Original Paper

Public Transport Effectiveness in Brazzaville

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Abstract

This research paper has to be set in the framework of an important urban growth. Such urbanization goes along with urban spreading that generates an increase in both urban mobility needs and the use of public transport.

The paper focuses on public transport effectiveness in Brazzaville, from the analysis of determinants linked to public transport's generalized cost on the one hand, and to the nuisance effects of such public transport on another hand.

Keywords

effectiveness, public transport, urban growth, urban spreading, moving, urban mobility, congestio

1. Introduction

The world population is getting more and more urban, in line with the evolution of urbanization rate (proportion in percentage of people living in urban zone) between 1950 and 2050.

Table 1. Evolution of Urbanization Rate in %

	The world	Africa	Asia	Europe	Latin America	Northern America	Oceania
1950	30	14	18	52	41	64	62
2015	54	40	48	74	80	82	71
2050	66	56	64	82	86	87	74

Source: Damon, 2016.

When observing urbanization in Africa, three major persistent trends are noticeable: a **lower** but increasing urbanization rate, in relation to the rest of the world, a faster increase in urban population, and a very heavy concentration of the population in big cities (Damon, 2016).

If the urbanization rate in Africa will reach 56% in 2050, urban population in sub-Saharan Africa will experience the world's strongest increase, given that 80% of such population will be urban in the aforementioned year; and big cities have the tendency to grow faster, along with an increase in both their urban transport needs and mobility (Infhotep Cabinet, 2016). Indicators reflecting living standards-health, education and hygiene—are higher in cities than in the countryside (Bloom & Khanna, 2008).

Congo B., a country in sub Saharan Africa, can be said to be a "macrocephalic" country, on the ground that there is a big city which dominates more (Gubry, 1991). Brazzaville is that city, with 1, 733, 272 inhabitants, and which represents 60% of the whole number of inhabitants in the country's six major towns (INS, 2015).

Brazzaville is a «macrocephaly» as it holds in it the whole lot of urban transport system of the country. We can then talk about an urban spreading of Brazzaville with, on the one hand, the increase in the population that moved from 1,373,382 inhabitants in 2007 (according to the 2007 general population and habitat Census), to 1,733,272 inhabitants in 2015 and, on the other hand, the creation of two new districts—the 8th and the ninth ones—in 2011, respectively Madibou (southern Brazzaville) and Djiri (northern Brazzaville). Such a creation of new districts results in considerable increase in the daily moving of people in Brazzaville. Madibou has an area of 80.04 square kilometers, while Djiri has 83.46 square kilometers. Together, these two districts represent 50.1% of the area of the city of Brazzaville (INS, 2016). Such an urban spreading made it possible for private-owned vehicles to play a key role, as many people have recourse to them for their daily moving, notably from home to office and vice versa. It is rather a constraining usage of the car. When leaving or entering the aforementioned districts, people are confronted to the serious problem of traffic jams, notably at rush hours.

Life in the city of Brazzaville is closely linked to public transport; which is often noticeable whenever there are sociopolitical events within the city. When public transport is operational, this surely means that life in the city goes on (Moyo Nzololo, 2008). Public transport is made of private-owned means of transport, notably taxis, collective taxis (commonly called "cent cent"-so called because of the silver franc CFA 100 coin-currency used in central African States-charged for minimum fare), minibuses and buses on the one hand, and State-owned means of transport made of buses of the urban public transport authority (STPU) on the other hand.

In addition to motorized conveyance, there is the moving on foot. Godard (2009) states that in sub Saharan Africa, "the other face of mobility is then the importance given to walking, which is almost the exclusive means of conveyance for an important part of the urban population. It represents an average rating from 50 to 80% of mobility mode in the majority of towns". Brazzaville citizens are often found walking on relatively long distance, within the nine districts of the city. There are exclusive

pedestrians—those who have no private vehicle or no money to catch a bus-and occasional ones that is, those who may own a private vehicle but cannot use it because of fuel shortage in the city.

For most of the population, the day-to-day moving within Brazzaville is made by public transport. Urban trips in collective taxis, minibuses and buses remain the places where the "living together as one" motto is experienced. Regardless of age and social status, passengers keep close to one another in conviviality and crowded conditions. Journeys are made either with anecdotes, jokes, stories told by passengers, or by listening to exclusively African music. The collective taxi always uses the same route in a given district, with the possibility of doing short-distance fares. The minibus has a direct line route, but it does not always abide by such a direct line: it can change its route if the number of passengers taking this line is not important; and it also does short-distance fares. As for the bus, it abides by its route which is generally a closed-circuit one. It does not practice short-distance fares.

The reasons to move from one place to another are various; they can be related to school, studies, professional activity, social-driven activities (accompanying someone, visiting parents, relatives, friends, neighbors, attending a wedding ceremony, a baptism, a mourning ceremony, an association meeting, etc.), leisure, shopping. The first three movements clothe the "compulsory" mention, while the last three movements are "not compulsory".

