RE-EXPLORING SOME REASONS OF THE LOW CAPACITY VEHICLES SUCCESS IN PUBLIC TRANSPORT PRODUCTION IN DEVELOPING CITIES

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Abstract

One observes an important role or even a domination of low capacity vehicles (minibus, shared taxi, motorcycle taxi) satisfying the public transport demand in many cities in the world. This paper which is focused mainly on the African experience proposes to explain this success which is contrary to the dominant thinking of international experts influenced by the model of large companies in the developed world. One explores three points of view: the operator, the user and the community. It appears that the operator and the user can find an advantage to use such small vehicles as the community should be sensitive to the negative externalities (congestion, pollution). But even for the community there can be a favourable argument which is the important effect on employment.

Finally one needs to manage urban transport systems made of many components including various types of low capacity vehicles. This reinforces the need of institutions in charge of managing and regulating the whole system.

Keywords: Transport efficiency; Vehicle size; Informal transport; minibus
Topics Area: E1 Assessment and Appraisal Method w.r.t. Transport Infrastructure Projects and Transport Activities

1. Introduction

Even in very different contexts many developing cities experiment the operation of small size (low capacity) vehicles in insuring the public transport supply. More, as one can observe on Table 1, these vehicles can catch the higher share of public transport trips, proving their apparent success and efficiency although they are classically criticized by a majority of the transport professional community. As stated by the World bank (2002), *informally supplied small vehicle paratransit (…outside the traditional public transport regulatory system)… is typically viewed as part of the problem and not part of the solution.*

According to an extensive definition of public transport including all modes of transport selling a transport service to any person who affords the price, there are varied types of such vehicles:

- individual taxis, metered or not (but we will not insist on this mode in our analysis, because the fare is too different and higher than the other modes one),
- motorcycle-taxis (1-2 seats),
- shared taxis (4-5 seats), sometimes 6 seats, exceptionally to 8
- micro buses (9-15 seats)
- minibuses (16-25 seats)…
- midibuses (25-45 seats) They are under the 50 passengers capacity beyond which one considers usually the vehicle as a bus.

We will try to assess the importance of such modes in meeting the mobility needs in developing cities and to bring some basic explanations to this apparent success despite of many criticisms made for many years by experts and decision-makers who announce periodically the end or the decline of these modes in urban areas.

Table 1 : Modal share in some cities (Motorised trips)

	Population (millions)	Private car, taxis	Métro, train	Autobus	Minibus	Shared taxi	other
Abidjan 1998	3,5	28%	-	28%	26%	18%	
Alger 2000	2,5	48%	5%	5%	40%	-	
Addis Ababa	2,6	14%	-	24%	62%	-	
Beirut 2002	1,3	85%		3%	7%	5%	
Cairo 1998	11,3	26%	23%	19%	28%		4%
Casablanca 2000	3,2	55%	-	20%	-	23%	2%
Dakar 2000	2,4	18%	1%	3%	58%	14%	6%
Dar Es Salam 2000	2,2	11%	-	2%	81%	-	7% (NMT)
Istanbul 2000	10	29%	6%	33%	29%	1%	2% (boat)
Mexico 1996	17	17%	14%	11%	58%	-	
Nairobi 2000	2,1	20%	-	24%	55%	-	1%

Source: Data gathered by the author from numerous sources

2. Method

We will first state the domination of small size vehicles in a sample of cities in Africa or in the developing world. It is difficult to gather relevant data on the travel pattern in many cities and its modal share. The attempts made by international organisations (World bank many years ago, in 1987, Uitp more recently, in 2000) have not been totally successful. In particular the Uitp data base was an interesting and valuable attempt but it was limited by the not solved difficulties and by the insufficient knowledge of considered cities by the authors so that it is hardly usable. One does not distinguish in this data base the share of each component of the public transport supply : *paratransit/artisanat* and institutional/enterprise sector.

We have gathered in the Annexe the data on a sample of cities according to our own sources. In some cases the data are based on detailed surveys and analyses, in other cases they are very rough and approximate estimations nevertheless founded also on an analysis.

