Journal of Infrastructure, Policy and Development 2025, 9(1), 10581.
https://doi.org/10.24294/jipd10581

Article

Intermodal practices between land transport and the hub of Lomé airport in Togo

Kossi Dizewe[1,*], Assogba Guézéré[2,3], Iléri Dandonougbo[4]

[1] Research Laboratory on Spaces, Exchanges and Human Security (LaREESH), University of Lomé, Lomé 01 BP 1515, Togo
[2] Research and Expertise center on spaces and societies Dynamics (PREDES), University of Kara, Rue de l'ENI, Kara BP 43, Togo
[3] Regional Centre of Excellence on Sustainable Cities in Africa (CERViDA-DOUNEDON), University of Lomé, Lomé 01 BP 1515, Togo
[4] Regional Centre of Excellence on Sustainable Cities in Africa (CERViDA-DOUNEDON), University of Lomé, Lomé 01 BP 1515, Togo
*** Corresponding author:** Kossi Dizewe, kossidizewe@gmail.com

CITATION

Dizewe K, Guezere A, Dandonougbo I. (2025). Intermodal practices between land transport and the hub of Lomé airport in Togo. Journal of Infrastructure, Policy and Development. 9(1): 10581. https://doi.org/10.24294/jipd10581

ARTICLE INFO

Received: 27 November 2024
Accepted: 11 December 2024
Available online: 13 January 2025

Abstract: All air travellers in Togo pass through Gnassingbé Eyadéma International Airport (AIGE: Aéroport International Gnassingbé Eyadema) of Lomé. To get in or out of the airport, they must use other means of land transport as part of an intermodal approach. The urban transport system in Lomé is disjointed, with no interconnection between the land transport hubs and the airport hub, making it extremely difficult for users to get to and from AIGE. It is true that there is a public transport service called SOTRAL, but it does not serve the airport, while the use of artisanal transports to access the airport is prohibited or very restricted. The aim of this study is to analyse intermodal practices between land and air transport in Great Lomé District. The methodological approach used is based on surveys of passengers at bus stations and AIGE, interviews with transport stakeholders, counts of feeder and distribution modes, and observation of practices in the field. The study shows that in the absence of a specific transport service to serve the main multimodal hubs such as the airport, travelers are bound to use their own means of transport or hire very expensive artisanal transports or private vehicles to get to the airport. To leave the airport, travelers make more use of the airport's VIP private taxis (32%), which are very expensive on arrival. Those who do not want to hire the airport's expensive private taxis are forced to walk 300 m with their parcels to pick up a city taxi at the side of the road.

Keywords: Grand Lomé (Togo); AIGE; intermodality; interchange; transport network; network integration

1. Introduction

Ground access to airports is an important factor in facilitating passenger travel. Faced with this challenge, airports are seeking to offer optimum accessibility by combining different modes of transport and assistance services to meet the varied needs of passengers. These airports are designed as "transfer points between different forms of automobile mobility and airlines" (Boichon, 2016, p. 4). As major gateways to the air network and the metropolitan areas they serve (Pierre, 2013, p. 6), airports are genuine multimodal hubs characterized by two properties: "Their centrality within a network and their intermediation capacity, that of organizing and structuring flows" (Fleming and Hayuth, 1994, p. 5). These hubs are places where 'flows are concentrated, dispersed and their complexity managed", acting as "network nodes" (Agnès, 2007, p. 86–88) or "circulatory nodal spaces" (Pierre, 2013, p. 56). Airports lead to the organization of multiple land transport networks, which in turn structure the regions. The multiplication of infrastructures makes multimodality effective and

intermodality possible. According to Pierre (2013, p. 7), the hubs with the largest areas of influence are those where ground access to airports is a major issue. For urban centers, the land transport services available from the hubs and the quality of their intermodal services are a criterion for distinguishing them from their competitors. Intermodality therefore focuses on the development of load breaks between two modes, known as interchanges (Cyprien et al., 2016, p. 2). This practice is facilitated by the articulation of a multimodal transport offer within interfaces called interchanges, as well as by an integrated approach to user information and service pricing. Passenger intermodality, by organizing the transition from one mode of transport to another and from one place to another, makes it possible to respond to the significant demand for travel. More than just new sections of network, it is helping to change users' perceptions and practices in the region (Pierre, 2013, p. 6).

The Gnassingbé Eyadéma International Airport (AIGE), located in Lomé, is of strategic importance not only for the Togolese capital, but also for the West African sub-region. The airport is a strategic point for air connections between West Africa and the rest of the continent, as well as facilitating trade and tourism. As Togo's main airport, AIGE plays a central role in the national economy and is an essential link in the regional transport network. However, its land accessibility remains a major challenge, particularly for intercity travellers, who have to contend with a fragmented and poorly co-ordinated transport system.

In sub-Saharan Africa, intermodal organization is still in its infancy (Pierre, 2013, p. 25). The continent faces major challenges in improving the accessibility of its airports, particularly in terms of land transport infrastructure (African Development Bank Group, 2019, p. 15). The integration of airports with road, rail and port networks is fairly limited, with less efficient logistics chains between the different modes of transport (Berger, 2016, p. 14). Many African airports are far from city centers, which makes access difficult (Boichon, 2016, p. 15). Road traffic congestion around airports is also a common problem, degrading their accessibility (Kouwenhoven, 2008, p. 4). Solutions such as high-service buses, cable transport and the organization of informal taxis are being explored to improve multimodality (Mazzola, 2019). Major airports such as Dakar (Senegal) and Abidjan (Côte d'Ivoire) offer taxi, shuttle bus and TER services to link the airport with the city center and hotels[1], promoting intermodality.

In the Great Lomé District, intermodality involves the combined use of public transport (SOTRAL), shared taxis and motorbike taxis. Analysis of mobility practices in Lomé shows that "these different transport services are insufficiently organized and not at all coordinated, since the bus, city taxi, motorbike taxi and tricycle networks operate independently" (Abélim et al., 2021, p. 2). The geographical location and level of organization of the various modal interchanges are out of step with the residential patterns and intermodal practices of the people of Greater Lomé. In the absence of a specific transport service to the airport, travelers are forced to hire very expensive artisanal means of transport to get to or from this multimodal interchange. Intercity travelers arriving in Lomé are also faced with high feeder and distribution costs from this multimodal interchange. These intermodal practices, which are already very restrictive, become even more pronounced when it comes to getting from one origin to a destination with goods. As Jean-Jacques et al. (2001, p. 14) point out, the efficiency of transport systems is determined by the nodes, whose function within

networks is to ensure connections and disconnections, but which are also the places where decisions are made and value is added. In view of these shortcomings, the linking of several journeys is a constraint. Lourdes et al. (2016, p. 4) describe intermodality as "suffered, de facto and not de jure". This observation raises the problem of the poor organization and lack of integration of transport networks in Great Lomé. This fundamental concern leads us to the following question: What explains the lack of intermodal practices between land and air transport in Great Lomé?

The aim of this research is therefore to analyse intermodal practices between land transport and air transport in Great Lomé District Lomé, focusing on the organization of networks and interchanges as well as passenger feeder and distribution practices to/from airport. This study is structured in two parts. The first section presents the methodological framework. The second part analyses the results of the research. Specifically, this last part analyses the organization of the networks and interchanges in Grand-Lomé, as well as the practices used by travelers to get to and from the AIGE.

2. Methodological framework of the study

The methodology used is based on classic field survey techniques in the social sciences and humanities. It is based on a mixed approach, combining qualitative and quantitative methods for data collection and analysis. The first approach appears useful for the descriptive analysis of data and factors that are not visible with simple statistical measurement. It has made it possible to observe the phenomenon, to deepen knowledge based on the analysis of documents, and to obtain the opinions of players and transport users through questionnaires and interviews. The quantitative approach is based on the collection and analysis of numerical data obtained from empirical investigation. Each of the two methods therefore provided distinct information to enrich this work. The two methodological approaches are structured into two essential phases. These are data collection and processing, which are analyzed in this article.

2.1. Data collection

In the context of this research, observation was the primary method of data collection, carried out through field visits. The tool used for this type of data collection was the observation grid, which focused mainly on the physical characteristics of the interchange between ground and air transport, accessibility, signage, passenger information, and interchange facilities and equipment (AIGE). The main aims of this observation technique were to: (1) identify the problems inherent in the AIGE's facilities; (2) describe the modes of transport used by users to get to or from the AIGE; (3) analyse the state of the AIGE's access routes, facilities and organization.

The second stage of data collection was documentary research, which was essential to provide documentation and useful information to better present the scientific context of the subject. The documents consulted included scientific works such as dissertations, theses, articles and reports. This documentation was useful for listing all the previous work carried out on urban transport and transport network interconnection issues. The emphasis is on work relating to the governance of urban transport, the organization of the various transport networks and the links between the various land and air transport systems. Work on the demographic and spatial dynamics

of Great Lomé District was highlighted in order to understand urban development in relation to transport infrastructure and services. The summary of the literature review provided a good theoretical framework for integrating transport networks in Great Lomé. The other major phase of the field survey was carried out by means of direct interviews with randomly selected passengers at the waiting halls, flight boarding gates and airport car park. It backed up the questionnaire survey of "passenger users" and drivers of small-scale modes of transport to and from the airport, in order to understand how they use the AIGE to get to and from the airport. These surveys provided statistical data and gathered users' assessments of the condition and operation of the interchanges, as well as their opinions on the conditions for intermodal use, the quality of facilities and services, and their expectations.