Private-owned means of conveyance are getting more and more numerous in Brazzaville, as shown on Table 2 hereto, for at least three core reasons:

- The first reason is that it is a business activity done by various types of owners: civil servants, businessmen, police or armed force agents, political authorities, wage earners of the private sector, unemployed people, retired people;

- The second reason is that it is an activity that makes it possible for the vehicle owners to get daily incomings, notably for owners who exercise their social influence in order not to pay for taxes related to this business activity. For vehicle owners, expected daily returns are: between 8,000 and 10,000 CFA francs for a collective taxi, between 12,000 and 15,000 CFA francs for a taxi, between 25,000 and 30,000 CFA francs for a minibus, between 80,000 and 100,000 CFA francs for a bus-noteworthy is the fact that 1 euro=657 FCA francs;

- The third reason is that those vehicles are second-hand vehicles, with a percentage that amounts 79% for this type of vehicles in Brazzaville. The acquisition of such vehicles is quite easy in informal markets—located both in Brazzaville and Pointe-Noire. Of course, information on these markets is asymmetric, as indicated by the Akerlof model (1970) which pinpoints the advantages to have an item that seems to be good, rather than actually being good: this is deceptive counterfeiting, according to which poor-quality cars chase off genuine or good ones (Moyo Nzololo, 2016a).

Table 2. Private-Owned Means of Transport in Brazzaville, from 2007 to 2016

Means of transport	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Taxi	2115	3120	4700	5406	6104	8824	10824	12000	12307	12356
Collective taxi	65	75	108	132	220	389	489	590	678	689
Minibus	900	975	1215	1350	1802	2509	3209	4008	4207	4218
bus	143	160	183	196	220	221	228	232	256	269
Total Tc	**3223**	**4330**	**6206**	**7084**	**8346**	**11943**	**14750**	**16830**	**17448**	**17532**

Source: SRTU/Brazzaville.

It is in such a highly competitive—but also very profitable—environment that an urban public transport authority (STPU) has been created in 2015, with 150 new Ashok Leyland-branded buses, manufactured in India, each bus having a capacity of 80 passengers and a diesel-fueled engine. The buses are apportioned in the two major cities of the country: 82 in Brazzaville and 68 in Pointe-Noire. STPU is a public limited company, with a capital shared as follows: 60% for the government (ministry of finance, budget and public portfolio), 20% for the Brazzaville Town Hall 20% for the Pointe-Noire Town Hall. The bus abides by its scheduled route, and it is not engaged in the short-distance fare practice.

Brazzaville is therefore experiencing a context of increase in the use of public transport.

In this research paper, the core question to be answered is the following: is there any public transport effectiveness in Brazzaville?

In the literature dealing with public transport effectiveness, several authors addressed the issue in several approaches.

Public transport effectiveness is associated with the density of either populations or activities: "where such public transport shows weaknesses, it cannot play an important role, given that the present trends in favor of both residential habitat and urban spreading do not favor such public transport" (De Palma, Pahaut, & Quinet, 2006). On the contrary, where urban density is high, the latter increases mobility needs and favors distance reduction in terms of the moving of people (Pouyanne, 2004; Audard et al., 2012).

Public transport effectiveness is linked to an important offer of road infrastructures because the road has a dual objective, that is, an internal objective- or that of circulation—which is to meet the need for traffic between two points, and an external objective- or that of development—which is to meet the objectives of city planning and development (Kyriacos, 1984; Mvuezolo & Bazonzi, 2005). It goes without saying, however, that the issue of maintenance of such road infrastructures ought to be carefully dealt with (Crozet, 2006; Devarajan & Fengler, 2014).

Public transport effectiveness is worthy if it contributes to the promotion and establishment of sustainable cities, notably by making it possible for the latter to enjoy environmental benefits; that is: reducing local pollution in urban areas; decreasing the amount of greenhouse gas emissions that unfortunately contribute to global warming; diminishing fuel consumption and diversifying alternative energy supplies; mitigating noise pollution or emissions (Kaufmann, 2003; Prud'homme, & Bocarejo, 2006; Bonnaure & Lamblin, 2006; GRAME, 2011).

Public transport effectiveness is related to the specificity of each city in socioeconomic, institutional, cultural and geographical terms: it is not possible to reproduce a common model applicable to all types of urban public transport; which is corroborated by Massot et al. (2004): "The effectiveness of public transport systems is closed linked to the characteristics of terrain served by such systems".

Public transport effectiveness is linked to its multiple impact on urban planning, that is to say, its successful integration into urban planning and development, given that public transport contributes: to maximize the returns of public and private investments in each sector; to have a positive impact on land value; to revamp sociocultural drive, equity and social inclusion (CUTA ACTU, 2009).

