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Paratransit Reform and Quality of Services in West Africa Cities: The Case of Minibuses in Dakar, Bamako and Conakry

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ABSTRACT

The ability of paratransit to better adapt to demand is not necessarily an argument that justifies the adequacy of its offer in relation to the concerns of users, especially in the African context. Then, the reform of paratransit remains a challenge for stakeholders in the sector. This work focuses on four paratransit networks in Dakar, Bamako and Conakry, namely the "Association de Financement des Professionnels du Transport Urbain" (AFTU), "cars rapides" and "ndiaga ndiaye" in Dakar, "sotramas" in Bamako and "magbanas" in Conakry. The objective of the research is to make a comparison on the level of access to services of these different types of networks. Chi-square and normality tests are used to analyze primary data collected from surveys. Observations, interviews and documentation were also used to complete the information for the analysis. The results show that, even if the AFTU network in Dakar fails to meet the regularity of services as required by the concession contract that binds it to the public authorities, it remains the best network in terms of pricing and its services are closer to the populations.

1. INTRODUCTION

In most African cities, public transport is provided by a hybrid system in which formal and informal transport are not complementary, but compete with each other [1, 2]. Everywhere, the observation remains the same: a deterioration in the quality of formal transport services and a predominance of paratransit [1, 3-7]. Nor does the ability to adapt better to demand make informal transport a system where the services offered are appreciated by customers. Because the operators in this industry operate individually, their supply is unplanned, their services irregular and they show strong competition between themselves on the routes they serve [2, 8]. Negative externalities such as pollution, accident risks and road congestion resulting from this type of transport do not guarantee city dwellers a better quality of life. This is because they do not complement formal public transport services when they exist, but above all because the equipment used by the operators does not meet the required standards [2, 8]. Paratransit reform remains a challenge for African cities [9]. Such a reform should make it possible to improve the quality of service of informal transport, particularly its accessibility. This can be achieved through good regulation, more rational allocation of vehicles to routes and better service planning [2, 9]. Furthermore, the development of infrastructure, the structuring of the offer and the governance framework can have a positive impact on improving people's travel conditions within the urban transport perimeter (UTP), in the African context [10, 11].

The Dakar region launched its minibus reform program in 2001 by renewing the fleet of "cars rapides" and "ndiaga ndiaye" vehicles [3, 12-14]. This operation gave rise to the network of the AFTU, presented in this document as the NMN. This project, which was to replace all the old minibuses with new, more reliable and higher-capacity rolling stock by 2018, is still underway [13]. Recommendations to formalize and professionalize minibuses actors have been made by the World Bank and the European Union for the cities of Bamako and Conakry [15-17]. The transformation of this industry is an opportunity for public authorities, operators and users, who do not necessarily have common interests, to work together to find a balance in satisfying their needs [18]. One of the aims of financing paratransit minibus through fleet renewal programs is to regulate informal transport sector, make operators more profitable and improve service quality [12, 13]. The formalization of operations through the concession of lines and the requirement to comply with a set of specifications involves these different actors in the production of services [14].

Many authors agree that paratransit services are poorly

planned, irregular and poorly organized. Although some studies have looked at the quality of service of small-scale transport it is perhaps rare to find research in the literature that pays particular attention to the comparison of paratransit minibus networks in several African cities [19]. However, Behrens et al. [9] and Roux et al. [20] carried out a comparative study of public transport in three cities in South and East Africa, namely Cape Town (South Africa), Nairobi (Kenya) and Dar es Salaam (Tanzania). Their studies approached public passenger transport in a global manner (formal and informal), without focusing specifically on paratransit by minibus or examining in detail the impact of renewing this type of vehicle on improving the offer. The present study aims to fill these gaps by proposing a comparative analysis of three West African cities: Dakar (Senegal), Bamako (Mali) and Conakry (Guinea).

The experience of renewing the minibus fleet in Dakar, 19 years after the launch of the operation, appears to be yielding satisfactory results, although it may be rare to see the literature talking about it [9, 14]. However, it has to be acknowledged that this project to formalize and professionalize paratransit actors is not yet fully complete, given that cities in neighboring countries (Bamako and Conakry) are aiming to adopt it. So, isn't it necessary to evaluate the performance of the minibus networks in our study area in order to examine the improvements brought about by the renewal of paratransit' minibuses? The aim of this study is to analyze the accessibility of NMN and OMN services, in particular the "car rapide" and "ndiaga ndiaye", the "sotrama" and the "magbana" in the capitals of Senegal, Mali and Guinea Conakry.

Chi-square and normality tests were used to assess accessibility indicators, in particular waiting time, network coverage and fares. These tests are applied to primary data collected from passengers and observation data, i.e., surveys of vehicle frequencies at critical stops in the three cities. The information collected in the field (surveys and observations) is supplemented by documentation consisting of study reports, thesis, scientific articles and official documents on urban mobility (Urban Transport Plans - UTP, Sustainable Urban Mobility Plan - SUMP, SSATP Sustainable Accessibility Policies for African Cities, Household Surveys, Satisfaction Surveys, etc.). Interviews were conducted with resource persons in the private sector (transport operator's union, drivers' union, technical inspection of vehicles, etc.) as well as in the public sector (public structures involved in urban transport governance).

In order to answer the research question, the first section of the document presents the four minibus networks. In the second section, an analysis of the level of accessibility of minibus services is carried out. Finally, the contribution that minibus renewal programs can make to passenger access to transport services in the context of African cities is discussed in the last section.

2. METHODOLOGICAL APPROACH TO THE STUDY

2.1 Presentation of the study area

The study covers the metropolitan areas of Dakar, Bamako and Conakry, the capitals of Senegal, Mali and Guinea Conakry. These medium-sized cities (less than 5 million inhabitants) are located in three neighboring West African countries. Table 1 shows the demographic situation of the study area.

Table 1. Demographic situation in the study area

Cities	Dakar	Bamako	Conakry
Agg. Pop. (million)	4.04	3.05	2.18
Nat. Pop. (million)	18.62	24.68	14.85
Ratio to Nat. Pop.	**22%**	**12%**	**15%**
Agg. Pop. growth rate (%)	3.23	4.14	3.21
Nat. Pop. growth rate (%)	1.57	3.05	2.51
Ratio to national rate	**2.06**	**1.36**	**1.28**
Aggl. area (km²)	547	267	450
Nat. area (km²)	196 7121	220 190	245 720
Ratio to nat. territory	**0.278%**	**0.022%**	**0.183%**
Aggl. area (km²)	547	267	450
Aggl. density (hbts/km²)	7 321	11 423	4 840
Aggl. density (hbts/km²)	96.1	20.06	60.05
Ratio to Nat. density	**76**	**569**	**81**

Sources: World Population Review, ANSD and INS; 2023 and 2024

These high population growth rates and densities testify to the attractiveness of these capitals, which welcome large numbers of people. For the majority of migrants, the main reason for moving is to find work and support their families. However, African cities rarely provide housing close to employment and activity zones for these populations. This leads to dysfunctions in the host areas in terms of land use, access to basic services, and, above all, the accessibility of business zones, which attract the majority of minibus users. These three cities are no exception to the rule, and this situation may influence passengers' perception of the quality of the minibuses offer. If we add to these problems those linked to the physical configuration of cities and inadequate planning, we can see just how complex accessibility to urban infrastructure and facilities can be.