The quantitative data was supplemented by qualitative information obtained from resource persons likely to shed light on issues of modal interconnection or the integration of the urban transport networks of Grand Lomé. The people targeted for these interviews were the authorities in the ministries responsible for transport (Ministry of Road, Air and Rail Transport), road infrastructure (Ministry of Public Works) and town planning (Ministry of Town Planning, Housing and the Living Environment). These meetings also concerned the officials in charge of ensuring security at the AIGE, the heads of local authorities (Great Lomé District), public and private urban transport companies (SOTRAL, Olé Togo, Z-mobile), bus stations, trade union organizations (motorcycle taxi drivers, collective taxis, etc.) and the Delegation for the Organization of the Informal Sector (DOSI); companies providing vehicle rental services for the feeding/distribution of passengers to/from the AIGE. During the meeting, it was a question of gathering information on the subjects of the governance of urban, airport and interurban transport, the integration of networks or intermodality between the different transport systems in Lomé.

2.2. Data processing and analysis

The statistical processing of the data was carried out after the field surveys. All the data collected was analyzed using Sphinx and processed using Excel. The tabulated data was used to produce tables and graphs to give a quantitative dimension to the various representations of the populations. The analysis of the data collected was used to produce thematic maps to better explain the phenomena observed and to make the locations and networks easier to understand. These maps are processed on the computer using ArcGIS 10 and Illustrator. Internet research was also used to obtain some physical data for the study site from the "Google-Earth" and "Global mapper" software.

3. Results

The fieldwork yielded results in the form of quantitative and qualitative data, which are analyzed in this section.

3.1. Presentation of the study framework

This section presents the Lomé airport hub by analyzing its territorial and governance framework. The main aim is to describe this transport infrastructure in

geographical, historical and organizational terms, not forgetting its influence at local, national and regional level.

3.1.1. AIGE, a dynamic hub in Great Lomé District

Lomé-Tokoin International Airport, renamed Gnassingbé-Eyadema International Airport (AIGE) in 2016, is a national and international airport located in the commune of Golfe 2, along Avenue de la Paix, five km north-east of the city center (Lomé's main market). It is Togo's only international airport serving Greater Lomé and the Maritime Region. The country has a second airport called Niantougou International Airport, which was opened in 1981. It is mainly used by the Togolese air force and civilian government flights, with occasional charter and private flights. Its commercial traffic is very embryonic, as attempts to schedule regular commercial flights to serve northern Togo, such as round-trip Ouagadougou-Niamtougou-Lomé services, have not proved commercially viable. The figure below shows the location of AIGE in Great Lomé.

Figure 1 shows that the AIGE is located in the extreme south-east of the Golfe 2 commune between latitude 6°10′ 7.990″ North and longitude 1°15′ 15.36″ east. It covers an area of 413 hectares and handles direct flights to and from New York and Johannesburg. On 25 April 2016, a new terminal building was inaugurated after extensive expansion and modernization work lasting 4 years. As a result, AIGE's capacity has increased from 700,000 passengers per year to 2,000,000 passengers per year, while its freight handling capacity has increased from 15,000 tonnes per year to 50,000 tonnes per year (Kpemoua, 2018, p. 10). The figure below shows an aerial view illustrating the administrative boundaries of AIGE.

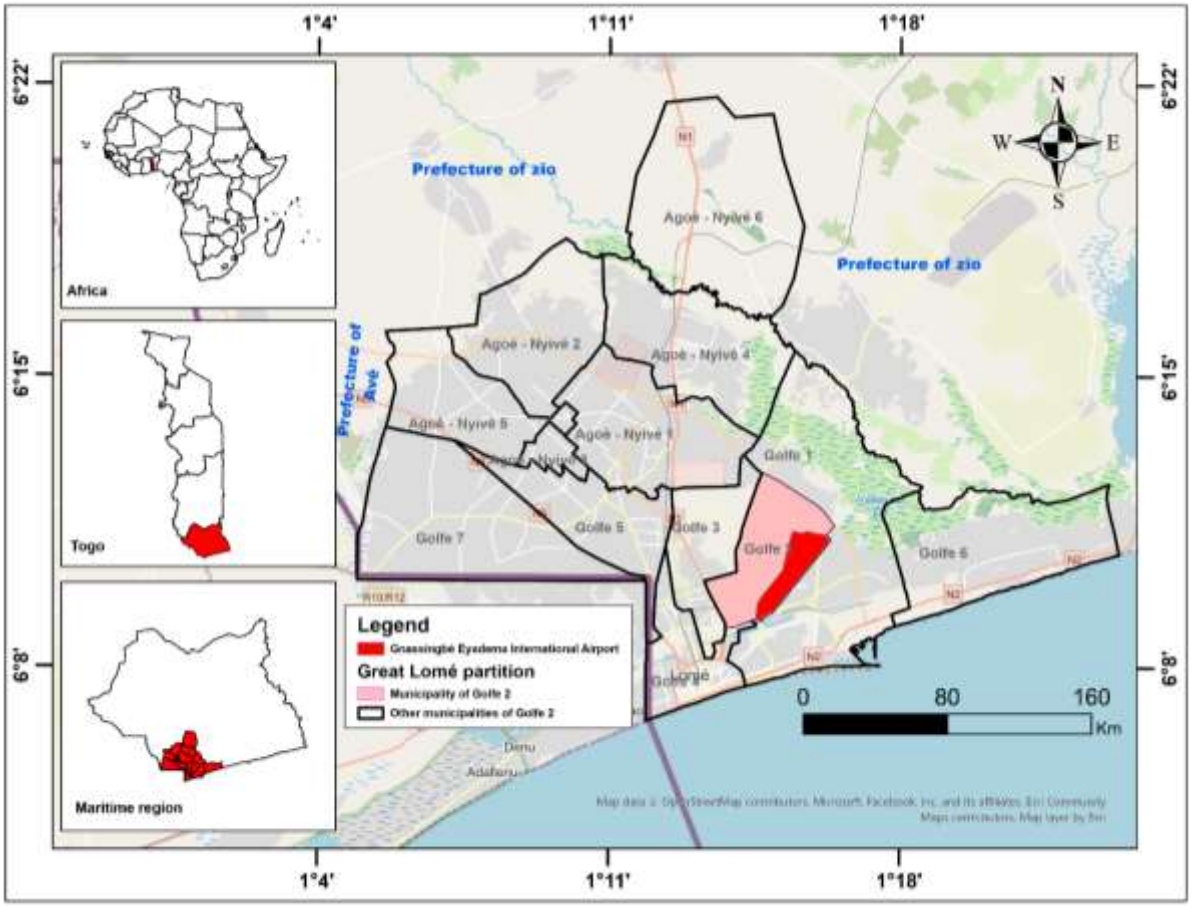

Figure 1. Location of AIGE.
Source: OpenStreetMap, processed by the authors, 2024.

The figure below shows an aerial view illustrating the administrative boundaries of the AIGE.

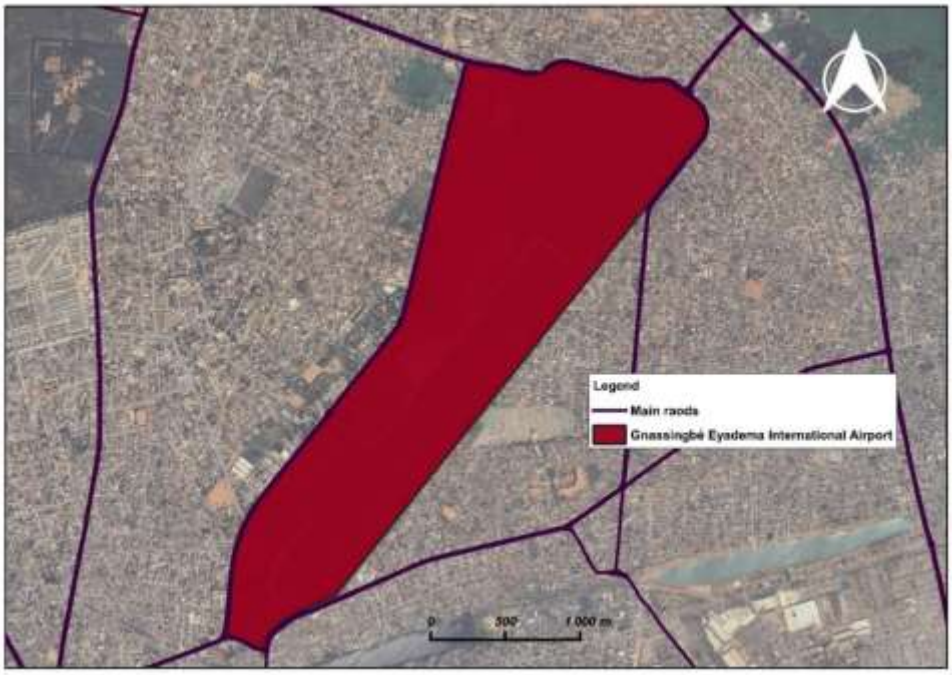

Figure 2. Aerial view of the boundaries of the AIGE.
Source: Authors, 2024.