Public transport effectiveness not only favors the mobility of active workers towards their workplace, but also extends their reach while job hunting. Symmetrically, companies in search of manpower, benefit from the public transport effects, which enables those companies to access or reach new opportunities of potential workforce. Public transport therefore matches job offer with labor demand. By shortening time for transport, the room for possible matching widens, the job market is therefore more efficient, thus making employment easier (Costes, Kopp, & Prud'homme, 2009).

Public transport effectiveness is associated with the preservation of the lives of people who, on a daily basis, use these vehicles for various points of destination; hence the importance of highway safety in order not only to prevent, but also to reduce road accidents (Fleury, 2004).

Public transport effectiveness is linked to the increase in the usage cost of a private or individual car. McFadden (1974) pinpoints a price effect on the mobility demand. "In the case of a private or individual car, the mobility demand increases when the car usage cost is lessened or reduced. Such a demand also increases when the income, the cost and time devoted to wait for public transport increase. Likewise, the mobility demand through the use of public transport increases when the car usage cost increases, and decreases when the cost and time devoted to wait for public transport increase" (Souche, 2009).

Based upon the input of the literature review, we have considered a theoretical model of public transport effectiveness (EFTC) associated both with the generalized cost of public transport and nuisance effects of public transport.

2. Theoretical Framework

In line with the theoretical model, the EFTC issue leads us to the very EFTC issue in relation to the generalized cost of public transport on the one hand, and nuisance effects of public transport, on the other hand.

This double questioning leads us to formulate two hypotheses:

- The first hypothesis stipulates that EFTC is associated with the decrease in transport's generalized cost.
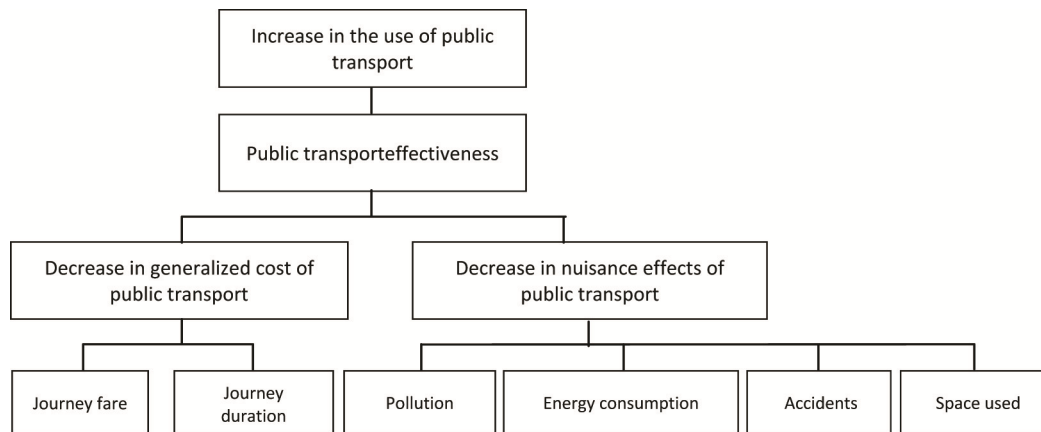
The generalized cost for transport (or the total cost for a journey, or the overall cost for moving from one place to another) is defined as the aggregate of two sides (Kilani, 2015):

Generalized cost (CFA)=monetarycost (FCFA)+duration of the journey (hour) x time value (XFA/hour)

- The first part is a direct monetary cost in CFA: it tallies the price for the ticket, or fare for the journey, or the cost of fuel used;

- The second part is non-monetary cost in XFA: it tallies the time spent in the vehicle (what is at stake here is opportunity cost). It is indirect cost associated with time valorization. As Prud'homme and Bocajero (2006) state it, choosing time value is always a delicate task as such. Conveyance for professional purposes has a higher time value; for bus and minibus users, time value is of lesser importance in general and in least developed cities or countries in particular. In London, the time value used by Transport for London is 15.6 euros per hour. Which obviously tallies with the British culture or motto of "time is money". In the Parisian agglomeration, time value is 13.7 euros per hour. In Africa, there is always plenty of time, so much time that it is no harm to postpone for tomorrow what can be done today: and this explains why time value is lesser (Godard, 1985).

- The second hypothesis considers that EFTC is associated with a decrease in the nuisance effects of public transport.

Economists consider that slow moving traffic on a highway network generates negative external consequences which, on their turn, produce the deterioration of collective welfare, and thus justify corrective arrangements from the government (De Palma, Pahaut, & Quinet, 2006). The nuisance effects that we will consider as negative external consequences that ought to be reduced are: pollution, energy consumption, road accidents, the space used.

This theoretical approach that we summarize through Figure 1 below is inspired by that of the *Victoria Transport Policy Institute*, statedby Litman (2017).