The Dakar region is a peninsula (Cape Verde Peninsula) located between longitudes 17°10 and 17°32 west and latitudes 14°53 and 14°35 north. It covers an area of 550 km², i.e., 0.28% of the national surface area, and in 2024 will be home to almost a quarter of Senegal's population, i.e., nearly 4 million inhabitants. Population density exceeds 7,321 inhabitants/km². Mali's capital is located between 7°59 west longitude and 12°40 north latitude. More than 15% of the national population lives in Bamako, on a surface area of just 0.02% of the country's territory (i.e., less than 300 km²), making it an area of high population concentration (i.e., more than 10,000 inhabitants/km²). Most of the country's economic and political activities and major infrastructures are located in Bamako. Conakry, like Dakar and Bamako, is the economic, administrative and political capital of the Republic of Guinea Conakry. One of the largest ports in West Africa is located in Kaloum, the country's largest business district. It is located on the Atlantic Ocean in the extreme southwest of Guinea, between 9.5° north latitude and 13.7° west longitude. The city covers an area of 450 km², i.e., 0.18% of the national territory, with a high population density of over 4,000 inhabitants/km². All three cities have a population growth rate of between 3% and 4%, i.e., almost twice the national rate, making them the leading cities in Senegal, Mali and Guinea in terms of population. All three cities studied have physical constraints (Figure 1).

Dakar is bordered on the east by the Thiès region and on all three sides by the Atlantic Ocean, providing the region with a single overland exit. The Senegalese capital comprises 4 towns and 5 departments: Dakar, Pikine, Guédiawaye, Rufisque, and Keur Massar. The District of Bamako straddles the Niger

River, which divides the six (6) communes of the Bamako conurbation into two zones: the left bank (communes 1 to 4), home to the older districts such as Bamako Coura, Dar Salam, etc. (communes 2 and 3), concentrates most of the region's activities and jobs, while the right bank (communes 5 and 6), with its large population, plays a residential role. The two areas are connected only by three bridges: the "Pont des Martyrs", the "Pont Fahd" and the Third Bridge. Conakry is a peninsula bordered by the Atlantic Ocean to the west and south. To the north and east, the city extends into outlying areas, with urban development reaching into neighboring rural regions. The city is longitudinal, stretching over 30 km and crossing 7 communes, namely Kaloum, Dixinn, Matam, Matoto, Ratoma, Dubréka and Coyah.

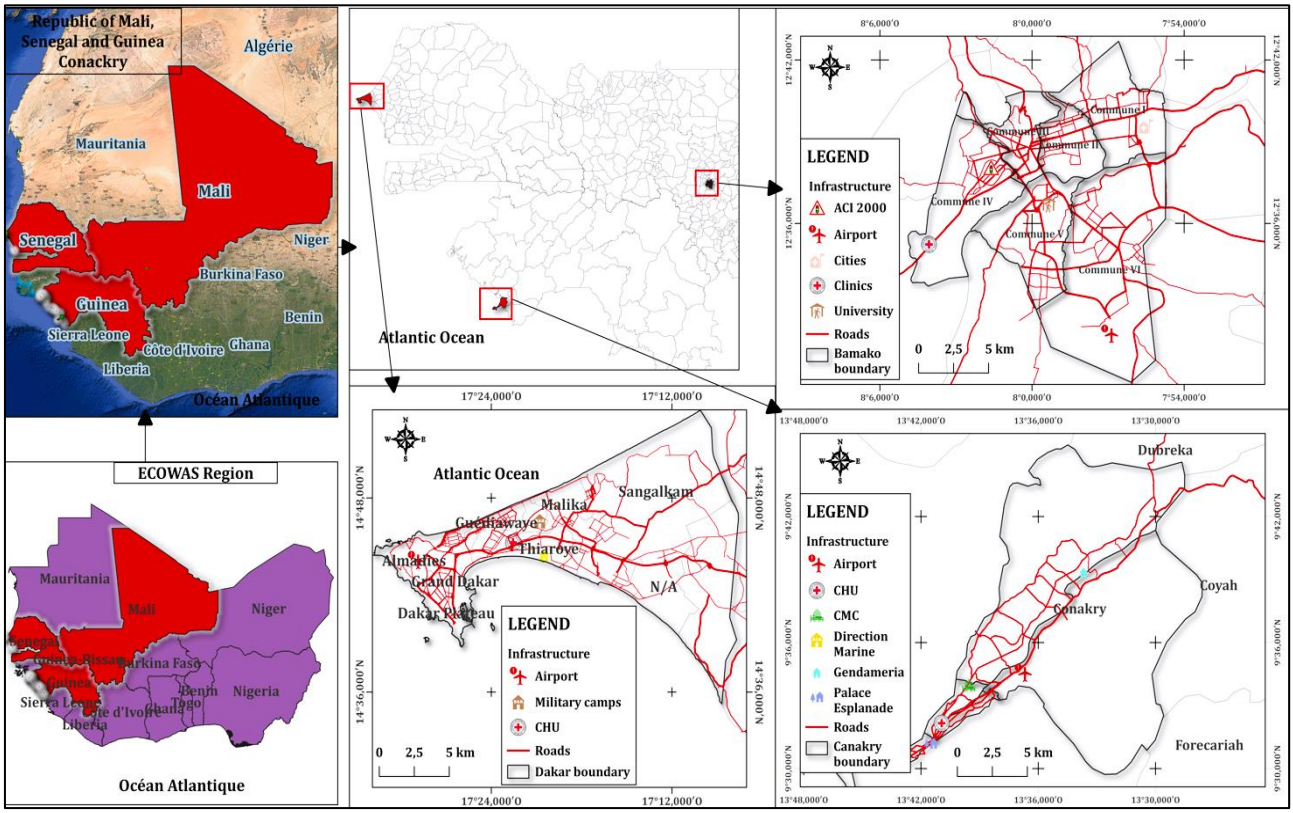

Figure 1. Study area
Source: Author, laboratory work, 2024

2.2 Methods and tools

The database used for analysis in this research is based on questionnaire surveys from users of paratransit by minibus in the capitals of Senegal, Mali and Guinea Conakry. Vehicle frequencies were recorded at a number of critical stops (Bus stops most frequented by users) on the minibus routes in Dakar, Bamako and Conakry. At least 300 people were interviewed in each network, including AFTU, "car rapide" and "ndiaga ndiaye" (Dakar), "sotrama" (Bamako) and "magbana" (Conakry). In Dakar, the people surveyed use both minibus networks. The stratum sampling methodology was used to reach travelers in each commune of Bamako (i.e., 66 individuals per commune) and Conakry (i.e., 57 individuals per commune) and the departments of Dakar (i.e., 120 individuals per department, 60 per network). The interviewers went to the main boarding points (stations or termini and critical stops) to randomly interview passengers on board the minibuses or to wait at the stops for vehicles coming from or going to the city centers.