Figure 1 shows the outline of AIGE, which is rectangular in shape, with two parallel runways running north-east and south-west. AIGE began work on modernizing its infrastructure in 2010, as part of the project to renovate the country's airport, port and road infrastructure. The apron was extended to accommodate fifteen wide-body aircraft, and the new terminal building, with a main hall featuring twenty-four check-in desks, was inaugurated on 25 April 2016. Since 2010, AIGE has seen strong expansion thanks to the arrival of the African airline Asky, which is headquartered in Lomé.

The latest modernization work at AIGE, financed by China Exim Bank and carried out by Chinese companies, was completed in 2019. The work mainly involved reinforcing the runway and taxiways, extending the new terminal building, installing two footbridges and building an aircraft parking area. Today, the terminal has a surface area of 25,000 square m, with five footbridges, which has significantly increased the frequency of take-offs and landings at the airport, as shown in the figure below.

The **Figure 3** shows the AIGE terminal, with the visible boarding bridges that did not exist before its redevelopment. The renovation of the single runway and the development of two taxiways have allowed direct access to aircraft, thus improving the fluidity of operations such as landing and takeoff traffic. The management and operation of AIGE have been ensured since 1986 by the (Lomé Airport Company) called Société Aéroportuaire de Lomé Tokoin (SALT), which also oversees its development. SALT is a mixed economy company of an industrial and commercial nature, with legal personality and financial autonomy. It was created and organized by Decree No. 86–85/PR of 20 May 1986. It actually started its activities in January 1987 and its shareholders include the State, the Chamber of Commerce and Industry of Togo and the insurance company GTA C2A Vie. It is the commercial manager of AIGE and has a management contract for Niamtougou International Airport.

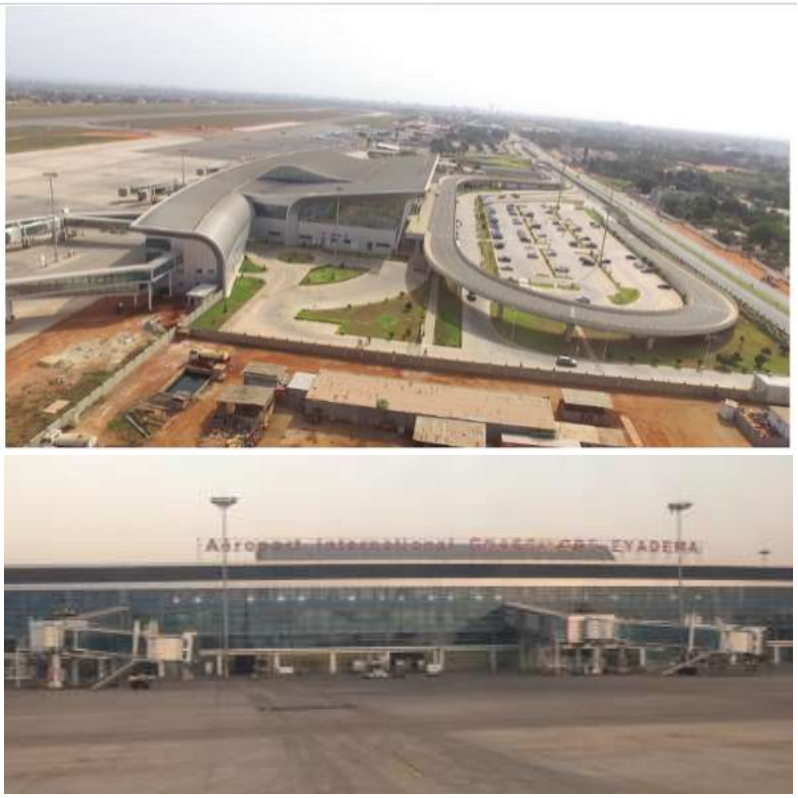

Figure 3. Aerial view of the AIGE terminal building.
Source: AIGE website, 2024.

3.1.2. AIGE, an airport platform widely connected to African capitals

AIGE is a very dynamic multimodal platform, operated by about ten air transport companies. ASKY is the leading airline that was founded in 2007 by regional banking institutions in Africa such as the ECOWAS Bank for Investment and Development (EBID), the West African Development Bank (BOAD) and the ECOBANK group to replace Air Afrique, which disappeared in 2003. According to the "Chairman of the Board of Directors and Founder"[2], its main partner is Ethiopian Airlines, which holds 40% of the capital. ASKY has achieved its success through a well-developed management policy, in close collaboration with its strategic partner Ethiopian Airlines. Its policy is focused on developing a strong intra-African network that promotes regional development, tourism, economic growth and regional integration as a major economic catalyst for the continent with its long-term objective of a sustainable business focused on profitability. ASKY's inaugural flight took place on 14 January 2010, between Lomé and Ouagadougou. Its network includes, in 2024, 28 destinations spread across 26 countries in West and Central Africa such as Abidjan, Abuja, Accra, Bamako, Bangui, Banjul, Bissau, Brazzaville, Conakry, Cotonou, Dakar, Douala, Freetown, Johannesburg, Luanda, Nairobi, Praia, Kinshasa, Lagos, Libreville, Lomé, Malabo, Monrovia, N'Djamena, Niamey, Ouagadougou and Yaoundé. ASKY currently operates a fleet of 16 aircraft including ten Boeing 737–800 s, four Boeing 737–700 s and two latest-generation Boeing 737 MAXs (Information collected from the Asky website)[3]. The table below presents the characteristics of this airline's fleet.

Table 1 shows the workforce and number of seats in the Asky fleet according to aircraft models. The analysis reveals that the "Boeing 737–800" is the most dominant

model. The number of seats varies according to aircraft models. The new aircraft models (Boeing 737 MAX) have a greater number of seats (160 seats) than the old ones (Boeing 737–700) which offer 115 seats, or 48% less than the new ones. Apart from the ASKY airline which holds the air traffic monopoly (66.2%) on the Lomé metropolitan area, there are about ten companies in transit at Lomé airport. Among these companies, through which 4.5% of passengers transit, are the companies Air Burkina, Air France, Ethiopian Airlines, Air Côte d'Ivoire, Royal Air Maroc, CEIBA Intercontinental and Bruxels Airlines (**Table 2**). These airlines transiting through AIGE thus ensure the transport of passengers from Lomé to other metropolises or hinterland countries. **Table 2** below shows the evolution of the number of passengers at AIGE according to the companies in 2023.

Table 1. Characteristics of the ASKY fleet.

Aircraft models	In service	Number of seats		Total places
		J	Y	
Boeing 737–700	4	16	99	115
Boeing 737–800	10	16	138	154
Boeing 737 MAX	2	16	144	160
Total	**16**	**48**	**381**	**429**

Source: SALT, 2024.

Table 2. Evolution of the number of passengers at AIGE according to companies in 2023.

COMPANIES	PASSENGERS					
	Arrival	***Departure***	***Correspondence***	***Transit***	***Total***	***Percentage***
Air Burkina	1554	1282	0	2338	**5174**	**0.4%**
Air France	55,902	61,591	0	156	**117,649**	**8.6%**
Ethiopian Airlines	76,459	89,880	0	38,709	**205,048**	**15.0%**
Air Côte d'Ivoire	17,665	17,396	0	5002	**40,063**	**2.9%**
Royal Air Maroc	11,413	12,863	0	8322	**32,598**	**2.4%**
CEIBA Intercontinental	2711	3143	0	1675	**7529**	**0.6%**
Asky	447,845	95,854	359,268	0	**902,967**	**66.2%**
Liz Aviation	1958	1923	0	0	**3881**	**0.3%**
Brussels Airlines	20,428	20,188	0	5073	**45,689**	**3.4%**
Miscellaneous companies	1117	1520	0	0	**2637**	**0.2%**
TOTAL	**637,052**	**305,640**	**359,268**	**61,275**	**1,363,235**	**100%**
Percentage	**46.7%**	**22.4%**	**26.4%**	**4.5%**	**100%**	

Source: SALT, 2024.

Analysis of the table above reveals a significant proportion of travelers (69%) who take direct flights from (46%) or to (22.4%) AIGE. A little over a quarter of travelers (26%) make modal connections from ASKY airline planes, which has made this airport its main connection hub. The airline "LIZ Aviation", newly established in Togo, has the lowest level of attendance (0.3%). This company opened its Ouagadougou–Lomé route on 10 June 2023. Officially launched in Ouagadougou in April 2023 with domestic flights to Burkina Faso, the company's main objective is to

improve air transport in the West African sub-region. The new Lomé-Ouagadougou route aims to strengthen trade, tourism and cultural exchanges by offering travelers a practical option without connections.