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┌─────────────────────────────┐
│ Increase in the use of public│
│          transport           │
└─────────────────────────────┘
               │
┌─────────────────────────────┐
│ Public transporteffectiveness│
└─────────────────────────────┘
               │
      ┌────────┴────────┐
┌──────────────────────┐   ┌──────────────────────┐
│Decrease in generalized│   │ Decrease in nuisance  │
│  cost of public       │   │ effects of public     │
│  transport            │   │ transport             │
└──────────────────────┘   └──────────────────────┘
    ┌──────┴──────┐         ┌──────┬──────┬──────┬──────┐
┌────────┐ ┌──────────┐ ┌─────────┐ ┌──────────────┐ ┌──────────┐ ┌──────────┐
│Journey │ │ Journey  │ │Pollution│ │Energy        │ │Accidents │ │Space used│
│ fare   │ │ duration │ │         │ │consumption   │ │          │ │          │
└────────┘ └──────────┘ └─────────┘ └──────────────┘ └──────────┘ └──────────┘
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Figure 1. Synthesis of the Theoretical Framework

Source: ourselves, inspired from Litman (2017).

The objective of this paper is not only to show the importance of public transport in urban mobility in Brazzaville, but also to appreciate public transport effectiveness in Brazzaville in relation to two components, viz, the generalized cost of public transport, and public transport nuisance effects.

The first component pinpoints the importance of the Zahavi paradigm (1973) known as the "law of budgets-time constancy in transport". This law means that everyone aims at maximizing distance covered all along the day, under the budget-time constraint, that is, not to go beyond the expected time for transport in the one hand, and not to spend or devote much more money than planned or expected, on the other hand (Halleux, 2001). The second component recalls the responsibility of vehicles not only for global warming or climate change, but also for urban pollution (Bonnaure, Lamblin, 2006). That is the reason why environmental standards are being stressed with the years; and one the most emblematical standards adopted at the Paris conference-COP 21-is the +2°C limit about the average increase in the world temperature that should not be exceeded (Mathieu, 2015).

When observing Figure 1, we notice that it shows six determinants associated with public transport effectiveness: the fare for the trip, trip duration, pollution, energy consumption, accidents and space used.

The methodology used in this paper is determinants analysis. In fact, each determinant is reviewed, prior to analyzing the gap between expected result and observed one. The analysis from determinants is relevant, given that it is associated with collective costs related to public transport (Mirabel & Reymond, 2013). Such an analysis is completed by the elaboration of an explanatory model for public transport in Brazzaville, with the aim of identifying the most significant means of conveyance.

3. Analysis of Determinants

3.1 Journey Fare

The fare for a trip or journey has been set since 1992 by the Brazzaville Town Hall:

- Taxi: 700 CFA francs;
- Collective taxi: 150 CFA francs;
- Minibus, bus: 150 CFA francs.

The price for a taxi ride varies between XAF 1,000 and 5,000 CFA francs on the ground that drivers of those vehicles pretend either the existence of traffic jams in certain zones or certain city districts, or the long distance to be covered. At nights, the price for a taxi ride may turn to be double or thrice. When there is fuel shortage, the price for the ride is beyond 1,000 CFA francs. The driver thus goes as far as to take two or three passengers going in the same direction, but each of the passengers has to pay for his ride.

As far as collective taxis are concerned, travelling conditions are poor. According to the vehicle model, the number of passengers to be on board varies from 6 to 8. Passengers are enclosed. Those collective taxis are on the traffic thanks to the complaisance of both the Brazzaville Town Hall and policemen assigned to regulate the traffic. Most of the drivers of this type of vehicles have no insurance, no car inspection certificate, and no driving license; which is a serious concern in terms of highway safety. As a matter of fact, those collective taxis are dangerous, and they ought to be banned from road traffic on the ground that they are "moving coffins".

Minibuses and buses have respectively a capacity of 15 and 40 seats. The routes of minibuses and buses are defined through forty-five intra urban lines and eight suburban lines. The routes or itineraries must be displayed on the windshield of vehicles. However, drivers and money collectors of minibuses have instituted a disguised increase in fares with the practice of short-distance rides. This practice consists in splitting a line into several rides, thus making the traveler pay 150 CFA francs for every ride. Furthermore, once the minibus drivers have agreed on such a short-distance practice, it is impossible for vehicle users to engage in any protest. The Town Hall vainly tried to combat this treacherous practice with the help of the police, but the latter couldn't certainly be travelling in such vehicles all the day long and for several days running. In addition to these, certain dishonest and easily corrupted policemen also contribute to encourage this fraudulent practice of short-distance rides.

With taxis, collective taxis and minibuses, it stands out that there is no decrease in the fare because of their practice of short-distance ride.