The surveys were developed on the basis of a literature review on the analysis of the quality of public transport services, in particular paratransit in Africa and elsewhere, with a focus on the challenges associated with service accessibility [9, 19-22]. In addition, exploratory interviews were conducted with transport sector professionals (experts, academics, managers, public authorities, etc.) in the various cities studied, in order to better understand the specific issues and adapt the survey content. The questions were organized into three main themes. Firstly, an attempt was made to understand the profile of users (age, level of education, occupation, marital status, etc.), then the reason for travel and finally the passenger's perception of the accessibility of minibus services, in particular the proximity and regularity of services, waiting times at stops and fares. Using the KobotoolBox tool, the questions were designed, and it was possible to collect the data, even from a distance.

The information collected in the field (surveys and observations) was supplemented by documentation consisting of study reports, theses, scientific articles and official documents on urban mobility (Urban Travel Plans - UTP, Sustainable Urban Mobility Plan - SUMP, SSATP's Sustainable Accessibility Policies for African Cities, etc.). Interviews were conducted with resource persons in both the private sector (transport operator unions, drivers' unions, etc.) and the public sector (public bodies involved in urban transport governance). To gather all this data, we carried out two one-month internships at the ministries in charge of transport in the Republic of Guinea and Mali. The interns found on the site were trained and sent out into the field to collect the data. In Dakar, students from the Université Cheikh Anta Diop (UCAD) were mobilised. The surveys were carried

out in all the departments of the Dakar region (Dakar, Guédiawaye, Keur Massar, Pikine and Rufisque), in all the communes of Conakry (Kaloum, Ratoma, Matoto, Dixinn, Matam, Dubréka and Coyah) and the district of Bamako (communes 1 to 6) at critical bus stops and lineheads. The collection work was carried out during the school period, on working days during peak hours (mornings 7:30 am-9:30 am and evenings 4 pm-8 pm) and off-peak hours (10:30 am-3 pm).

The primary data obtained are both categorical qualitative and quantitative. They provide information on the conditions of access to minibus services in the study area. The approach used to analyze the data is more similar to that of the study [19]. We were interested in three indices of accessibility to public transport services. These are network coverage, waiting time at stops and fares. In addition to the approach adopted by Nwaogbe et al. [19], who evaluated the quality of service of tricycles in Aba (Nigeria) using the Chi-square test, we use the normality test to evaluate the regularity of services and fares.

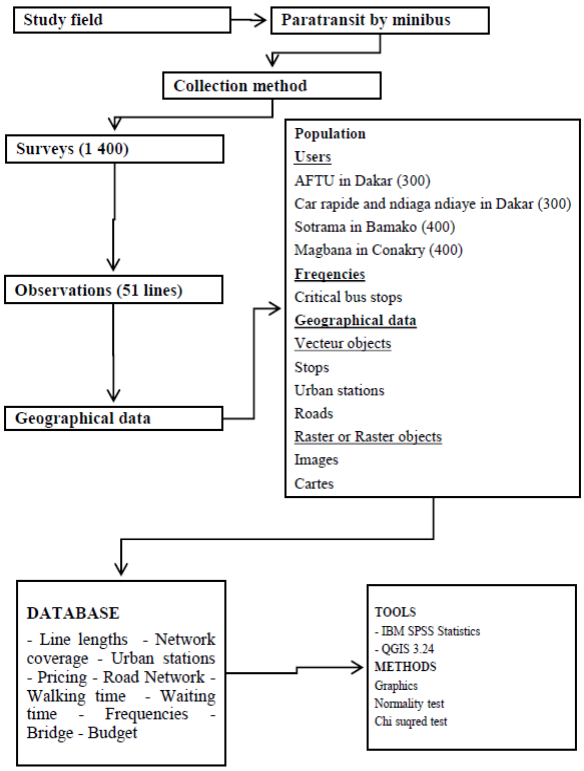

Figure 2. Methods and tools scheme
Source: Author, 2024

The usefulness of the Chi-square and normality tests in our study is to be able to analyze the relationship between minibus service accessibility indicators (fare, proximity, waiting time) and network type. Given that our data are categorical and that the theoretical values obtained are all above 5%, the Chi-square test is well applicable in our case. The Chi-square test is used to compare the four networks of interest. By analyzing differences between observed and expected numbers, it measures the existence of interdependence. On the other hand, the normality test makes it possible to assess which network is best regulated in terms of service and pricing. Using IBM SPSS Statistics, cross-tabulations were performed on the selected indicators. This enabled the Chi-squared test to be applied to the data obtained. Still using the same tool, the normality test is run in the “explore” section of the “analysis” tab, then “descriptive statistics”.The hypotheses of the Chi-squared test are: $H0_1$: There is no significant difference between the networks in terms of the proximity of services for users. $H0_2$: There is no significant difference between the networks in terms of waiting time at stops. $H0_3$: There is no significant difference between the networks in terms of the safety of TCAs according to users.

Hypothesis H0 of the normality test is: the frequency distributions or intervals at which vehicles pass through the stops and the daily budget allocated to the minibus by users are normal.

With regard to the decision rules, for the Chi-square test, if the p-value found is less than the threshold value of 0.05, H0 is accepted. There is, therefore, a dependency between the accessibility indicator and the type of network. Otherwise, H0 is rejected. Thus, there is no link between the accessibility indicator and the type of network. For the normality test, if p-value is greater than 0.05, H0 is accepted. The distribution is therefore normal. The distribution is abnormal if p-value is less than 0.05. Figure 2 gives the summary of the methods and tools that we have mobilized in this work.

3. RESULTS

3.1 Minibus users with varied profiles

Most of the people surveyed were young, with 69% aged under 35, only 6% over 45 and the remaining 25% aged between 36 and 44. Users are more likely to be women (60% women, compared with 40% men), and most of them (users) are single (49%, compared with 46% married). 2% are widows/widowers and 3% are divorced. Travelers in the various networks are generally educated, with 71% having at least primary education. In fact, 29% of those surveyed had completed secondary education and 28% had a baccalaureate. 14% had only completed elementary education, 18% had no education, and 8% had studied only the Koran. The remaining 3% did not answer the question. 60% of travelers are self-employed and pupils/students, compared with 17% housewives, 12% employees, 10% unemployed and 1% retired. The most common reasons for travelling are work, study and shopping.

In all the cities, traffic flows towards the centre during the morning rush hour and in the opposite direction during the evening rush hour. This is a commuting pattern that encourages overcrowding on the main roads, which are very limited due to the shape of the three cities and the specialization of the area.

3.2 Overview of minibus services in the study area

A history of the emergence of the four existing paratransit networks in the three cities, namely Dakar, Bamako and Conakry, is drawn. Also, a description of the offer is made to better understand the similarities and differences in the operating methods. It should be noted that in the three cities, artisanal public transport (APT) is provided by different modes, especially minibuses, shared taxis and tricycles. In our work, we are only interested in minibuses. These are the "car rapide", "ndiaga ndiaye" and AFTU in Dakar, the "sotramas" in Bamako and the "magbanas" in Conakry.