In 2020, AIGE had the 2nd intra-African passenger volume in the UEMOA[4] area according to a study carried out by the Association of African Airlines (AFRAA, 2021, p. 13). According to the report of this study which covered 36 African airports with annual traffic exceeding 500,000 passengers, Togo is second only to Côte d'Ivoire. Overall, Togo closes the continental top 10 countries with the airports most connected to other African capitals. The performance justifies the major reforms undertaken in recent years, in order to make the country a regional hub, through the extension of reception and freight capacities, in particular with the construction of a new terminal. Since the rehabilitation of Lomé international airport in 2016, nearly 1.5 million passengers have passed through Lomé annually, according to the same report.

3.2. Organization of transport networks and intermodal practices of AIGE users

The public transport offer in Lomé is made up of several complementary services that are linked together. On the one hand, there is a bus network that provides a service framework and, on the other hand, artisanal transports networks made up of city taxis and motorcycle taxis that operate online or on demand. In addition to this offer, there are interurban transport networks that complement the bus and taxi network.

3.2.1. A deficient and inaccessible public transport offer for AIGE users

SOTRAL is the only conventional public transport company by bus that was created in 2006 to operate and organize a public transport network in Great Lomé District. It began its activities in 2008 with the launch of the experimental line "BIA-Adidogomé" (SOTRAL, 2015). The network has gradually evolved with the strengthening of its operational capacities. In 2012, SOTRAL was already operating around ten bus lines, the basis of the current ordinary offer[5], connecting the outskirts to the city center in the morning and the city center to its outskirts in the evening. According to our interviews with the network's operating managers, the company integrated the student lines into the network in 2016, formalized in a partnership agreement with the University of Lomé. SOTRAL currently has 19 lines, including 9 ordinary lines and 10 student lines[6], which are exclusively dedicated to transporting students from the University of Lomé (**Figure 4**).

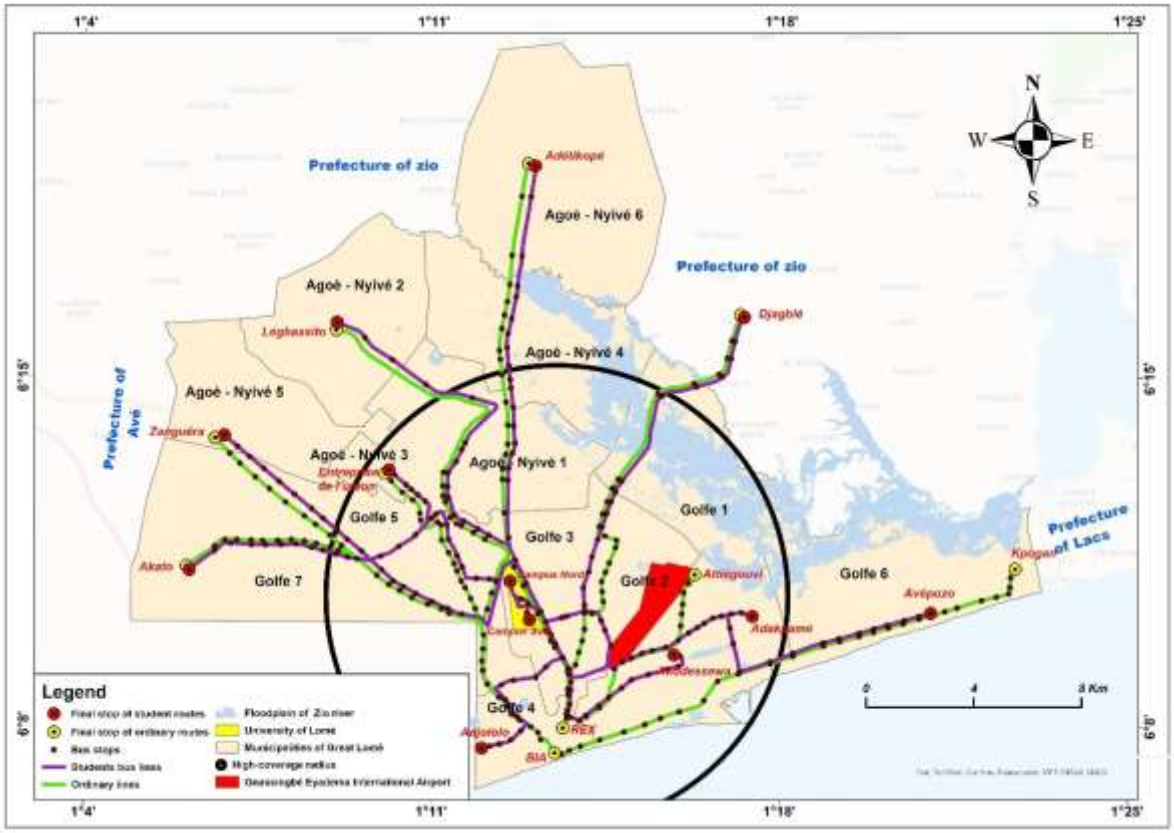

Figure 4. SOTRAL road network.
Source: Authors, 2024.

The analysis of the figure shows a high density of the SOTRAL network in the city center and a low coverage of the lines in the peripheral municipalities of Grand Lomé. The range of services on ordinary lines extends from 5:30 a.m. to 7:00 p.m. (first and last departure) with an interruption during off-peak hours between 10:30 a.m. and 3:00 p.m. on lines with low traffic. On lines dedicated to student transport, it is from 6:00 a.m. to 8:30 p.m. The average commercial speed of buses varies from 15 to 23 km/h depending on the time of day. Today, SOTRAL continues to develop by prioritizing operational aspects.

The organization of the lines poses a problem of territorial network coverage. Until 2024, the SOTRAL network is only composed of radial lines connecting the peripheral districts of the north of the agglomeration to the University of Lomé and the employment area formed by the commercial district of Adawlato and the administrative district of CASEF[7]. "That organization of ordinary lines towards the city center (Grand Marché) does not allow SOTRAL to meet all the travel needs of the population of Lomé" (Dizewe et al., 2024, p. 8), in particular for all those who want to go to AIGE. The absence of transverse lines requires the feeder of customers at the Rex and BIA termini in Assigamé before any change of direction. No transverse line is created to facilitate connections and "East-West" travel for the populations of Great Lomé. The deteriorated state of its vehicle fleet and the low number of buses available are a major problem for the opening of cross-border or specific routes. As a result, the number of regular routes has often fluctuated in recent years: 11 routes in 2020, 8 in 2021, 7 in 2022, then 9 in 2024. Two little-used lines (line 5: Togo 2000-Rex and line

9: Adakpamé-Rex) were closed in April 2021 due to a lack of rolling stock. In addition, radial line No. 5 (Togo 2000-Rex[8]) which served AIGE, has been suspended since 2021 due to its inefficiency and low ridership.

Rail transport infrastructure dating from the German colonial era remains quite dilapidated and disconnected from the SOTRAL bus network. The project to rehabilitate this infrastructure, entrusted to the Bolloré Transport and Logistics Group, with a view to reviving rail transport, including the 10 km long experimental line (railway station—Cacavéli) inaugurated since 2015, has been suspended (our interviews with the head of studies at the Road and Rail Transport Directorate, 2024). The aim was to develop a multimodal transport offer while encouraging a modal shift towards rail transport to the detriment of road transport in order to reduce the externalities induced by artisanal transport and guarantee the sustainability of transport systems. The rail transport projects envisaged mainly concern interstate rail transport, to the detriment of urban and intercity passenger rail transport.

The rail transport infrastructure dating from the German colonial era is dilapidated and out of order. There is no rail transport to serve the airport as in cities in developed countries. There was a project to rehabilitate urban rail transport entrusted to the Bolloré Transport and Logistics Group, with a view to renewing transport, the 10 km long experimental line (railway station—Cacavéli) inaugurated since 2015 is suspended. It was an interesting political project that planned to develop a multimodal transport offer to operate a modal shift towards rail transport to the detriment of road transport in order to reduce the externalities induced by artisanal transport and guarantee the sustainability of transport systems. Political projects being what they are, this project of the Bolloré group did not last long until 2013 when the initiator of the project had legal problems with the French financial prosecutor who accused him of having fraudulently helped the 2010 presidential campaigns of President Faure Gnassingbé in exchange for juicy contracts[9].

3.2.2. A poorly organized and inefficient network of collective taxis

Collective taxis or city taxis are public transport vehicles with a capacity varying between 5 and 15 seats. Recognizable by their yellow license plate, these artisanal transport vehicles mainly follow predefined lines. Almost all (96%) of the city taxi line routes according to our field work go from the Grand-Marché and are distributed in a star flow towards all peripheral urban directions, even interurban and international according to the spatial configuration of the city of Lomé as shown in **Figure 5** below.