On the other hand, STPU buses serve long and remote lines that converge for downtown for a fare of 150 CFA francs. They do not practice short-distance rides. Badly needed by Brazzaville citizens, STPU buses significantly reduce the unit price of the ride for their users. One then can talk about a decrease in the ride cost. Victims of their fame, there are more passengers standing (about 50) than seated (30 passengers) in those buses that are consequently called "mal-à-l'aise" (a French expression which means "not feeling physically comfortable" or "not making you feel comfortable" when travelling).

The perspective of increasing their number will certainly improve the quality of service delivery for passengers.

Thus, one can discuss about relative decrease in the ride cost with buses in general and STPU buses in particular.

3.2 Duration of the Ride

Here, the ride duration refers to the time spent on board a vehicle. Congestion is time loss in relation to traffic jams. Congestion infers behavior change: delays, absenteeism, leaving the workplace early. It also reduces manpower mobility. We recall that collective taxis, minibuses and buses have recourse to the illegal practice of short distance rides, particularly during the rainy season; which extends or lengthens the duration of the ride. The factors that increase ride duration in Brazzaville are known:

- Traffic jams because of road narrowness, bottlenecks, lack of road treads, lack of parking lots, or unexpected emergency situations (road works, accidents, unauthorized parking, etc.);
- Insufficiency of secondary roads that are either tarred or paved;
- Potholes on main roads;
- Authorized circulation—at daytime-of 18-21m heavy trucks loaded with containers, stopping wherever they want, breaking down anywhere, and which are often the causes of very serious road accidents;
- Passengers waiting for so long in the minibuses and buses at bus stops until the seats in the bus are full, prior to leaving the bus stop (at the departure point of a given line);
- Poor condition of certain roads-because of poor maintenance—during the rainy season (notably the «Union Africaine» avenue, in northern Brazzaville);
- Insufficiency of interchanges to insure circulation fluidity;
- Recurrent breakdowns or lack of traffic lights; which lead to approximate regulation of the circulation by policemen who are sometimes the cause of road accidents;
- Vehicles that are broken down in the midst of the main road, at a roundabout, at a turning point; and such vehicles may remain right on the spot for hours and even days. Sometimes, the broken vehicle is repaired on the road;
- Lack of roads or lanes designed for minibuses and buses.

As far as new roads construction is concerned, one should not overestimate positive impact of road investments because the improvement of the highway network will, on its turn, increment the growing number of users; which means that such investments are not always a profitable solution to congestion-related problems (De Palma, Pahaut, & Quinet, 2006). In fact, according to the Downs-Thompson paradox, the construction of new roads automatically involves an increase in road traffic, until a new saturation point is reached, even if there is no demographic growth noticed.

There is a great number of Brazzaville citizens that are compelled to walk for rather long distance to reach one's destination. Unfortunately, road adjustment or arrangement designed for pedestrians is either mediocre or non-existent.

In their attempt of catching up lost time owing to congestion, the drivers of vehicles got into the bad habit of creating double or triple driving line, or driving along sidewalks, jeopardizing pedestrians' security.

Catching a taxi, with the aim of catching up time, turns to be betting at lottery, given that there are taxis that have no proper documentation for the vehicle; and in case of any unexpected police check, the driver will either try to flee or drive away by taking another direction, or if the driver fails to drive away because of the traffic jam, the police will charge him: in both cases the taxi driver and the policeman will make you waste time.

However, we can conclude that only the taxi can make it possible to reduce the duration of the ride, but with a relatively higher cost for the ride, given the low purchasing power of Congolese people in general.

3.3 Pollution

Nowadays, automobile traffic is the main source of gas emission in urban areas, and day-to-day mobility is the cause of diversified atmospheric pollution (Glandus & Beltrando, 2013; Kengne Ouabo & Laponche, 2014).

Even though the issue is not included among the main concerns of the Brazzaville Town Hall, pollution is associated, among others, with the very large fleet of second-hand vehicles, weaknesses or lax attitude noticed at the level of vehicle technical control service, the possibility given to vehicles to circulate with polluting exhaust pipes. Given that transport is essentially fuel-dependent (gasoline, diesel oil), its combustion involves not only high grade CO_2 emissions, but also greenhouse effect gas (GES). Furthermore, traffic jams increase both emissions per kilometer covered and local pollution. Formerly called "green Brazzaville", the city has lost many trees downtown and in living districts because of the construction of edifices and buildings, public works along main roads (canalization, electrification, paving); those trees could have played their photosynthesis role).

Air pollution increases the quantity of greenhouse gas (Tubiana & Kieken, 2007). As the market of counterfeit spare parts is very prosperous in Congo and notably in Brazzaville, it makes it possible for the ageing public transport automobile fleet-most of the second hand vehicles having the Japanese brand name of Toyota-to operate.

We can therefore conclude that public transport does not contribute to reduce pollution.