3.2.1 AFTU, an NMN with low efficiency in Dakar

The NMN in Dakar was created in 2001 as a result of a

program to finance the renewal of "car rapide" and "ndiaga ndiaye" fleet, which is presented here as an OMN [3, 12-14]. Throughout the region, AFTU minibuses served neighbourhoods and municipalities to move people around. In 2024, 71 routes were conceded to the 14 economic interest groupings (EIGs) formed within AFTU, with the requirement of a certain level of service, described in the specifications accompanying the concession contract [23, 24]. This means that performance indicators such as regularity, fares, timetables, respect for stops, etc. must be monitored. On their routes, the stops are well marked with vertical posts listing all the lines that serve these facilities. Stops are around 400 to 600 metres apart, and there are notches in the roads to allow minibuses to give way, so that passengers can get on and off safely. Control and regulation of the network is the responsibility of the "Centre d'Appui pour la Professionnalisation des Métiers de Transport (CAPTRANS)" [2, 3, 13, 14].

Several lines may meet at a single stop along the way. The last few kilometres towards the city centre, where there are three major termini - Colobane, Petersen and Lat Dior - make certain sections common trunks. This situation explains the limited road access to Dakar city centre.

The vehicles are TATA (the name given to the network's vehicles by the people of Dakar), ASHOK-LEYLAND and King Long with a maximum capacity of 50 seats and standing. The fleet of vehicles put into service in 2005 did not begin to be renewed until 2024, thanks to collaboration between AFTU, CETUD and local banks. Before this renewal, minibuses less than 5 years old accounted for 31% of the fleet, while 47% of vehicles were less than 15 years old, and 22% were close to 19 years old. This program involves minibuses that have been in use for almost 20 years.

The technical specifications of the vehicles were defined by the operators and the authorities in order to adapt the equipment as closely as possible to the needs of users. Seating and standing arrangements, low floors and two straight side doors make boarding and disembarking easier, while optimizing passenger flow, particularly at peak times.

Before 2005, the only minibuses in Dakar were "cars rapides" and "ndiaga ndiaye". In 2000, paratransit's share of the region's public transport market was 93%, with a fleet estimated at between 2,500 and 3,000 minibuses [25]. In 2015, for a modal share of 91% for paratransit, minibuses accounted for 65%, i.e., 35.2% for NMN (AFTU) with a fleet of 1,607 minibuses, 18.4% for "car rapide" and 4% for "ndiaga ndiaye". The informal offer was completed by "clandos" (11.5%) and "Taxis jaune-noir" (10%) [26]. On the contrary, Dakar Dem Dikk (DDD) covered only 6% of the market [26]. By 2024, a total of 2,200 OMN vehicles were replaced by new minibuses, making AFTU the leading public transport network in Dakar, carrying more than one million passengers a day.

According to the latest census of OMN vehicles authorised to provide urban transport in Dakar (vehicles holding an urban licence), carried out by CETUD in 2023, the fleet still to be renewed did not reach 200 minibuses. However, to this remaining fleet must be added a very large number of minibuses with interurban licenses, which have not been registered and which therefore operate as urban transport vehicles.

Figure 3 shows the minibus models assembled in Senegal by the supplier SENBUS Industrie. The new minibuses are all white with two blue stripes and the line number visible on the windscreen to the right of the driver's seat.

Figure 3. AFTU minibus in Dakar
Source: Author, photo taken in front of UCAD in Dakar in 2024

3.2.2 Inefficient old minibus networks (OMN)

In all three cities, the old networks emerged in the 70s and 80s, in a context marked by structural adjustment policies (SAP), inefficiency of regular public transport services and deregulation of the sector. These include "cars rapides" and "ndiaga ndiaye" in Dakar, "sotramas" in Bamako and "magbanas" in Conakry.

"Cars rapides" and "ndiaga ndiaye" network in Dakar. This was the first form of small-scale collective transport to exist in the Senegalese capital, even before the country gained sovereignty. Before independence, around 1947, the vehicles were blue with a white stripe down the middle marked "transport toute direction" [4]. They had a capacity of 15 seats and operated alongside the "Régie des Transports du Sénégal" (RTS) created in 1971, which was later replaced in 1987 by the "Société de Transport du Cap Vert" (SOTRAC). The fleet of minibuses was first replaced around 1976 to increase capacity. Renault-SG2 with 23 seats (including the driver) called "super" (in reference to the fuel consumed by this type of minibus) or "cars rapides" (referring to the speed of the vehicle), were introduced into Dakar traffic [14]. In the 2000s, this paratransit offer was reinforced by the services of the "ndiaga ndiaye" after the Senegalese government allowed them to provide urban transport to satisfy the high demand in the capital. It should be noted that from 1980 until 2000, this mode of transport provided exclusively intercity services (intercity license). With a capacity of 35 to 45 seats, these vehicles are named after a famous carrier who owned a large fleet of Mercedes [10]. The OMN's fleet is made up of very old vehicles, over 30 years old.

OMN serves Dakar city centre, its outskirts and suburbs via major roads and well-developed secondary routes that are heavily used by public transport users. It operates short, medium and long routes. At Dakar's urban stations (Colobane, Lat Dior and Pétersen), the "ndiaga ndiaye" connect the Dakar city with the other departments of the conurbation, namely Pikine, Guédiawaye, Keur Massar and Rufisque. Their services are often express, and their routes generally take in the main roads and arteries, which are often the feeder roads, in particular the A1 toll motorway, the RN1 trunk road and the VDN (voie de dégagement nord). Figure 4 shows the vehicle models of Dakar's "car rapide" and "ndiaga ndiaye".

At Lat Dior urban station, where the "cars rapides" leave from the city centre, minibuses are on the prowl. They head for the outlying districts and suburbs (Parcelles Assainies, Patte d'oie, Ngor, Yoff, Ecole Dior, HLM, Colobane, Ecole Normale, etc.). Because they are not bound by any formal specifications, they are not obliged to respect stops, even if they share these facilities with the NMN. In addition, their

modus operandi, which is to operate the most profitable routes, does not always allow for maximum coverage of the territory. In addition, practices that penalise passengers, such as wasting time at stops (waiting for customers), untimely stops, negotiating fares, especially during rush hour, and the obsolescence of the vehicles used (over 35 years old), are all factors that hardly guarantee a quality service for users.

Figure 4. Car rapide and ndiaga ndiaye
Source: Author, photo taken at Lat Dior and the Ecole Normale Supérieure in Dakar in 2024

"Sotrama" network in Bamako. The minibuses operating in Bamako, commonly known as "sotrama", are green in colour and refer to the “Société de Transport du Mali” (SOTRAMA) created in 1978. As a result of illegal practices aimed at increasing its fleet, the company solicited minibus owners in Bamako who wanted to work illegally as urban passenger transport operators. In return for a payment of CFA 1,000 per day per vehicle, the company authorised these vehicle owners to operate on routes where SOTRAMA had the exclusive right to operate [27]. This operating method could not be sustained from an administrative point of view, and if we add to this the internal difficulties, the company will cease to operate as an autonomous entity. The owners of the minibuses subsequently withdrew and embarked on an individual operating system [28]. The vehicles, which were mostly Toyota Hiace at the beginning and had a capacity of 18 to 20 seats, kept the company name. Their fleet grew considerably over the years, and with the tarpaulin-covered pick-ups ("durundi"), they ended up completely replacing the formal urban transport services. The capacity of the vehicles has increased and many of the minibuses, which currently have 23 seats, are Mercedes. In 2024, the only transport services available in the Malian capital were informal, and in 2019 the modal share of "sotramas" was 69% of public transport services [27]. The remaining 31% is divided between "durundis" (tarpaulin pick-ups), motorcycle taxis and tricycles.