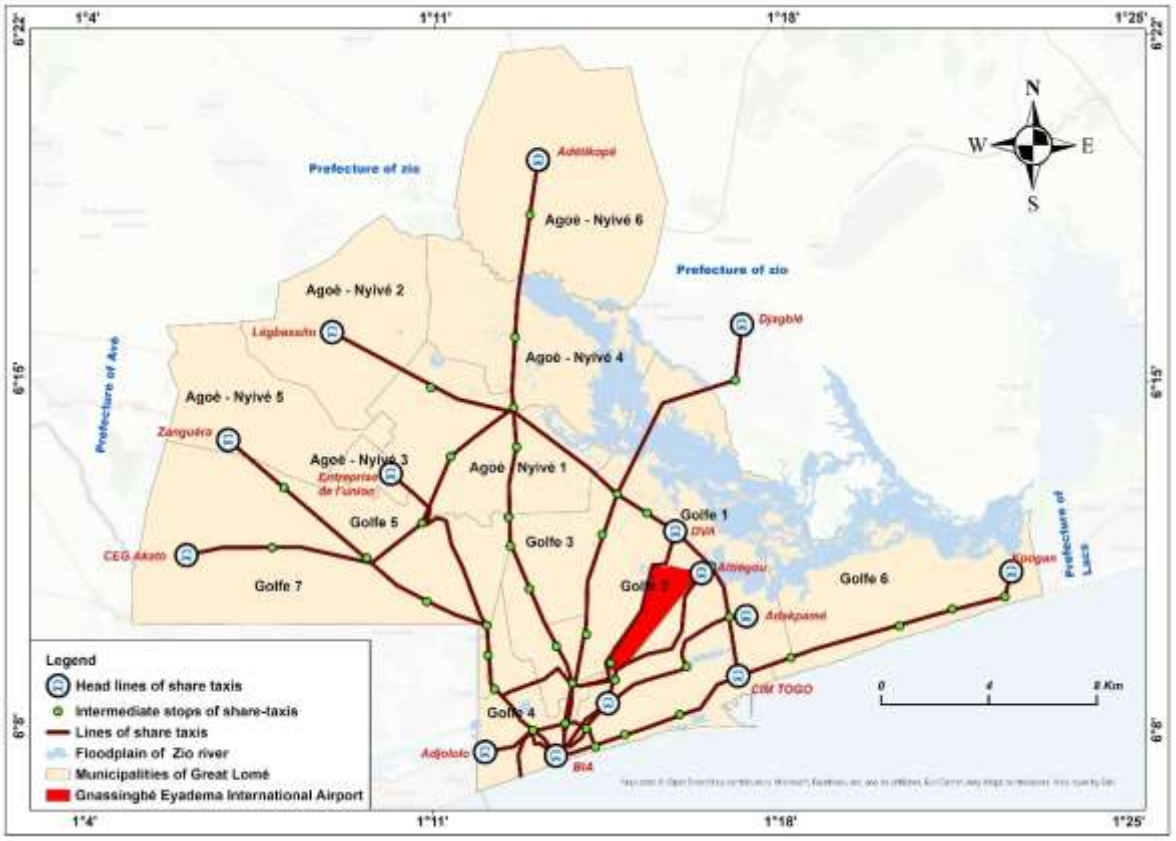

Figure 5. Network of collective taxis in Great Lomé.
Source: Authors, 2024.

Unlike SOTRAL, "the quality of service is very little highlighted in the choice of lines to travel" (Gado, 2014). They correspond to the city's arteries, presenting more or less favorable traffic conditions. These taxis have a large coverage area, making it possible to avoid isolation for many city dwellers in the outskirts where the main means of transport used remains motorcycle taxis with high fares. The network currently has around forty lines, almost twice the current SOTRAL network. Commercial speed ranges from 40 km/h to 80 km/h depending on the condition of the vehicle, traffic density and the driver's goodwill. Apart from these predefined lines, drivers also drive at the customer's request. Taxi stops are scattered throughout the city to connect urban or interurban bus lines. A study conducted by Assogba in 2008 counted at least 26 intra-urban line heads, including 10 stations concentrated in and around the shopping center with nearly 13 lines served (Assogba, 2008). Apart from the linear links that converge towards the city center, there are also cross-links connecting the other hubs of activity to each other and certain neighborhoods. Today, this network has not undergone any major changes. Analysis of the **Figure 5** above reveals that the network of collective taxis has a configuration similar to that of SOTRAL, which does not allow it to respond favorably to the needs of the population for travel to AIGE. Thus, the artisanal transport lines that should constitute an adjustment variable of the transport network have shortcomings in terms of organization. Although several studies (Assogba, 2008, 2013, 2021; Gado, 2014) highlight their advantages, it should be noted in this context that the current configuration of the city taxi network does not meet the travel wishes of the

population, particularly users of the AIGE. Indeed, collective taxis are prohibited from stopping or accessing the airport for security reasons. Only private VIP taxis or tele-taxis set up by the airport authorities and managed by SALT can access it and park on the airport platform. No city taxi line serves the AIGE as seen at Blaise Diagne International Airport in Dakar, Senegal. All shared taxi lines bypass AIGE without stopping at the entrance to serve the platform. On the way back from the trip, the only option to leave AIGE is to rent a private taxi or VIP taxi from the airport because travelers have no choice to travel with another means of artisanal or institutional transport. Others use friends or family members (parents or close relatives) who are authorized to access it with a personal car. To fall back on the platform, travelers instead resort to renting shared taxis, but they are forced to get off on the way to access it on foot. According to our field work, the walking distance from the road to the airport platform varies between 200 and 300 m. There is no train station or shared taxi stop nearby to directly serve AIGE, which makes intermodal travel difficult and expensive for these travelers. City taxis are generally not allowed to directly access AIGE for several reasons. First, any access to an AIGE security zone is subject to the possession of an access pass issued by ASAIGE (Gnassingbé Eyadema International Airport Safety Authority). Vehicles are searched upon entry and the driver must present specific authorizations. According to our interviews with the ASAIGE coordinator, these reinforced security measures aim to strictly control access to the airport, which is a sensitive area. Only private and VIP airport taxis that have obtained the necessary authorizations and authorizations access by parking on the airport platform to transport passengers or goods. This ensures that only vehicles that comply with security and regulatory standards can enter sensitive areas of the airport.

3.2.3. Disconnected transport hubs that make travel difficult

In addition to the taxi and SOTRAL networks, many intercity bus lines terminate in Lomé. They are most often operated by private coach and minibus operators. The MTRAF[10] (2024) lists 38 intercity transport lines from Lomé. Departures and arrivals are organized from 5 official bus stations, namely Agbalepédo, Kodomé, Madiba, Akodessewa and Aflao stations. The organization of these stations is not such as to connect the different networks in the city. The eastern lines serving localities located in the south-east of Togo as far as Benin and Nigeria end in Lomé via the Akodessewa and Aflao stations. Agbalépédo station has about twenty lines covering the interior of the country and Sahel countries such as Burkina Faso, Mali and Niger. The southwestern part is served by 5 lines that leave from the Kodomé and Madiba stations. These different official interchange hubs that are intended as intercity and international bus stations are in competition with other types of stations. There are formal private stations intended to receive large-capacity coaches (30 to 60 seats) from private companies and informal public stations that are loading and unloading points created by groups of drivers. Informal stations, commonly called “pirate stations” or “wild stations” are developing along the main roads of Great Lomé. The figure below illustrates the location of formal and informal bus stations in the urban area.