The success of low capacity vehicles operation, in opposition to the large bus industry, can be analysed through many factors of explanation. Among them the attractiveness for the user has to be considered. But these modes are also classically considered as producing external costs for the community higher than those involved by the high capacity vehicles, ie the buses. One has therefore to consider at least three main groups of criteria to understand the observed situations and to design a relevant policy:

- the operator efficiency and profitability;
- the user satisfaction, particularly from the travel time point of view;
- the minimisation of external costs for the community

Other dimensions should be added in a comprehensive analysis, such as the urban structure, the road system and traffic management techniques... But we are obliged to limit our analysis in this short paper. As this question is very linked to the question of the organisation of the operation, we cannot avoid to consider this dimension of debate but we will overview the parameters explaining the success of theses modes without developing particularly the analysis on the opposition between enterprises and *artisanat* (*informal* transport according the usual English terminology).

One will sketch some theoretical but very simple considerations on these three points of view. These views are combined with observations from various cases in Africa. In particular our analysis will benefit from case studies in African cities (Abidjan, Bamako, Dakar) where detailed surveys were conducted in 1999 by Sitrass (2001) on urban transport micro enterprises.

3. Domination of small size vehicles in many developing cities

The domination of these vehicles could be observed in 2000 in the majority of Sub-Saharan African cities. It is very linked to the bus companies collapse in 90's which gave the opportunity to the *informal/artisanat* sector to develop their activity very much. In this competition inside the market, one observes the domination of minibuses, and also of shared taxis in some cities. In extreme cases one observes also the success of motorcycle taxis.

The important role of small size vehicles was also observed elsewhere in the world, classically for instance in Manila (Philippines) or in Lima (Peru) but surprisingly also in cities which are not very poor but are characterized by an intermediate level of development like Beirut (Lebanon) Casablanca (Morocco) Algiers (Algeria) and Damascus (Syria), and even in megacities like Cairo, Mexico or Istanbul.

In **Casablanca**, the crisis of the bus public company Ratc was the reason why the authorities opened the sector to new private bus operators in 1985. But the difficulties accumulated by this bus supply have permitted the development of shared taxis besides the metered taxis: they are Mercedes cars used to transport 6 persons (plus the driver) on fixed routes at a fare lightly higher but very similar to the bus fare (5Dh versus 3 Dh). This supply was estimated to be the first component of the public transport supply in the city in 2000 (Godard, 2003). There was around 5 100 registered vehicles in 2003, and probably more really operated if one integrates the illegal and clandestine vehicles.

In **Cairo**, the supply of so called *shared taxis* has been developed very rapidly in the 80's and more in 90's as it did not exist before. Actually they are microbuses and not formally shared taxis as their capacity is around 10 seats. The estimated fleet was 14 000 vehicles in 1985 and 27 000 vehicles in 2000. They were supposed to satisfy 28% of motorized trips in Cairo in 1998 (Godard, 2003). They have become the first mode of public transport in Cairo, despite the efforts made to invest in public transport through the metro investment. Despite or thanks to the metro development? Actually the efforts have stayed concentrated on the metro supply so that the bus supply has stayed at a low level compared to the travel needs: that explains why these minibuses could develop very fast thanks to the relevant service they offer to meet travel needs of many urban dwellers. It is notable that the large bus company CTA has also been incited to operate minibuses which look like to the so called *shared taxis*. This activity seems profitable as CTA can apply higher fares than those in the classical and old buses. Its fleet was 750 minibuses in 1998.

In **Mexico**, the supply of public transport was dominated in 2000 by the microbuses and minibuses (*colectivos*) the share of which was much more important than the bus share: 58% of motorized trips are estimated to be covered by the low capacity vehicles. The estimated fleet was very impressive: around 140 000 vehicles (without distinction of taxi, microbus and minibus). The affirmed goal of the Authorities was to reduce their influence as they contributed to congestion and pollution (Enriquez, 2000). But the political feasibility and willingness of this program were doubtful for many reasons, mainly social and institutional reasons.