As in many African metropolises, urban form and land use are determining factors in the nature of motorised travel within the urban transport perimeter (UTP). In a context of poor governance of the sector and fragmentation of responsibilities, the unions find comfort in organising the operation of urban transport, and they manage the routes in their own way. The most profitable routes remain their priority and it is generally the developed routes that are served. In Bamako, traffic flows are pendular, and the main routes are often national roads, in particular Route Nationale 27 (RN 27), which serves Commune 1; RN1, RN7 and RN27, which serve Commune 2; RN1, RN4, RN7 and RN5, which serve Commune 3; RN5 which serves Communes 4 and 5; and RN6 and RN7, which serve Commune 6. Almost all of the minibus routes (92%) are radial, converging on the town centre where most of the jobs, economic activities and major basic service infrastructures are concentrated [27]. From the right bank of the River Niger, the left bank, where the centre is located, is only accessible via three bridges: the “Pont des Martyrs”, the “Pont Fahd” and the Third Bridge. In town, the "sotramas" have their termini concentrated in communes 2 and 3, notably Gare de Médine, Railda, Assemblée nationale, CHU, parking vox and "anneau sotrama". The vehicle fleet (Figure 5) is very old, and most of the minibuses are over 30 years old.

Figure 5. Sotrama in Bamako
Source: Author, photo taken at the Vox car park in Bamako in 2023

"Magbana" network in Conakry. The development of paratransit in Conakry, in particular collective taxis, minibuses and motorbike taxis, is the result of the failure of a formal public transport system, as in many African cities. From the first Republic of Guinea (1958) until 1984, the “Société des Transports Urbain de Conakry” (TUC), directly managed by the State, was responsible for transporting the population. The “Société Générale de Transports Guinéens” (SOGETRAG), a mixed economy company, took over from the TUC in 1985 when it ceased operations. SOGETRAG operated until 2000, when it disappeared. In the 90s and 2000s, private urban transport services began to develop alongside SOGETRAG in the Guinean capital. These included the companies “Futur Transport Béa” and “Cellule d'Appui et de Gestion Transport Urbain Conakry” (CAGETUC), which, although not viable, gradually took over a significant modal share from SOGETRAG. This led to the creation of “Société Guinéenne de Transport” (SOGUITRANS) in 2008 and “Société de Transports de Guinée” (SOTRAGUI) in 2012. SOGUITRANS will disappear 3 years after its creation in 2012 and SOTRAGUI will cease its activities in 2018, leaving the entire market to informal transport. This informal offer has always been dominated by collective taxis, which accounted

for 36% of motorized transport in 2016, compared with 30% for minibuses, just 1% for SOTRAGUI and other buses and cars 3% [29]. In recent years, there has been a decline in the minibus fleet, which in 2019 reached 20% of the paratransit fleet at a time when collective taxis accounted for 80% [17]. A reduction in the supply of “magbanas” is due to several factors linked to the political context of neighboring countries, Liberia and Sierra Leone, where many nationals of these countries who found refuge in Conakry invested in the “magbanas” business. Today, most of them are back in their respective countries. Other factors include the advanced obsolescence of the fleet and the accessibility of financing for tricycles, which are direct competitors.

As in the other cities studied, the nature of journeys is pendular, and the urban form of the Guinean capital does not offer much scope for developing transport infrastructure, again because of physical constraints. Most of the traffic in both peak and off-peak periods is carried along three main routes, namely the “Corniche Nord”, the “Fidel Castro motorway” and the “Route le Prince”, which is over thirty kilometers long. These roads run longitudinally and in parallel, converging at the tip of the peninsula in the commune of Kaloum and crossing six municipalities: Matam, Dixinn, Matoto, Ratoma, Dubréka and Coyah. A count carried out by the University of Koffi Annam in 2015 gives the modal share of "magbanas" as a proportion of journeys recorded on each of these radial routes, i.e., 42% on the motorway, 26% on Route le Prince and 4% on the Corniche Nord at a time when the share of collective taxis was respectively 21%, 48% and 59% [29]. By 2024, only the first two lines will be served by these minibuses. In addition to the long routes that these minibuses share with taxis, the latter also serve the 10 transversal routes that run perpendicular to the three major arteries right up to the edge of the conurbation. Figure 6 shows the advanced deterioration of the "magbanas".

Figure 6. Magbana in Conakry
Source: Author, photo taken at Madina in 2024 in Conakry

The road network remains a challenge for the public authorities, with secondary and tertiary roads often undeveloped and impassable, which means that public transport is only concentrated on asphalted roads, sometimes a long way from residential areas [29]. On the outskirts of the Guinean capital, the busiest stops are at crossroads, at the junctions between the main routes and the transversal routes (T). In 2018, over 65% of APT, "magbanas" and shared taxis, were over 30 years old. The minibuses, which have a capacity of 18 to 21 seats, have their main terminus in the city at Madina (Dixinn) and at the opposite end of the port of Conakry (Kaloum).

3.3 The minibus networks, an accessible offer but mediocre services

The accessibility of minibus services in the three cities is assessed through the proximity of services to passengers, the waiting time at stops and the cost of travel. Service reliability is analyzed by the regularity of services obtained if the standard deviation of vehicle frequencies at peak and off-peak times tends towards zero (0). Tables 2 and 3 show the results of the Chi-square tests and the distribution of passenger responses on the accessibility of minibus services in the different networks studied.

3.3.1 Interdependence between service accessibility and network type

The interdependence between network type and service accessibility in paratransit by minibuses is analysed using the Chi-square test (Table 2). To test this interdependence, we applied the Chi-square test on indicators, such as network coverage, walking time to go to stop, waiting time, and pricing on the basis of data obtained from users' déclarations in different minibus networks in the three cities.

Table 2. Chi-square test of minibuses service accessibility

Chi-Square Tests	Valeurs Théoriques	Test X-Squared	P-Value
Network coverage	> 5	85,01	< 0.001
Walking time to stop	> 5	231,02	< 0.001
Waiting time	> 5	273,25	< 0.001
Pricing	> 5	255,94	< 0.001

Source: Author, users surveys 2023-2024

The results in Table 2 show that for all the paratransit service accessibility measurement indicators selected, the p-values found are above the threshold value of 0.05. There is a link between the type of network and the accessibility indicators of minibus services in our study area according to users. In other words, users' assessment of network coverage, minibus waiting time at stops and fares depends on the type of network they travel on.