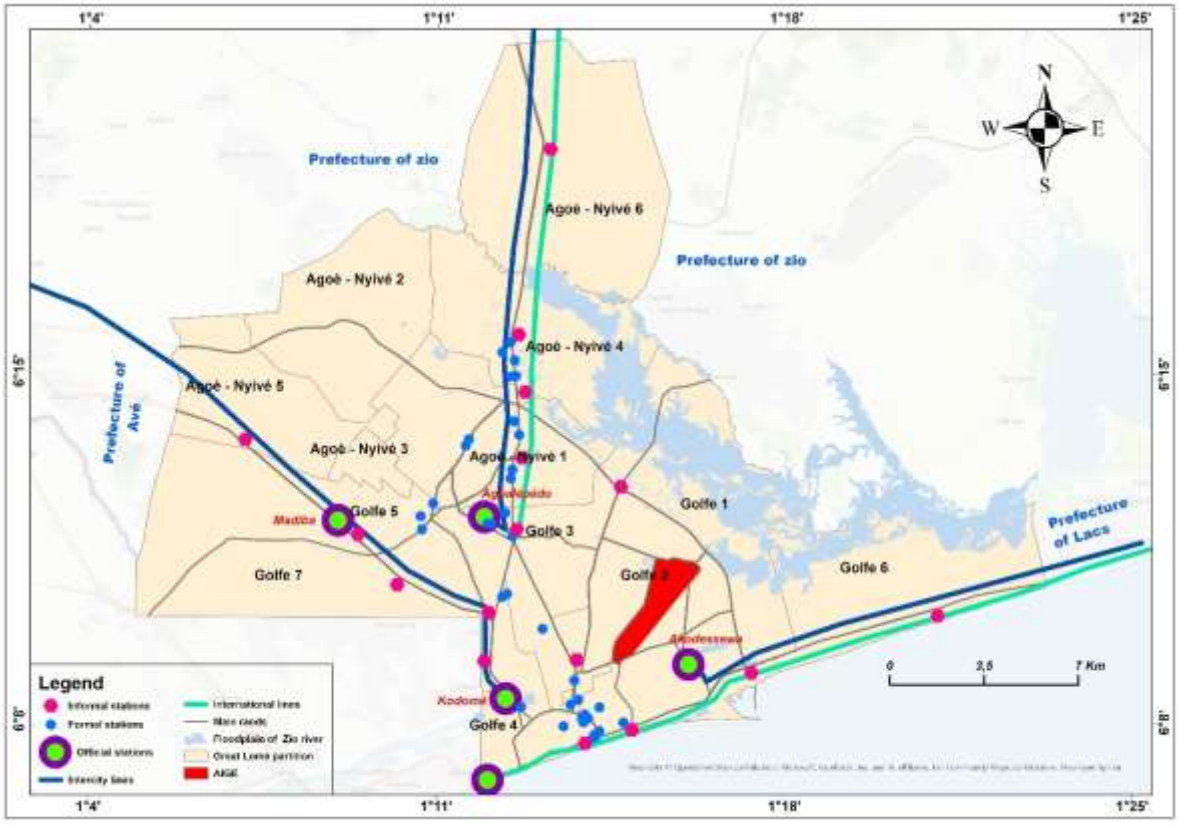

Figure 6. Location of bus stations in Greater Lomé.
Source: Authors, 2024.

Figure 6 reveals a proliferation or spread of private and informal bus stations in Great Lomé. On private initiative, these various bus stations are located throughout the city without any logic of complementarity of networks. Indeed, they are born and developed, particularly along the main roads of Great Lomé. In the absence of a Central Station, the various networks are disconnected from each other and have no direct connection with the airport. Each bus station serves in isolation lines that reveal organizational voids. Map 4 is a clear illustration of the isolated location of the AIGE in relation to the various networks and railheads that are completely disconnected, which penalizes the displacement of the populations of Greater Lomé. Those who have to leave their homes in Lomé or who come from the interior of the country to join the AIGE are obliged to hire city taxis or very expensive share taxis and to use private or personal means of transport such as private cars and motorcycles, as shown in **Figure 7** below.

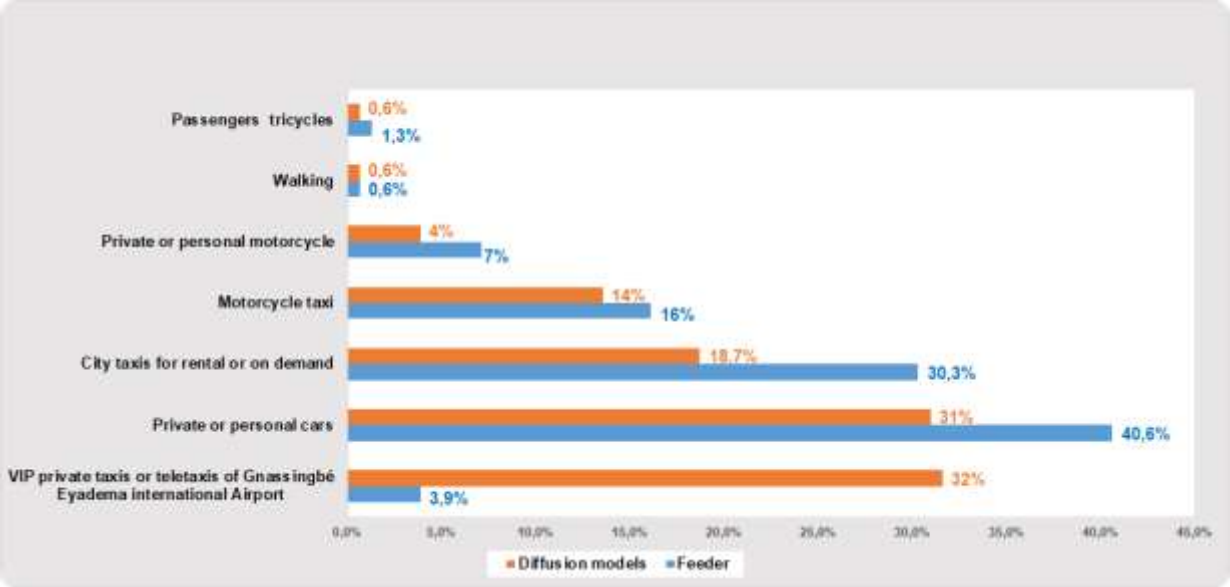

Figure 7. Modes of feeder and passenger distribution from the AIGE.
Source: Our field surveys, 2024.

The importance of the feeder means on the AIGE are not the same as those used to start from the platform. To reach the AIGE, personal means of transport, city taxis and motorcycle taxis are more used. On arrival, it is the private VIP taxis or tele-taxis of the airport that have the monopoly of passenger transport. The analysis of **Figure 7** shows that the preferred means of travel by travelers to get to the AIGE are private or personal cars (40.6%) and rented city taxis or on-demand taxis (30.3%), which are difficult to find. The different modal shares of the means of transport used, on the other hand, fall in favor of the airport's VIP private taxis for broadcast routes from the AIGE. Indeed, to leave the AIGE, travelers tend to use the airport's VIP private taxis (32%), because city taxis do not have access to the AIGE. It is forbidden for city taxis and motorcycles to access the platform or to stop at the entrance to serve the AIGE. On arrival, travelers who do not want to hire private taxis from the airport due to a lack of means must walk long distances (200 to 300 m) with their packages to pick up a city taxi, on the side of the road or proceed with a reservation through Gozem application. This situation explains the arduousness of the intermodal and accessibility practice of the AIGE, especially at night when travelers want to leave from the airport to the city.

Transport rates vary according to the distances travelled and the means of travel used to reach or leave the AIGE. The figure below shows a pricing grid for the different modes of drawdown and distribution from the AIGE.

The analysis of **Figure 8** reveals that private taxis or tele-taxis at the airport are more expensive than other means of transport to and from the AIGE. The fare for these private airport taxis is all the more expensive when the distance increases. Over a distance of less than 5 km, the difference in fare is 3000 CFA francs compared to city taxis and more than 4000 CFA francs compared to tricycles and motorcycle taxis. Beyond 20 km, this difference in fare is 10,000 CFA francs compared to city taxis and 14,000 to 16,000 CFA francs compared to tricycles and motorcycle taxis. A sign indicating the different fares is located at the exit of the public hall of the airport. It

should be remembered that in Togo, taxis are not equipped with meters and the passenger must therefore negotiate the price of the ride with the driver before entering the vehicle. Special means of travel are solicitations from a friend or family member that incur less costs. These requests are mostly free of charge or based on simple contributions to cover fuel costs. Travelers prefer city taxis over motorcycle taxis because of the packages and the great distance between the AIGE and their home in Lomé. The majority (50.5%) of travelers live more than 15 km from the AIGE.

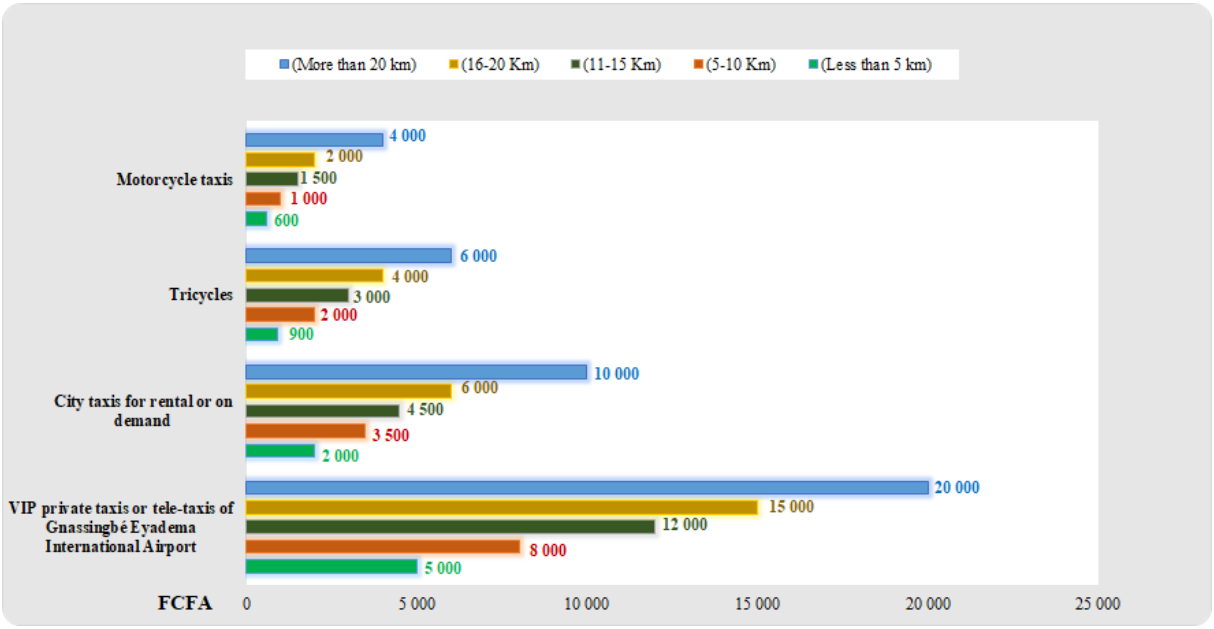

Figure 8. Pricing (in FCFA) by mode of transport and distances (in Km) to go to or come from the AIGE.
Source: Our field surveys, 2024.