Even in **Istanbul** low capacity vehicles represent an important share in public transport trips, with the so called *servis*. Many years ago there were many minibuses or shared taxis called *dolmus* operating in this city, but they have been eliminated by the Authorities which wanted to modernize the urban transport sector. They have been replaced by buses, but also by *servis* which are minibuses used mainly for employees transport and other specialised transport: they can be considered as a substitute of the ancient *dolmus*. Their share is revealed to be important in the total trips.

4. Brief overview of factors to explain the success of low capacity vehicles

Many factors can be listed to explain the observed success of low capacity vehicles operation in urban transport systems. Most of these factors are classical arguments one will try to synthesize here from our experience (few references are given). They seem all justified but also partial.

Informality of activity: As low capacity vehicles are most often operated by *informal/artisanat* operators the advantages of this so called informality benefit to the low capacity vehicles operators. Actually the operators are more efficient to catch the benefits from the informality using these vehicles rather than high capacity buses. We do not want to insist on this point (see Cervero, 2000, Godard, 2002) as the word *informal* can be criticised.

Unfair competition with bus companies: the weakness of regulation, the insufficiency of enforcement and obligation for the level of service to be delivered give an advantage to the *informal/artisanat* sector which is not submitted to the same constraints the bus operators have to cope with.

Adaptable and flexible operation: small dimensions of the vehicles and the low capacity give them more facilities of adaptation in operation, either physical facilities according the roads or organisational facilities according the demand: a small size vehicle is more adapted to a road network in bad conditions with potholes. The operator can more easily modify the route and adapt it to an instantaneous demand evolution. This flexibility makes possible very high rates of occupancy of vehicles, maximizing the receipt.

Operation rule : full vehicle for departure from the station. This rule applied to stations of shared taxis or minibuses operated on fixed routes maximises the rate of occupancy at the departure but it obliges the passengers to wait for the vehicle filling. It is a negative and repulsive aspect of the paratransit practices which is minimized when the demand is high enough.

High length of driving daily time. One aspect of the informality is the length of the working days which is more important for the crews (driver, controller) in charge of low capacity vehicles. The working conditions are difficult and they can be accused to involve more dangerous driving. Nevertheless it is not intrinsic to the parameter of capacity.

Low level of investment : easy access to the market. The cost of a low capacity vehicle is evidently cheaper than a large capacity vehicle so that many persons who have some saving can invest to purchase a vehicle and start the activity as a driver or as an owner "renting" to a driver. If the context is deregulation, the access to the market is easy what can explain the increasing fleet of such vehicles in many cities. This trend is reinforced by the liberalisation of imports and also by the crisis in public finances which obliges the authorities to incite the private involvement in the sector and to tolerate alternative and informal ways to finance the public transport supply: low capacity vehicles are an alternative way of implementation of the public private partnership (PPP).

Better risk management: The financial risk of the activity is reduced with a small vehicle so that some investors prefer to get two or three small vehicles (15-20 seats) rather than a large one (40 seats): if one vehicle cannot be operated for breakdown or accident reasons, the financial loss is more reduced with a small vehicle.

Vehicle production cost and price : The investment cost according the capacity can be analysed through a very simplified indicator: the investment cost by seat. It is difficult to get relevant and homogeneous data when one considers the second hand market which is the most important in many countries and explains the rapid development of paratransit in Africa or in Latin America. One would need some light coming from the industry producing the vehicles, and its evolution for explaining the cost of purchase of vehicles. Our hypothesis is the opposition between two industrial processes applied either to a large

scale production of low capacity vehicles (private car, minibuses) or to a more restrained production of buses : this production does not benefit from the same potential economies of scale benefiting to the low capacity vehicles. Comprehensive analyses could be done integrating the cost for their production, their operation and their maintenance and considering varied types of vehicles according their capacity and the price of manpower in the concerned countries: (new or old) industrial countries for the production, developing or developed countries for the operation.