3.3.2 AFTU network, more accessible services

Figure 7 shows the statistics on what users say about network coverage, waiting time at stops, and fares for the different networks studied. About the first two indicators**,** we classified the estimated walking times of users to the nearest stop and times lost by passengers at the stop to wait for the minibus arrival, into two categories. On the one hand, those who estimate that their walking and waiting time is less than 5 minutes and, on the other, those who believe that their walking and waiting time exceeds 5 minutes. The results below show the breakdown of passenger responses to service accessibility.

According to users (Figure 7), NMN services are closer to passengers than OMN, with 73% of NMN passengers appreciating this indicator, compared to 56%, 48% and 39% for the respective services of "magbana", "car rapide” and “ndiaga ndiaye" and "sotrama". Then, users in the two first networks (AFTU and “magbana”) generally take less than 5 minutes to get to the nearest boarding and alighting point, with respectively 50% and 60% of respondents against 16% for “magbana” and 18% for “car rapide” and “ndiaga ndiaye". On the NMN in Dakar, stops 400 to 600 meters apart are visible on all vehicle routes, corresponding to approximately a 5-minute walk.

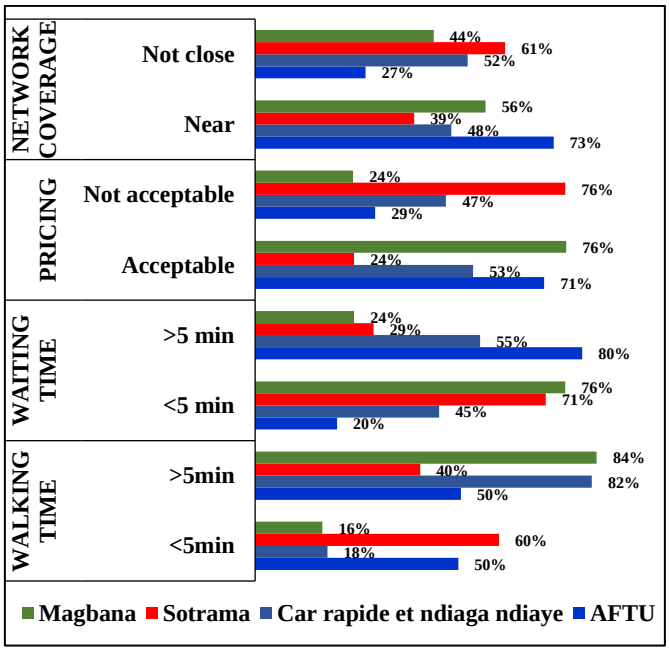

Figure 7. Distribution of user responses regarding accessibility of minibus services
Source: Author, users surveys 2023-2024

Fares are a good indicator of the accessibility of public passenger transport services. Paratransit generally targets the middle class and the poor, which means that pricing policy must take account of the incomes of these population groups. In the three cities, passengers using this informal mode of transport gave their opinion on the accessibility of the services in terms of cost. The result remains the same that network coverage and fares. NMN and "magbana" are the most popular networks in terms of pricing, with 71% and 76% satisfaction respectively. However, prices can be higher on the AFTU network than on the OMN. On the one hand, this can be explained by the fact that NMN passengers have accepted that there is an additional price to pay as part of the improvement in urban transport services. On the other hand, the ticketing system and the official pricing system introduced in the AFTU network guarantee the stability and transparency of ticket prices. In contrast, the users in the other OMN are agreed for 53% in "car rapide" and "ndiaga ndiaye" network and 24% in "sotrama" network. Thus, even if we recognize the competitive fares of the OMN in the market of urban transport, we know that they are unofficial and may be subject to negotiation between the customer and the fare collector.

The only indicator that AFTU passengers rate lower is waiting time at stops, with 20% losing less than 5 minutes waiting for minibuses to arrive at peak and off-peak times. The passengers of the OMNs wait less than 5 minutes to see the minibuses arriving at stops with 76% of respondents in "magbana" network, 71% of respondents in "sotrama" network and 45% of respondents in "car rapide" and "ndiaga ndiaye" network. However, it is important to point out that once at the stop, the minibus of OMN can lose more than 3 minutes waiting for customers, especially during off-peak hours, in an attempt to maximize its load. If we add the time lost at stops to fill their vehicles, we come close to the frequencies applied in NMNs, which are not allowed to wait for passengers at stops, as stipulated in the concession contract. Technically, in public transport, the time used to get to the stop and the time spent waiting for the vehicle at the stop (time waiting for the vehicle to arrive and time waiting before starting its journey) form an integral part of the journey time, which the operator must minimize to improve journey speed.

3.3.3 Irregularity of services and budget allocated to minibus networks by users

No frequency standards have been defined by the various networks to enable an objective assessment of service regularity. However, in the concession contract for AFTU routes in Dakar, operators are required to provide regular services and to be transparent about their official fares. The normality test is used to analyze the dispersion of minibus intervals and the budget allocated to minibuses by users around the average, in order to assess which network is the most regular, i.e., the best regulated. The results presented in Table 3 are based on frequency measurements taken at critical stops in the three cities during peak and off-peak hours. In addition, information was collected on the daily expenses incurred by users when travelling on minibuses in the study area.

Table 3. Average and standard deviations of frequencies for the various networks

Networks	Average	Stan. Dev.	Spread
AFTU	11.58	6.97	13.94
Car rapide and ndiaga ndiaye	6.40	6.79	13.58
Magbana	2.17	2.25	4.50
Sotrama	2.97	3.78	7.56
Periods	**Average**	**Stan. Dev.**	**Spread**
HP	12.09	6.77	13.54
HC	11.19	7.12	14.24
Budget per day	**Average**	**Stan. Dev.**	**Spread**
AFTU	816	403	806
Car rapide et ndiaga ndiaye	859	436	872
Magbana	1 151	723	1 446
Sotrama	525	154	308

Source: Author, frequency readings 2023-2024

Frequency and budget distributions are abnormal for all networks, with a high dispersion around the mean, especially for OMN. Table 3 confirms the results obtained from minibus users in Dakar, Bamako and Conakry on waiting time at stops. For the older networks, the average time lost at stops is less than 5 minutes. It is over 10 minutes for the new Dakar minibus network (NMN). For the AFTU network, 68% of values fall within the range (5-18) minutes, i.e., a dispersion of 14 minutes. On the other hand, the dispersion interval for OMNs is between (0.51-9.17) minutes, i.e., 68% of frequencies fall within this interval. However, the "magbana" and "sotrama" network have the lowest mean frequency and the smallest spread. It is therefore difficult to distinguish between peak and off-peak hours on the basis of the frequencies applied in all networks. This shows the relationship between vehicle capacity and public transport minibus intervals. Indeed, the larger the vehicle size, the higher the frequency between two departures.