Most of the feeder routes on the AIGE come from the distant districts of Grand Lomé. Short distance journeys are made from the AIGE to the various surrounding districts and vice versa. The long drawdown distance is due to the phenomenon of urban sprawl which has led to the distance of homes from the main centers of activity in Great Lomé. Almost all travelers who live far away in peripheral neighborhoods and outside Greater Lomé are forced to travel long distances by renting a car or travelling with their own means of transport to catch a plane at the AIGE. Foreigners who arrive in Lomé by intercity transport usually get off at a bus station before renting an expensive vehicle to catch a plane at the AIGE. However, the AIGE has a paid car park with 650 spaces to ensure parking and vehicle safety for workers and vehicles. It is located at the entrance of the airport terminal. A payment terminal allows you to pay parking fees at rates that vary according to the duration of parking, as shown in **Table 3** below.

Table 3. Parking rates at the AIGE.

Price (FCFA)		**Subscription (FCFA)**			
Duration in hours	**Cost**	**Type**	**Trimester**	**Semester**	**Year**
1	300	Airport professionals	15,000	28,000	50,000
2	500	Outside people	18,000	32,000	60,000

3	Increase of 100 FCFA/h				

Source: Our field surveys, 2024.

The statistics in the table show that from the third hour, an increase of 100 CFA francs per hour is applied to customers. Thus, subscriptions are available both for airport professionals and for outsiders who have to park daily for long periods of time. It is 15,000 CFA francs per quarter for workers at the airport and 18,000 CFA francs for those coming from outside. Some car rental companies that offer their services to travelers in the agglomeration have an agency at the airport. Among these agencies, we can remember the rental agency "IS AFRIC" located within the AIGE premises.

4. Discussions

Feeder and broadcast practices to/from the airport are aimed at improving land accessibility to international airports. This implies a bus service linking the airport to its employment area, structured as a feeder to the main stations in the area. The analysis of the network shows a contrasting reality where the networks are completely disconnected, penalizing the travel of passengers, especially those going to the AIGE. The organization of the networks in Lomé, as we have pointed out above, is out of phase with the movement of travelers in Greater Lomé. The transmission line scheme does not correspond to any logic of the interconnection of transmission networks. These networks should be based on the theory of modal interconnection developed in the research on transport networks by Dupuy G. at the end of the 1980s.

This theory consists of connecting, between them, at least two transport networks that are heterogeneous in their technical, organizational or institutional aspects (Dupuy G. 1988 cited by Cyprien, 2008). It entered everyday language long before the notion of intermodality, at least in the discourse of development policies and in the daily practice of the actors. It is often associated with different transport scales (long-distance, regional or local) (Jean, 2000). According to the author, "the interconnection of rapid transit networks presented here, which is basically punctual or nodal either at the airport or at the central station, can be quickly classified as interconnection by nodes" (Cyprien, 2008). Jean simply wants to ensure that, through certain services (single ticket, baggage check-in in the central station, etc.) and in certain situations (mixed traffic on the rail network, etc.), the trinomial is also the result of an interconnection through flows (Cyprien, 2008; Jean, 2000). Territories concerned is thus genetically linked to it, and an interconnection of rapid transport networks is therefore a major node in an integrated transport network, which has been in place for more than two decades". Interconnection is thus of a different nature than the simple connection establishing a link or a link between two points or between two axes of the network of the same mode of transport (plane or train or car), either by adding a section (linear connection) or by improving connections at a point (punctual and spatio-temporal connection) (Jean, 2000, cited by Cyprien, 2008). Applying this concept to Lomé would require the creation of a multimodal central station that would integrate the SOTRAL bus network, taxis and future rail services, while facilitating connections with the AIGE.

The airport platform appears to be the main visible manifestation of air transport networks, which must respond to this principle of network interconnection. It constitutes an "interface" between air and land transport, as Sarr (2017, p.17) points out, but also between air transport and the airport community. Moreover, it is in a real logic of regional development and connectivity that the States have set up airport infrastructures, with both national and regional dimensions, which meet the principles of intermodality. The intermodal connection is thus the subject of more and more reflection and implementation" in developed countries (Lourdes et al., 2016) where it is a key word in passenger transport policies (Cyprien et al., 2016). In these regions of the world, it represents for public authorities, "a technical-organizational means of making the most of existing transport networks, in order to ensure high levels of service to territories and to improve the sustainability of transport systems" (Lourdes et al., 2016). In fact, intermodal connection is facilitated and encouraged in these developed regions thanks to the technical measures implemented by the players in the transport supply sector: Fare integration, timetable adjustment, provision of park-and-ride facilities, etc.

A rather critical observation can be made in the cities of the South, particularly in sub-Saharan Africa, where the notion of modal interconnection is almost absent from the concerns of public authorities. It is very rarely addressed either in transport projects or in the actual organization of the different types of transport "or even in scientific studies on the field of transport" (Abélim et al., 2021; Lourdes et al., 2016). Many African city dwellers are confronted daily with the need for intermodality, whose daily mobility conditions are trying and restrictive (Lourdes et al., 2016). There are various reasons for this lack of interest in intermodality in these "disconnected cities" (Françoise and Marcello, 1995 cited by Assogba, 2021). First, "the large cities of sub-Saharan Africa are characterized by a deregulated, unsubsidized transport system dominated by fierce competition between multiple artisanal operators" (Lourdes et al., 2015). This dominant form of organization leaves little room for the search for complementarity between public transport offers (Aaron and Robert, 2011; Lourdes et al., 2012 cited by Assogba, 2021). In sub-Saharan Africa, intermodality at airports is even more limited; but efforts are underway to improve connections between different modes of transport. In Nigeria, for example, major airports such as Lagos (Murtala Muhammed) and Abuja are well connected to road networks, while public transport links remain inadequate[11]. There are few direct rail connections to airports. Only Abuja Airport has a connection to the rail network, thanks to the light rail line inaugurated in 2018. In 2013, the Nigerian government launched a programme to renovate all of the country's airports, which should improve connections with other modes of transport. Plans to build new airports such as Lekki, near Lagos, include plans for multimodal links with road and rail networks[12]. In Senegal, intermodality at Dakar-Blaise Diagne Airport (DSS) includes several transport options. The country has had a Regional Express Train (TER) train station since 2022. This allows a direct connection between the airport and downtown Dakar via the rail network. Unlike the airport platform in Lomé where shared taxis are prohibited, in Senegal they are available in the airport parking lot and are a convenient way to get to the airport and different destinations in the region[13]. Dakar Dem Dikk buses are also available for travel between Dakar and the airport. These shuttles offer regular connections between

the airport and Diamniadio train station. Departure times are regular, with buses departing every 90 min until 1 p.m and every 60 min until 10:30 p.m[14]. Trains run every 10 min from Monday to Saturday, and every 20 min on Sundays and public holidays. All of these options allow travelers to choose the means of transportation that best suits their needs and preferences.

In a context of uncontrolled urban sprawl, increasing travel distances and traffic congestion on the arteries of Greater Lomé, there is reason to think of a new scheme for the organization of networks and interchange hubs integrating all modes of transport. To achieve this, specific policies must be put in place to improve connectivity between the different modes of transport. An essential first step would be to strengthen the SOTRAL network, with the creation of direct lines linking the airport to Lomé city centre. The challenge is to "coordinate the levels of service between them" following the example of the RATP in France (Agnès, 1993) and the major transport networks in Africa. The AIGE will have to be taken into account in this new network organization scheme, which will be composed of a central platform (Lomé central station), an urban platform and a railway platform. A well-connected central station would offer varied transportation options, allowing travelers to easily move around the city of Lomé and its surroundings. This includes SOTRAL buses, taxis and public transit services to serve the AIGE. Political measures must be taken to introduce a direct public transport line linking the AIGE to the city centre to improve connectivity. Consideration should also be given to integrating a multimodal transport network that includes buses and taxis in a coordinated fashion, to improve the flow of journeys. This network should be accompanied by an integrated pricing policy, similar to that seen in cities such as Dakar, so that passengers benefit from a unified and competitive price regardless of the mode of transport used. In addition, the development of park-and-ride facilities at major transport hubs, such as the central station and the airport, would encourage the use of public transport and thus help to reduce congestion. These measures should form part of a coordinated approach to regional planning, aimed at creating a multimodal central station that would link not only the SOTRAL bus lines and shared taxis, but also an area dedicated to AIGE users. This station will facilitate connections and simplify boarding, offering an efficient and practical solution for passengers. Examples of good practice in this area can be seen in Dakar, where the airport is directly linked to the city centre by the Regional Express Train (TER). This project has created an efficient multimodal connection, combining rail and road networks, with a single fare for passengers. In Lagos, although the interconnection between the airport and the rail network is not yet optimal, projects are underway to improve this multimodal connection. These examples show that it is possible to establish a strong connection between the airport and other modes of transport in similar cities.