3.4 Energy Consumption

To consider or address the issue of the decrease in energy consumption, there are three challenges to face:

- removing from circulation all the polluting, fuel-consuming and noisy vehicles;
- using "clean" fuel that has a controlled amount of sulphur particles, bio-fuel or gas, under the form of liquefied petrol gas (GPL);
- encouraging the circulation of "clean" vehicles, notably for public transport.

A very small scale experience has been conducted in Brazzaville since 2016, with about forty taxis and buses owned by the Bolloré company, known as Bluecongo. It is about electric vehicles (VE). Inserted in the today's traffic, they found their way without slacking such a traffic. If this experience is conclusive, the installation of charging points in Brazzaville and free share cars could be considered. Car rental companies would then order electric cars (VE) from Bolloré Bluecar. Major car manufacturers (Bougnoux, 2011; Bonnaure, 2012) have started producing both electric vehicles (VE) and hybrid vehicles (VH), with the aim of reducing energy consumption, CO_2 and greenhouse gas (GES) emissions, which makes it possible to fight global warming. Hybrid vehicles (VH) have a thermal engine. At the purchase, VH is more expensive than VE (Bonnaure, 2012). The thing is that VEs are more adapted in towns and likely to impose themselves in the automobile market, especially with the advent of hydrogen-fueled battery instead of the electrical battery. "But the electric vehicle is still facing handicaps and uncertainties that hinder it from massively substituting thermal vehicles before 2030, given that the renewal of an automobile fleet takes time anyway, on the ground that the today's cars have a lifetime of 10 up to 15 years" (Pélata et al., 2010).

The decrease in energy consumption is a real challenge to be met, for "Most of the experts, among which Pricewaterhouse Coopers, consider that classical gasoline and diesel fueled engines will keep on dominating the market in the coming decades" (Jaumin, 2018).

We can therefore conclude that public transport does not contribute to decrease energy consumption so far.

3.5 Road Accidents

There is lack of dynamism in the road accident prevention policy, in light of numerous dark points identified in Brazzaville, but which are not dealt with hitherto. Many accidents regularly occur in such dark places: the «patte-d'oie» roundabout, the small "Blanche Gomes" roundabout, the "Loutassi-Boulevard Alfred Raoul" crossroad, the "Koulounda" roundabout, the "Ebina" roundabout, the "BouetaMbongo-Avenue des trois martyrs" crossroad, the "ministère de la defense" roundabout, the "La Coupole" roundabout, the "avenue Maya-Maya—Mbochi" intersection, the intersection between "avenue Maya-Maya" and "avenue des trois martyrs", the "Bifouiti" roundabout, etc.

Other recurrent factors that generate accidents are: fake driving license, bad traffic regulation by the police, vehicle poor maintenance, lack of both pedestrian walking areas and pedestrian crossings, repetitive breakdowns of traffic light, serious road decay, poor street and road lighting, very few road signs and poor maintenance of road marking. Taxi drivers are involved in several accidents; very often, those accidents between themselves occur owing to refusal of priority, disregard of security distance between two vehicles, dangerous overrun and riding another vehicle's tail. But several accidents in which taxis are involved are caused by the "clandestine relief driver" phenomenon, organized by the main driver. The latter recruits another driver called "releveur"-a substitute driver that replaces the main driver in order to do his duty, without the knowledge of the owner's car. The substitute driver works either by day, or by night- if the vehicle is said to be parked at the main driver's—when the

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vehicle is supposed to be parked for the night. Generally, such a substitute driver has an on-the-job training. Among the causes of road accidents—rated in terms of seriousness or importance—we can list the following: refusal to priority, 40.94%; excess speed, 18.57%; non-observance of stop signs, 8.74%; dangerous overrun, 7.08%; engine default or breakdown, 6.79% and incapacity to master the steering wheel, 4.70% (DGTT, 2010). The leading cause of accidents in Brazzaville is refusal to respect priority, widely known in Lingala language (one of two national languages spoken in the country) as "tiamutuba kata"—which means "though driver Xhas priority, he must let driver Y enter between the waiting line of other vehicles on the main road". This expression symbolizes, or implies driving in an impulsive, arrogant and reckless way, with noticeable difficulties to master the steering wheel.

Minibuses are sometimes involved in road accidents because of excess speed. Their strategy lies on how fast this or that driver can reach the next bus stop before the competitors, aiming at taking on board his vehicle the maximum of passengers waiting. In so doing, the drivers incur serious risks such as: inobservance of traffic light, stop signs and security distance.

Indeed, drivers bear responsibility as far as highway safety is concerned. Yet, it is also a matter of concern for the decision makers in charge of road and street management, given that it is also possible to act on infrastructures—by intervening on road and highway works and its environment—so as to reduce the injury or death toll. It is therefore a systemic vision on road accidents around the triple approach of man-vehicle-infrastructure which needs to be addressed accordingly (Reigner, 2004; Fleury, 2004).