When considering the NMN in isolation, Table 3 shows that vehicle frequencies are higher during peak hours than during off-peak hours. The new minibuses in Dakar respect the departure times according to the flow periods. However, given the constraints related to traffic management and line sizing (allocation of sufficient equipment to the line), this regularity of service is difficult to achieve, particularly at critical charging points generally located in the department of Dakar

and on the main arteries of the region. A situation that implies the responsibility of the public authorities in traffic management and the failure to respect the concession holder's commitments on the exclusivity of the operation of AFTU routes by its operators as announced in the concession contract. Also, the failures of CAPTRANS, to whom AFTU delegated the network regulation mission, should be highlighted. For the OMNs, the irregularity of their services is inherent in their operating mode, which is based on individual management where each driver freely regulates his offer. Other factors also contribute to this irregularity, notably poor traffic management in the various cities and the dilapidated state of the vehicles used by the operators of these networks. The transport budget is the daily amount spent by users when travelling on the paratransit minibus networks. Table 3 shows that 68% of the values are in the interval (413-1,219) for the AFTU network in Dakar and for the OMNs, they are in the interval (371-1,874), i.e., a dispersion gap of CFA 1,503. The spread is greater in the OMNs than in the Dakar NMN. It is therefore easier to predict the budget allocated to transport in the NMN than in the OMNs.

For all the networks, the regularity of services is not respected, but it is better in the NMN. The individual operation and fragmentation of operators in the old networks encourages the disorganization of the activity of paratransit. At bus stops, minibuses can meet at the same time and in large numbers, creating strong competition between them. This situation confirms the lack of service planning in this informal transport industry. In the same way, the budget allocated to AFTU services by their users is more regular than those of other networks, i.e., easier to predict.

4. DISCUSSIONS

The results of our research show that, overall, minibus services are accessible to users in the study area. However, there is a dependency between the type of network and the level of access to services. Passengers who use OMNs lose less time at stops to wait the minibuses arrival. However, in terms of fares and network coverage, the Dakar NMN appears to be the best according to passengers.

Network coverage depends on the study areas and may be linked to road infrastructure, transport governance and the organization of operations. Research into the proximity of public transport services in Montreal (Canada) in 2010 shows that the average walking time to a stop is more than 5 minutes, in contrast to research carried out in the United States between 1960 and 1980. This research revealed that walking distances were on average 400 m, equivalent to less than 5 minutes between home and the nearest stop [21]. In southern cities, where the road network is not dense, not well meshed and transport governance is not efficient, the results may be different from those above. Also, the fact that the paratransit concentrates more on developed and more profitable routes, sometimes far from residential areas, does not make it difficult for certain populations to access services. This is the case in certain cities in our study area, notably Bamako and Conakry, where certain neighborhoods are not well served by road infrastructure, making these areas impassable and keeping minibus services away from certain residents. Dembélé et al. [27] confirm the results of our research, showing that in Bamako, “sotrama” stops are inaccessible to users on the right bank of the River Niger who are far from the roads. This situation is similar in the Guinean capital, where “magbanas” are only accessible from the three main roads that run alongside the city, namely the RN1 motorway, “Route le Prince” and “Corniche Nord”, as well as from the transverse roads.

In the absence of any real involvement on the part of the public authorities in the organization of OMN operations in the three cities, the unions are everywhere the most visible when it comes to dimensioning the minibus routes. The operation of routes that they (unions) may consider rational, may not be so from the community's point of view, because operators are more interested in the most profitable routes, which bring in more revenue. Apart from crossroads where they can stop to wait for customers, they have no fixed stops, and untimely stops by drivers are a road safety risk [27]. In Dakar, the two networks, notably AFTU and the old network, share the same urban transport facilities, roads and infrastructures. NMN routes are approved by the authority in charge of urban mobility, not on the basis of the profitability of the routes but according to the needs expressed by demand. The network serves all the districts and municipalities in the region so as to benefit all the region's inhabitants. On their routes, the stops are physically marked by well-sized poles 400 to 600 meters apart where all the routes serving the stop are listed. The formalization of minibus operations forces operators to respect stops and itineraries, whatever the traffic load during peak periods [13]. These factors may justify the greater proximity of AFTU services compared with the old paratransit networks in the three cities studied.

When designing public transport provision, particular importance is attached to the frequency of services. As waiting time is an integral part of the traveler’s journey time, managing it properly helps to reduce journey times. Regular vehicle frequencies (regular time intervals) ensure the reliability of the services offered. The interval between journeys made by public transport vehicles is strongly linked to the urban transport environment (or context), the regulation system in place, the flow periods (off-peak and peak times), the traffic days (working days, weekends, public holidays, school holidays and the school term), the type of service and the capacity of vehicles. In our study on minibuses, whatever the context, the time spent by passengers at stops waiting for vehicles rarely exceeds 5 minutes in both off-peak and peak periods. However, depending on the flow of traffic, particularly at times when traffic is less dense, minibuses may stop for long periods at stops to wait for customers. This can be a normal situation for OMN, which operates on an individual basis. Unlike NMN, operators are bound by a schedule, and no vehicle should lose time at a stop. AFTU operators have always complied with the specifications regarding respect for timetables and stops, but for some time now, vehicles have been waiting for passengers at stops, especially at off-peak times, as OMN does. This situation has arisen at a time when most operators have paid off their loans with AFTU. The operators of "car rapide" and "ndiaga ndiaye" in Dakar, "sotrama" in Bamako and "magbana" in Conakry do not attach particular importance to the frequency of their vehicles because of their individual operating mode. The fact that their services is not organized exacerbates competition between them and means that many minibuses meet at the same time and in the same place to load their vehicles as part of their activity. On this subject, studies [2, 8, 9], through theoretical analysis, consider minibus services to be unplanned and irregular, thus confirming the results of our work. In the

book [9], authors McCormick, Schalekamp and Mfinanga compare paratransit in Cape Town, Nairobi and Dar es Salaam, and find that services are of low quality. They highlight the lack of vehicle comfort and the poor frequency of services, especially during off-peak hours. They also underline the difficulty for users to accurately predict vehicle departure and arrival times, and the lack of safety on board minibuses. Technically, the low frequencies recorded, especially for OMNs, make it impossible to judge the quality and rationality of the services offered. The fact that minibuses arrive at a stop at the same time means that drivers sometimes wait for customers for long periods to maximize their vehicle's load. As a result, OMN services can be described as mediocre. Regularity, which is assessed on the basis of the consistency of the intervals at which vehicles pass by, helps to confirm or not the efficiency and reliability of the public transport offer. The NMN in Dakar, which is in the process of being professionalized and formalized, even though it has the highest frequencies, is in this process of respecting intervals. For reasons linked to traffic conditions and the capacity of the lines, particularly the number of minibuses assigned to the routes, it can be difficult to maintain regularity on certain sections of the road. However, in both peak and off-peak periods, the average interval between AFTU minibuses is around 10 minutes. These frequencies are better than those of the Manila MRT-3 metro in the Philippines. Mijares et al. [30] show in their work that metro passengers lost an average of 30 minutes in the queue before boarding in the train to complete their journey. Concerning regularity, the results of our work differ from those of Nwaogbe et al. [19], which show that 77% of tricycle users in Aba consider the services of this mode of paratransit to be regular. However, the approaches used are not the same. These authors tried to understand users' opinions of the regularity of tricycle services (subjective approach). In our case, regularity is assessed objectively through the analysis of minibus frequencies taken at critical stops on the various networks studied.