Lobbying power: The social and political weight of small capacity vehicles operators can be very high and it can explain why the authorities are often not able to limit their activity. In reality this factor is explaining the difficulty to reduce the share of this sector of activity, and to decrease the presence of low capacity vehicles in the congested roads but it cannot explain in itself the reasons for the increase of the vehicles. There are various types of situations and various ways the operators have to act as a lobby. The bus companies can also act as a lobby, and they acted in the past as powerful lobbies in African cities. One of the key factors of the power of *artisanat/informal* operators is the high number of people involved in the activity in the considered cities and getting revenues necessary to their family.

Arrangements with the Police : One knows the *informal/artisanat* transport can have dual relationships with the police. The low capacity vehicle drivers are repressed by policemen who are interested most often by getting money from them and not by enforcement. But the policemen can also invest in the sector and bring their protection to the drivers by a way or another. That can also explain the success of some low capacity vehicles, either motorcycle taxis, shared taxis or minibuses. These ambiguous relationships are observed in many cities.

5. Inside informal sector, what about the profitability of vehicle operation according the size?

Four cities have been specially studied about this question of micro-enterprises profitability and financing (Sitrass, 2001): Abidjan, Bamako, Harare, Nairobi. In these cases (particularly in Abidjan where are operated 18-seat and 32-seat vehicles) the data seem to show mitigated results depending on the criteria one can use, but there are elements to pledge the high profitability of low capacity vehicles. But the conclusions by the authors are more in favour of higher capacity vehicles: *25- and 30-seat vehicles are clearly more satisfactory than smaller vehicles in all respects, including financial performance...* One has to wonder about the conclusions of these reports in Abidjan and Dakar.

In Abidjan the imports of second hand minibuses were in the year 1999: 170 vehicles with 14-19 seats, 19 vehicles with 20-29 seats and only 4 vehicles 30-40 seats. The market expressed its preference. Actually the consideration of payback periods gives approximately the same period for 18-seats vehicles (1,1 year) and 32-seats vehicles (1,2 years). Formally the financial profitability seems higher for 32-seats vehicles but the financial risk and the amount of money to invest when starting the activity are also higher.

The study on Dakar concluded the same result in favour of higher capacity vehicles (30 to 40 seats by opposition to 22 seats vehicles). If one examines the hypotheses of calculation it is easy to understand that some data are not justified on some points (and have probably been chosen only to justify the conclusion which was wanted a priori according a very classical process in studies (Godard, 2002).

These studies seem to be very representative about the process one can summarize from the following schematic way:

- Presupposition on the necessity to get high capacity vehicles (for congestion reasons or else)
- Search of funding to incite the operators to get high capacity vehicles
- Choice of hypotheses favourable to this conclusion inside profitability studies
- Conclusion on the higher profitability of high capacity vehicles: this conclusion is supposed to convince the bankers that their loan will be justified and not too risked according the profitability.

Actually there is a confusion in the diagnosis on several elements:

- The intrinsic profitability of low capacity vehicles operation,
- The variability of profitability depending on some parameters (vehicle age for instance)
- The comparative cost for the community of using low capacity vehicles
- The potential profitability of activity according many types of organisational measures by the authorities (or by the professional organisations)

6. Case of motorcycle-taxi

One observes an important role of motorcycle taxis in some large African cities (also small cities and in rural areas for a longer time). This travel mode is present in a limited but increasing number of cities : Cotonou (Benin), Douala (Cameroon) Lomé (Togo), according to the table 2. It is also observed in Uganda or in Nigeria. This importance in a limited number of African cities is the copy of the experience experimented in many Asian countries. For different reasons the motorcycles fleet is very important and still increasing in some cities like Phnom Penh (125 000 *motodubs*) or Bangkok (100 000 *rub jong*s)

Table 2 : Role of motorcycle taxis in some African cities

City	Population (millions)	Motorcycle taxis fleet	% in motorized trips
Cotonou	1	50 000	60%
Douala	2	15 000	25%
Lomé	1	15 000	40%

Note: The data are approximate estimations by the author which are based on partial data

From our topics dealing with the vehicle size, the motorcycle taxi is interesting to consider as an extreme case of low capacity vehicle, with only one passenger, sometimes two passengers: it is lower than taxi capacity as a metered taxi (a car) can be used as a shared taxi transporting 4 passengers.