Table 3. Evolution of Road Accidents in Brazzaville from 2007 to 2016

Year	Number of d'accidents Acc	Deathtoll	Number of people injured
2007	1754	118	260
2008	1416	107	1339
2009	1573	121	973
2010	1512	82	635
2011	2003	90	1109
2012	1760	83	655
2013	2120	88	880
2014	2231	94	897
2015	1925	336	767
2016	2028	81	776

Source: BCA-Brazzaville, 2016.

The previous table shows that between 2007 and 2016, the number of accidents has increased up to 15.62%.

Statistics from the Office for Accident Control (BCA, 2016) reveals that out of five road accidents in Brazzaville, public transport is involved in three, notably with taxis. Furthermore, on the average 67% of accidents occur during the rainy season. This is explained by the serious degradation of certain roads during that season, the absence of policemen at dark points and traffic light breakdown.

Buses are relatively safer as their speed is lesser than that of the other competitors, and their routes are fixed. We can then conclude that public transport partially contributes to the decrease in road accidents.

3.6 Spaceused

Unfortunately, public transport in Brazzaville does not converge with the decumulation of space used. One could have thought, for example, that non-users of public transport people-those driving their personal vehicle—would take advantage of more space on roads. Which is not the case because they are also subject to traffic jams. Not only there is less free space, but there are fewer areas to park one's car downtown, around major city markets, along trading avenues ("avenue de la paix", "avenue de l'OUA", "avenue Matsoua", "avenue des trois martyrs", "avenue de France"). So many sidewalks have been turned either into juke points—bars and restaurants—or second-hand clothes shops, making it perilous to park vehicles. The lack of parking lots in Brazzaville remains a deep concern. In the world's big cities, the number of taxis is set by the authorities; and such a number varies according to countries: one taxi for 200 inhabitants in New-York, one taxi for 350 inhabitants in the Great London, one taxi for 650 inhabitants in Ile-de-France, one taxi for 1200 inhabitants in Brussels (Science & Décision, 2006). In Brazzaville, every citizen can own as many taxis as he wishes: there is one taxi for 140 inhabitants. What is really striking in Brazzaville is the impressive number of taxis in circulation. When there is fuel shortage, those taxis invade gas stations with long waiting lines. Actually, at such a period of fuel shortage, there is no traffic jam and circulation is both ventilated and enjoyable, for there is space liberated.

We can therefore conclude that public transport does not contribute to the decumulation of the space used.

3.7 Public Transport Explanatory Model

As variable to be explained in Table 2, we consider variable Total of public transport modes noted Tc, and taxi, minibus and bus as explanatory variables, along with the variable relating to the number of accidents in table III noted Acc. The review of correlations matrix from the table below shows that Tc strongly correlates with at least three variables Taxi, Minib and Bus. The moderately high correlation of Tc with Acc variable shows that public transport is nevertheless involved in road accidents. In addition, variable Acc has a relatively high correlation with Taxi and Minib, while such a correlation is lesser with Bus; which tallies with our analysis on the road accidents determinant.

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Table 4. Correlationmatrix

Variables	Taxi	Minib	Bus	Acc	Tc
Taxi	**1,000**	0.984	0.942	0.765	0.999
Minib	0.984	**1,000**	0.914	0.782	0.992
Bus	0.942	0.914	**1,000**	0.690	0.938
Acc	0.765	0.782	0.690	**1,000**	0.771
Tc	0.999	0.992	0.938	0.771	**1,000**

Source: XLSTAT-Linear regression.

The variance analysis table below shows that the calculated Fisher model F=122377.763 is higher than the Fisher read F (4. 5)=5.1922 at the threshold of 5%.

Table 5. Variance Analysis

Source	DDL	Sum of squares	Average of squares	F	Pr > F
Model	4	282980637.158	70745159.290	122377.763	< 0.0001
Error	5	2890.442	578.088		
Total corrected	9	282983527.600			

Source: XLSTAT-Linear regression Calculated against model Y=Average (Y).

In the table below, model coefficients are all significant with a reliance of 95%, given that each of them belongs to a reliance interval. Therefore, the model is globally acceptable (Tomassone et al., 1992). The most significant variables in the model equation are Taxi and Minib, for they have the highest values of test t, respectively 72. 172 and 34. 956.

In other words, the most explanatory variables of public transport in Brazzaville are taxis and minibuses.

Table 6. Model Parameters

Source	Value	Standard deviation	t	Pr > |t|	Lower landmark(95%)	Higher landmark(95%)
Constant	-106.476	113.143	-0.941	0.390	-397.345	184.392
Taxi	0.996	0.014	72.172	< 0.0001	0.961	1.032
Minib	1.191	0.034	34.956	< 0.0001	1.103	1.278
Bus	1.393	0.607	2.294	0.070	-0.168	2.954
Acc	-0.037	0.047	-0.785	0.468	-0.159	0.085

Source: XLSTAT-Linear regression.