Passengers using the minibus networks in the study area generally liked the fares applied by the operators. Although the approach adopted in this study is not the same as that of the study [19], the results remain identical. According to these authors, 72% of users of tricycles in Aba, Nigeria, were satisfied with the fares charged by operators. Fares are more appreciated in the AFTU network, which applies official fares that are known to all users and monitored by the public authorities, unlike in the older networks where fares are unofficial and may even be negotiated between the fare collector ("apprenti") and the passenger. Fares are an important indicator of the service quality of public transport. It can make the transport system very attractive through its transparency and accessibility. Pricing policy should be aligned with the income of the population, especially the poorest, to avoid discrimination in supply design [9, 6]. A condition that can be met by OMN services. Nevertheless, improving travel conditions in urban spaces comes at a cost that users should be prepared to pay. The study [31] shows that in Bamako, for example, public transport fares, particularly those of the paratransit, have changed little over the past 20 years. However, because the operators have no control over fares, they can sometimes negotiate with customers, especially during rush hour or in unfavorable weather conditions (e.g., rainy periods), for example, to cut a journey and charge double the normal fare. In such cases, it is difficult to effectively plan a daily budget for the paratransit. The low fares, transparency and ticketing system introduced by AFTU make it possible to forecast users' expenditure more accurately and make the system more attractive. In this sense, Varghese et al [32] shows in their studies of Dhaka's Mass Rapid Transit (MRT) that the sensitivity to passenger affluence in the MRT depends on passenger incomes and that public transport networks are more attractive if they apply low fares. The attractiveness of the AFTU network in the face of high demand for transport, especially at peak times, means that the NMN does not guarantee a certain level of comfort. The vehicles are sometimes so full that the drivers have difficulty closing the minibus doors.

The results of our study have several implications for the regulation and formalization of artisanal transport in Africa. More rigorous supervision of paratransit actors, particularly in terms of traffic management, fare control and safety, can only be achieved by strengthening regulation in the cities studied.

Furthermore, the formalization of informal transport operators will require improved governance, involving effective coordination between public and private actors in the urban mobility sector, as suggested by the studies [33, 34]. This would be a first step towards modernizing the APT, notably through a policy of renewing and maintaining minibuses, along the model of recent AFTU initiatives, which could be adapted to the contexts of Bamako and Conakry. In addition, improving the operating conditions of small-scale transport would encourage the integration of the various transport networks (mass and informal transport) into a coherent overall system. Finally, on a socio-economic level, this transformation would have a positive impact on employees' working conditions, offering them a more stable and secure environment.

5. CONCLUSIONS

This research aimed to assess the accessibility of paratransit minibus services in three cities in neighboring countries, namely Dakar, Bamako, and Conakry. The study compared four public transport networks serving municipalities and neighborhoods in these three West African capitals. Using public transport performance indicators such as waiting time, proximity of services and fares, we assessed the difference between the OMNs, namely the "car rapide", the "ndiaga ndiaye", the "sotrama" and the "magbana", and the NMN being formalized in Dakar. We examined the regularity of services provided by these different modes of paratransit by minibus. Normality and Chi-square tests were used in the research.

The results obtained show that users of the various networks are generally satisfied with the accessibility of the services offered to them. Even if passengers on the OMNs lose less time at the stops to wait arrival of minibuses, this does not prevent their service from being mediocre because it is unplanned and vehicles are irrationally allocated to routes. The Dakar NMN, which was born out of the renewal of the OMN's vehicle fleet and is currently being formalized and professionalized, is better in terms of the organization of operations. The regularity objective, which is a requirement for operators, has not yet been achieved, for various reasons linked to both internal factors (number of vehicles on the routes) and external factors (traffic management). Nevertheless, it remains the best network in terms of proximity of services and fares.

The funding of paratransit operators in Dakar has had a positive impact on the accessibility of services for passengers. However, even though our results show that it is the best network, the quality of its services has tended to deteriorate over the years. In recent years, disagreements have arisen between operators and the authorities over how to raise ticket prices. They often argue that fares should be brought into route with soaring fuel costs and difficult operating conditions. In the face of the public authorities' inability to do so, they were forced to increase fares. To this must be added the practices of certain drivers who tend to wait for customers at stops, especially at off-peak times, thereby wasting passengers' time.

Shortcomings in the design and execution of the project and a lack of long-term vision may be factors in this degrading phenomenon. Despite the concession of the routes, the supervision and monitoring of the operators was not rigorous during the term of the lease. Now that most of the operators have paid all the sums owed to AFTU, it is not easy to make them respect the terms of the contract and the specifications initially agreed with the grantor. In the same way, the public authorities have not been able to play their full role in controlling operations and are also shirking their obligations to AFTU's operators. A clear vision of what the NMN should be in the overall urban transport system in Dakar had to be set out at the design stage of the project. This would enable the operators to maintain their commitment to improving the accessibility of minibus services in a sustainable way.

To remedy these shortcomings and sustainably improve paratransit services by minibus, it is recommended that an autonomous local authority, endowed with sufficient financial and human resources, be set up and made operational within the UTP to manage mobility. Strengthening this institutional framework would be an essential step towards optimizing the regulatory environment, enabling the necessary funds to be mobilized and centralized efficiently. This would facilitate not only financing, but above all effective governance of the urban transport sector in West African cities. This study, while helping to strengthen the literature on the subject of reforming artisanal transport by financing its operators in Africa, also enables politicians and urban transport professionals to draw inspiration from the Dakar experience to avoid shortcomings in the implementation of transition projects from informal to formal or the more formalized integration of paratransit into the regular transport system. In this respect, we can mention the new hierarchical CETUD system with priority lines that may mark the desired evolution of AFTU operators towards legally recognized companies. However, this study does have some limitations that could provide the scientific community with avenues for future research. Firstly, the sample size could have been more representative given the high demand for transport in the study area. Although the number of people surveyed seems sufficiently representative for each agglomeration included in our study area, an average of 60 respondents per commune or department may be more representative. Secondly, the accessibility indicators used in the study are not exhaustive and could have taken into account other indicators such as the behavior of ticket collectors towards passengers, the availability of information for users, etc. Thirdly, even if the modes of operation of paratransit are similar in the three cities and the nature of the journeys is identical, the regulatory, institutional, political, economic, social and cultural contexts are not necessarily the same, which may have an influence on the results. So, to generalize the results of our study to other African cities, it is essential to take into account all the constraints mentioned above.

From the Dakar experience, it should be noted that any attempt to assimilate such programs to purely commercial ends could lead to unsatisfactory results. In such cases, the project designers tend to put more energy into collecting funds than into organizing the transport sector, which is the purpose of such an operation. The conditions initially put in place by the grantor for the beneficiaries of the funding will be respected as long as the loans are being repaid. But once the loan is paid off, if there is no more ambitious policy, there is a risk that the actors will return to the initial situation, sometimes even worse.

Future research could look at the accessibility of flow-generating areas via paratransit by minibus in the same study area. In particular, it could examine user travel conditions through a comparative analysis of criteria such as speed, comfort, crew behavior and safety within these networks. In addition, researchers could study the impact of APT vehicle renewal projects on sustainable urban mobility in West African cities, by comparing old and new minibus networks, along the lines of the developments observed in Dakar.

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