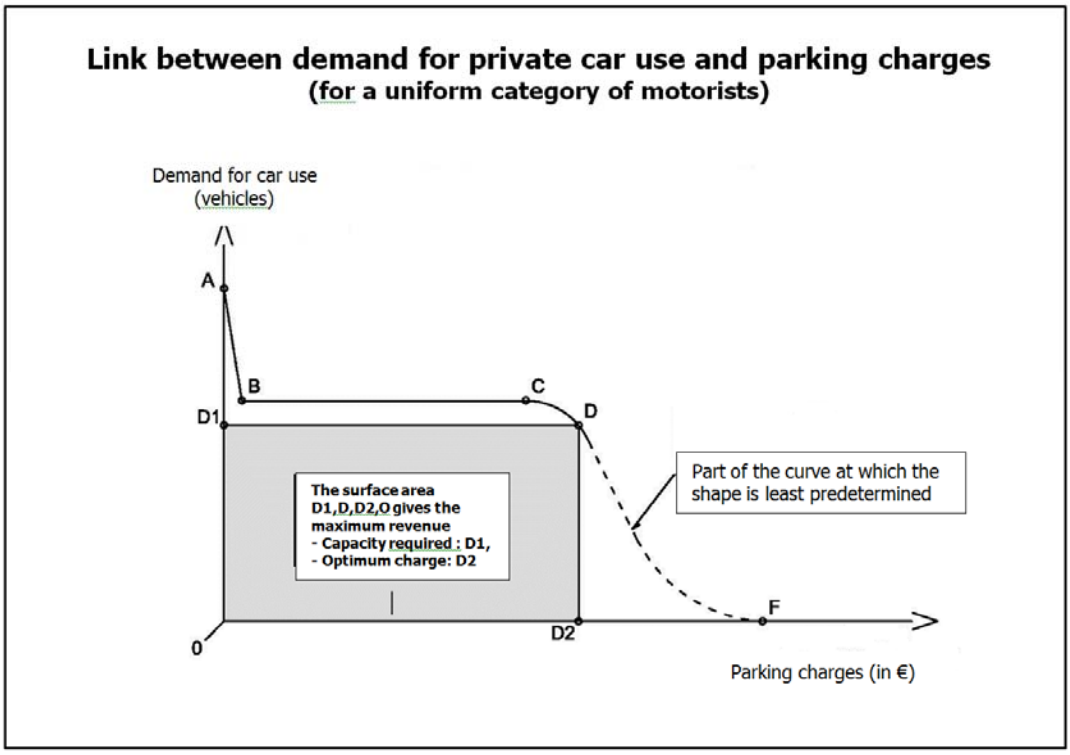
2.1.3. Conclusion

In cities, the average cost price per passenger kilometer is generally significantly lower in public transportation than in the private car.

2.2. The impact of parking fees

2.2.1. Preface

For a uniform category of users, the curve representing user responses to tariff changes always looks the same (see below). The shape of this curve was established in research carried out by SARECO for DRAST (Department of Research and Scientific and Technical Affairs, at the French Ministry of Infrastructure) in 1994.



In this graph, the demand for private car use is shown on the Y axis and the parking fee on the X axis. It may be interpreted as follows:

- Initially (point A) parking is free and demand is at its maximum.

  E.g. for people driving to work, and in the absence of other constraints (traffic congestion…), the rate of car use for commuting with a free parking space on arrival is some 85% on the edge of downtown in France's big provincial cities.

  This suggests that as soon as parking charges are introduced in an emerging city, there could be a fall in demand for automobile use that can easily be met by buses using (part) of the roads released by the absent cars.

- Next, as soon as they have to pay to park, a certain number of users reject parking fees "on principle" and choose another method of travel. This takes us to point B.

- If the charge continues to rise, users prove virtually indifferent to the price and pay without thinking; we get to point C with no significant change in demand. The length of this flat zone and the position of point C depend mainly on the category of users and the local "culture" in the destination area: how long parking charges have been in place, urban density, standard of living…

  NB: In Nantes, the roadside parking fee for visitors was in this indifference zone: before point C. An interview survey showed that only 25% of roadside parking users actually knew how much they were paying. This is a sign of people's indifference to parking charges when they are not high.

  The users who accept the highest charges are business travelers: in France, they may pay up to €30 a day in car parks at TGV stations or airports.

  In France, people who drive to work are at present prepared to pay up to 3 euros a day without changing their habits.

  In certain places, parking charges can be very high, e.g. $14 an hour in Chicago in 2008 (more than €10).

  It is likely that, in emerging countries, hourly charges of €1.5 to €2 will generate a significant reduction in demand by car owning visitors.

- The charges situated beyond point D arise:

  * Either from decisions by municipal authorities seeking to restrict demand: this is probably the case of the monthly rate of €90 at the la Défense business center in Paris, where the level of car use for commuting has fallen below 15%.

  * Or from operators who have other, more lucrative customers: a parking space rented for €150 or €200 a month earns less than a space charged at €3.5 per hour, which are the fees in the center of Paris: this explains the sub 5% rate

of car commuting in downtown Paris: public car parks no longer offer monthly rental spaces, since visitor demand is on the rise.

These low levels show that the demand for private car use can fall very low if parking charges are sufficiently high.

2.2.2. Scale of revenues from roadside parking fees

From observations in western cities with high levels of car ownership, it is reasonable to assume that, in emerging cities, **in the long run, when car ownership reaches maturity**, a ratio of 10 rotating spaces per 1000 inhabitants would be a satisfactory estimate of effective short-term demand.

This calculation excludes:

- Long-stay roadside parking charges (for residents and employees). These tariffs are lower, in particular for residents. We can assume that revenues will cover expenditure, without generating profit.
- Revenues from parking penalties, which will cover the cost of enforcement without generating margins – this means that all that needs to be done is to set the level of parking fines, cover the fitting and removal of Denver boots…

We therefore arrive at the following estimates:

- 10,000 parking spaces per million inhabitants,
- 1,500 to 2,000 hours of charges per space per year (depending on timetables), i.e. €2,200 to €3,000 per space per year, from a charge ultimately of €1.5 per hour.

  NB: This figure may seem high, but it is not unusual with parking attendants.

- One parking attendant can effectively patrol 20 parking spaces.

  For these 20 spaces, the approximate cost will be €6,500 a year:

  * To pay a reasonable wage and management costs, including social security contributions, for the parking attendant to patrol these spaces: €500 per month, i.e. €6,000 a year.
  * To cover the cost of signage and equipment (attendant's PDA with printer) over 7 or 8 years: investment of €3,000 for 20 spaces, i.e. €400 per year.

- The revenue from 20 spaces will be €44,000 to €60,000, i.e. an annual profit of €37,500 to €53,500, in other words €2,000 per space per year, €20 million per million inhabitants per year.

  This amount will not be enough to cover the operating costs of mass transit systems, but it is nevertheless far from insignificant – in some cases, it could

ultimately represent between 10% and 30% of public transportation operating costs.

The figures above are based on a broad picture and should be treated with caution: the amounts will vary very significantly from one city to another, depending on local living standards.