The model equation is therefore:

Tc=-106,476+0,996*Taxi+1,191*Minib+1,393*Bus-0,037*Acc

This model can be helpful in the prevision of public transport in Brazzaville, according to a level determined a priori for each of the four explanatory variables.

The constant term -106.476, that is, -106, can be interpreted as minimum need for taxis; in other words, it is the number of taxis for one inhabitant in Brazzaville.

4. Conclusion

In this article, a special focus was laid on the effectiveness of public transport in Brazzaville, in the context of the increase in public transport utilization in that city. For that matter, a theoretical approach was adopted; which made it possible to analyze EFTC in Brazzaville, based upon six determinants.

After an in-depth analysis, the following lessons have been learnt:

- The decrease in the trip fare is a reality for the users of STPU buses: lines are longer, and these buses are not engaged in the short-distance practice;

- The decrease in ride duration concerns the moving with the help of a taxi: the price for the ride is nevertheless high, in relation to the purchase power of an urban family. In terms of advantages, however, the assets of a taxi are speed and flexibility;

- With public transport, there is no decrease in pollution: the automobile fleet is essentially made of second hand vehicles using gasoline and diesel oil. CO_2 and greenhouse gas emissions worsen pollution, especially during traffic jams;

- With public transport, there is no decrease in energy consumption, on the ground that the vehicles used are not "clean" ones: their engines are essentially fueled with gasoline and diesel oil. Moreover, amounts of thin sulphurp articles in both types of fuel-that should be low—are not subject to stricter control;

- There are fewer road accidents involving public transport, except taxis. In the systemic vision of road accidents implicating the man-vehicle-road approach, it would be better to remove from circulation all those dangerous vehicles that pullulate on Brazzaville roads, while engaging in regular maintenance of roads on which there are big potholes that not only slack the circulation, but also cause accidents. Several roads have coatings that are badly or poorly done, and deteriorate very quickly as soon as it starts raining. And the narrowness of those roads are also the cause of many accidents;

- There is no decumulation of space used by public transport, for there is a lack of carpark or parking lots. In fact, one is far from being in a situation where those who transfer themselves towards public transport "liberate" space for circulation and parking; a space that could then be used by others. Defective taxis, minibuses and buses have to be removed from circulation.

The following perspectives have been considered:

As far as STPU buses are concerned, they are acquired new and they arouse so much hope for the population of Brazzaville. That is the reason why the customers service has to be improved, so as the nickname of "mal-à-l'aise"—implying "discomfort"—given to that public transport authority disappears. However, STPU should also care more about its clients by implanting bus shelters, as the latter will contribute to improve comfort while waiting for the bus, in a city where it is often hot and it rains abundantly. In all the big cities of the developed or industrialized world, buses are widely subsidized (Prud'homme & Bocarejo, 2006).

Given that the fare for STPU ride is attractive enough to increase its share of urban moving in public transport, there is inevitably a loss of profit that must be compensated by regular State subsidies.

Construction and maintenance of highway infrastructures are a necessity for urban transport development and traffic jams reduction (Kumar & Barrett, 2008). In Brazzaville, the hierarchical organization of the highway network is not clear; and this lessens public transport effectiveness. Avenues are often streets, and sometimes narrow streets, which is the case for "Itoumbi", "Lénine", "Loutassi", "Maya-Maya", "Opangault" and "des chars" avenues. Constraints relating to both environment and built areas make it difficult to engage in the construction of road infrastructures in the center of Brazzaville and in some districts. However, secondary and collector roads are numerous; they are worth being tarred or paved in order to free or clear main roads.

The experience of "clean" Bluecongo electrical vehicles is worth being encouraged and extended to the entire public transport system, given that they contribute to the reduction of greenhouse gas emissions, pollutants and noise pollution. Emissions reduction by particular or private cars is notably linked to the improvement of engine's technical performance that makes it possible to slightly reduce the unit consumption of vehicles, while the automobile fleet is getting larger and larger. But this has little impact, on the ground that in Brazzaville, the majority of the fleet is made of second-hand vehicles. Limiting the age of second-hand vehicles in circulation would certainly have to be considered.

As for official statistics on public transport, they are incomplete. Database is devoid of relevance, coherence, and are largely insufficient in terms of international comparison. Such statistics are therefore worth being elaborated with stringency, and updated in the framework of mobility household-survey (SITRASS, 2001) involving town halls and communes on the one hand, and the Office of road transport and National Statistics Institute on the other hand.

At the end of this article, one can conclude that public means of conveyance in Brazzaville is but partially effective, for the two hypotheses have been but partly verified.

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