The paradoxical success of the extreme case of motorcycle-taxis in some cities is explained by a combination of many factors where one finds :

- crisis in the institutional public transport (political strikes in Douala or in Lomé)
- quality of service : door to door service
- flexibility of operation
- low cost of manpower
- very rapid mode, specially in congested areas
- bad state of roads : motorbikes can go where buses and minibuses cannot go in peripheral areas
- low cost of fuel distributed by smuggling networks (from Nigeria in Cotonou and in Lomé)
- low cost of investment : imported second hand vehicles from Asia are very cheap; furthermore there is a new local Chinese industry of motorcycles located in Douala.

This success is obtained despite of important shortcomings of motorcycles taxis according to the modalities they are used:

- pollution due to: 2-stroke engines, too much oil in mixture, bad engine maintenance
- accidents, with a danger due to different factors: driver behaviour, no use of helm, vulnerability of two wheels, state of the roads.

7. The user point of view

Among the parameters which explain the choice of the mode by the user some ones are in favour of low capacity vehicles: waiting time and travel time can be very much in favour of these transport means even if the cost for the user is higher. It is evident that the frequency of vehicles will increase when the capacity by unit is decreasing in the constraint of keeping the same global capacity. This observation is made inside the limits imposed by the constraints of the road capacity. A very simplified example presented in the table 3 illustrates this advantage of small vehicle for the users : one can see the mechanical difference in interval between buses and minibuses or shared taxis. All things being equal, the user chooses the first available mode of transport, that explains very easily the success of low capacity vehicles. That explains also the critical and dangerous behaviour of drivers in search of new passengers.

Table 3: Frequency of vehicles according the capacity and the level of demand

Level of demand	Vehicle type	Necessary frequency	Average interval (minutes)
1000 pass/hour	Bus (100 pass)	10	6’
	Minibus (25 pass)	40	1’ 30’’
200 pass/hour	Bus (100 pass)	2	30’
	Shared taxi (4 pass)	50	1’ 12’’

This fact has been too often neglected as there is a dominant focus on the affordability of public transport for the urban poor (the question of operating cost) and on the congestion involved by the private car and by the low capacity vehicles such as minibuses.

Interesting lessons can be thrown from the experience in Abidjan where many transport means do coexist : buses (*Sotra*); minibuses (*gbakas*) and shared taxis (*woro woro*). Surveys implemented in 1999 by Certu/Stc (2002) registered the declared average waiting times of users in the main stations. Even if these observations are made in a period of bus crisis (but the crisis is unfortunately structural) they summarize the potential advantage of low capacity vehicles for the users. There is a very clear hierarchy of waiting times according to the capacity of the vehicles: according the table 4 the average waiting time for the bus was twofold compared to the minibus in morning peak (higher difference in evening peak). It was threefold compared to the shared taxi (the regularity of which seems to be higher).

Table 4: Waiting time of various public transport means in Abidjan (1999**)**

	Morning peak period			Evening peak period		
	Max	Min	Average	Max	Min	Average
Bus Sotra	42	19	30	46	25	36
Minibus gbaka	19	10	15	15	9	12
Shared taxi Woro	11	8	9,5	-	-	-

Source Certu/Stc 2002

The same type of observation can be made in Casablanca to explain why many users choose to use shared taxis more than buses: the waiting time is lower, the comfort is higher

because everyone has a seat in the taxi, at the opposite of the buses where many people have to stand up even in the first class private buses which were authorized only for sitting passengers at the beginning of their activity.

8. The community point of view: external cost and employment

Externalities

It is now very classical to point out the externalities of transport which are a cost for the community. One insists usually particularly on the externalities involved by the private car and by extension by the low capacity vehicles (see for instance Vasconcellos, 2002). These transport means are more costly from this point of view even if there are some technical and complex debates about them:

- External cost of congestion: the road space occupied by passenger is clearly increasing when the vehicle capacity is decreasing. But some complex analyses have to be made to integrate the influence of varied modalities of operation of the vehicles in dynamic schemes which can qualify this basic rule.
- Safety: the effect of the vehicle capacity is not evident, except for motorcycle taxis; but the effect of the operation practices (aggressive driving) is in disfavour with low capacity vehicles.
- Pollution: many parameters are involved to estimate the cost of pollution by varied types of vehicles. Clearly the large capacity vehicles have a comparative advantage but that depends on their real rate of occupancy. Vasconcellos (2002) insists on the superiority of large capacity vehicles (45 seats) on the private car even if their rate of occupancy is low: it is what he calls the 6-4-2 rule on which we are not sure to agree but it is another story.

The energy consumption is in principle integrated in the operating cost and therefore internalised in the comparison of transport cost according to the vehicle capacity. But it is useful to recall this dimension of energy consumption as it is also directly linked to the carbon emissions yielding the Green House effect.

This importance and the influence of these externalities are very variable according to the cities and in a city according to the market segment to be covered. In particular they depend on the urban density.

Evident influence of urban density

The density of demand concentrated in some axes (and also in time) influences clearly and directly the advantages got from vehicles characterized by different capacities. That is the basis of the design of the urban mass transport systems. Behind the density of demand there is of course the urban density, either for housing or employment or other activities, and the land use patterns. In the debate on the balance between private car and public transport, Uitp (J Vivier, 2002) insists on this point after the pioneer work on the automobile dependency by Newman and Kenworthy. The same type of debate could be launched inside the public transport system. But there is no mechanic rule linking density and efficiency of transport means as we stated the variety of situations and of parameters to consider.

Employment

The other aspect of externality to consider from the point of view of the community is the (direct and indirect) employment. The low capacity vehicles are probably more costly to operate by seat-kilometre as one needs to pay more drivers and more fuel etc for a given demand to satisfy. Nevertheless “in a situation of excess supply of labour” (World bank, 2002) the interest of the community is to generate employment for people and to favour such employment in the transport sector: what is considered classically as a cost is becoming an advantage offered by the low capacity vehicles. This dimension is very

important and is more and more considered when the policies are poverty focused. Of course this pledge in favour of small vehicles has to be qualified according to the corresponding working conditions (sometimes very bad) and the revenues the drivers get from this activity (most often higher than the average salaries).

9. Conclusion: Balance in these three logics

At the end of this overview we have the feeling that the interdependency of parameters makes very difficult an acute and detailed analysis. That confirms our choice not to try to design a model of optimization as one needs first to precise more the criteria of efficiency helping the choice of the best vehicle size in specific conditions and also to know better the interdependencies of parameters. Nevertheless some interesting conclusions can be proposed.

Considering the three points of view we adopted (the operator, the user, and the community), each one can give arguments explaining the success of low capacity vehicles:

- For the operator, the profitability is good thanks to high rates of occupancy and the limited risk compared to larger vehicles.
- For the user, these vehicles offer a reduced waiting time but it can often oblige to pay a higher fare all the users cannot afford.
- For the community the negative externalities (congestion, pollution) of such vehicles are generally not well taken in account by the authorities engaged in a deregulation scheme. But there is a kind of compensation between these negative effects and the positive effect on employment.

These arguments can also be used to pledge for the preservation or the promotion of these vehicles on condition that their sustainability be checked and that their role be situated more from the point of view of the community. In the (very hypothetic) case of quasi full employment the advantage of using such vehicles would be cancelled.

It is very clear these arguments pledge for the presence in developing cities of such vehicles in a global urban transport system where are operated also large buses (in cities with a minimum population depending the context) and eventually mass transit with Brt, Lrt, metro or regional railways. The difficulty which is still here is how to organise the coexistence between such various means: what degree of competition and of complementarity.

Finally the potential advantage of the low capacity vehicles depends also on the capacity of the institutions to manage a whole complex transport system. So we confirm again a conclusion presented in some of our previous publications on the necessity of a scheme of transport associating various vehicles types and various forms of transport : enterprises and *artisanat*. One can wonder about the reasons why the transport systems are often unbalanced from this point of view.

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