5. Conclusion

This research work on intermodality between land and air transport has made it possible to understand the constraints related to the intermodal practices of the populations of Greater Lomé. The results show that the organization of transport networks in Greater Lomé almost no longer responds to the logic of feeder and transfer

of passengers to the AIGE. The location of the AIGE in relation to the various disconnected networks penalizes the displacement of populations. All public transport lines are organized in isolation radially without any network matching logic. However, according to the expression of Jean (2000), a well-constructed network must include an interconnection pole or interconnection trinomial composed of "a central urban and rail platform, achieving the interconnection at the heart of the agglomeration between the conventional railway and urban public transport, an airport platform where air, rail and motorway networks are articulated at all scales (regional, national, international), and a high-performance link connecting the two platforms, the third element of the trinomial which thus allows correspondences between all scales of mobility" (Jean, 2000). The city of Lomé presents realities contrary to these practical provisions for sustainable mobility. These shortcomings have led to the development of a range of meandering intermodal points along the structuring axes. Faced with the lack of a specific transport service to serve the very important Lomé airport platform, travelers are forced to resort to the rental of very expensive private and artisanal means of transport to cover long feeder and broadcast distances. In the context of sustainable mobility, it is important for decision-makers to rethink the organization of transport systems by focusing on the reorganization of bus stations or interchange hubs in order to promote the integration of transport networks. A well-connected central station would provide a more enjoyable, convenient and accessible travel experience, offering a variety of transportation options, digital services, relaxation areas, and great fares. The AIGE should not be on the sidelines of this new network organization scheme. The well-connected Central Station can offer direct connections to the AIGE, making land or international travel easier. SOTRAL, the only public bus transport company, must restructure its network by creating transversal and well-connected lines to serve the airport and facilitate the connection or interconnectivity of networks in Greater Lomé.

Author contributions: Conceptualization, KD; resources, KD; data curation, KD; software, KD; formal analysis, KD; investigation, KD, AG and ID; visualization, KD, AG and ID; methodology, KD, AG and ID; Writing—original draft, KD, AG and ID; project administration, KD, AG and ID; Writing—review and editing, KD; supervision, AG and ID; validation, AG and ID. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Regional Center of Excellence on Sustainable cities in Africa (CERViDA-DOUNEDON), the World Bank and the Association of African Universities.

Conflict of interest: The authors declare no conflict of interest.

Notes

1 https://aorticconference.org/fr/a-propos/organisez-votre-voyage/

2 Statement by the Chairman of the Board of Directors and founder of Asky during the signing of an agreement for a contribution to the capital of the Pan-African Airline by the Togolese State on August 21, 2023.

3 Togo, new shareholder of Asky—Togolese Republic (republicoftogo.com).

4 West African Economic and Monetary Union.

[5] These are regular lines open to the entire population of Greater Lomé without distinction of class or socio-professional category.

[6] They are only used during school periods.

[7] Administrative Centre and Economic and Financial Services.

[8] Ordinary line of the SOTRAL network created in 2012.

[9] https://www.martinique.franceantilles.fr/actualite/economie/le-parquet-financier-demande-un-proces-pour-vincent-bollore-pour-corruption-au-togo-990215.php

[10] Ministry of Road, Air, and Rail Transport of Togo; A Study carried out as part of the Sustainable mobility plan for Grand Lomé.

[11] Ministry of Road, Air and Rail Transport of Togo; a study carried out as part of the Sustainable Mobility Plan of Greater Lomé https://www.tresor.economie.gouv.fr/Articles/2f68de3a-d71a-476d-b231-56dac58aa822/files/d7fc5d2d-a557-42f9-81be-5fe268f328a2

[12] Air transport in Nigeria—an opportunity for Czech companies | Embassy of the Czech Republic in Abuja (gov.cz)/https://mzv.gov.cz/abuja/fr/actualite/transport_aerien_au_nigeria_une.html

[13] https://www.au-senegal.com/nouvel-aeroport-international-de-dakar-ce-qu-il-faut-savoir,15061.html

[14] https://aorticconference.org/fr/a-propos/organisez-votre-voyage/

References

Adama Sarr., 2017. Societal issues and airport activity, from risk to opportunity. Right. ffdumas-01622777f

AFRAA, 2021. Air transport, report 2020, 16 p.

African Development Bank Group, 2019. Framework and Guidelines for Support to the Aviation Sector, 56 p.

Ageron Pierre, 2013. Intermodality-Passengers through the Prism of Globalization: Towards the Structuring of an Integrated Meta-Network, Doctoral Thesis in Geography of the University of Grenoble, 490 p. in particular pp. 3–88

Balbo Marcello and Navez-Bouchanine Françoise, 1995. “Urban fragmentation as a research hypothesis: Rabat-Salé cases study”, Habitat International, Vol. 19, No. 4, p. 571–582

Bavoux Jean-Jacques, Beaucire Francis, Chapelon Laurent, Zembri Pierre, 2005. Geography of Transport. Edition Armand Colin. pp 97–119.

Cervero Robert and Golub Aaron, 2011. “Informal public transport: A global perspective”, in Dimitriou H. T., Gakenheimer R. (eds), Urban Transport in the Developing World. A Handbook of Policy and Practice, Cheltenham, Edward Elgar Publishing, pp. 488–518.

David Fleming & Yona Hayuth, 1994. "Logistics networks and the role of intermediaries". Transportation Research Part A: Policy and Practice, 28(3), 225-239.

Diaz Olvera Lourdes, Guézéré Assogba, Plat Didier, Pochet Pascal, 2016. The intermodality suffered by African city dwellers. Examples in Conakry, Douala and Lomé, in Chapelon L. (dir.), Transports et intermodalité, London, ISTE, coll. “Sciences, société et nouvelles technologies”, pp. 289–308.

Dizéwé Kossi, Guézéré Assogba, Dandonougbo Iléri, 2024. Dynamics of public transport by bus and improvement of urban mobility in Lomé in Togo: From the RMTU to the SOTRAL, 23 p.

Guézéré Assogba, 2008. “Oleyia” (Motorcycle taxi): Actors and users of a recent mode of artisanal transport in Lomé, doctoral thesis in geography, University of Lomé, 413 p.

Guezere Assogba, 2013. Motorized two-wheelers and urban sprawl in Lomé, what is the link with the theory of the “three ages” of the city? Norois n°226? 2013/1, http://norois.revues.org. p58.

Guézéré Assogba, 2021. Motorcycle taxis in sub-Saharan African cities: the informal sector in question in Lomé, African studies, Geography series, l’Harmattant, 369 P.

Louis Berger, 2016. Transport Policy Framework, White Paper, funded by the European Union, 96 p.

Marco Kouwenhoven, 2008. Impact of accessibility on airport choice, The Hague, Netherlands, Registration Paper 2008-14 — © OECD/ITF, 2008, 41 p.

Mayimbo Gado, 2014. Constraints related to the organization of public transport systems in the agglomeration of Lomé, Master’s thesis, Department of Geography, University of Lomé, 151 p.

Melissa Mazzola. The airport in literature. Architecture, spatial planning. 2019. ffdumas-02483221f

Ministry of Road, Air and Rail Transport of Togo, 2024. Sustainable Urban Mobility Plan for Greater Lomé and Strengthening of SOTRAL, Diagnostic Report of Component A, 288 p.

Nicolas Boichon, 2016. Land accessibility at international airports, Institut d'Aménagement et d'Urbanisme en Île-de-France, Volume 1, 42 pPalakiyèm Kpemoua. Maritime and air traffic and economic growth in Togo. 2018. ffhal-01874954

Passoli Abélim and al., 2021. Intermodal practices in the autonomous district of Greater Lomé: what is the link between urban and interurban transport for sustainable mobility? In Géotransports n°15, 16 p.

Richer Cyprien, 2008. "The emergence of the notion of interchange pole: between the interconnection of networks and the structuring of territories", in Les Cahiers scientifiques du transport, n° 54.

Richer Cyprien, Meissonnier Joël, Rabaud Mathieu, 2016. What intermodality(s) in daily mobility? ISTE Editions. Transports et intermodalité, ISTE Editions, pp.261–288, Collection Sciences, société et nouvelles technologies. ffhalshs-01386621

Richer Cyprien, Rabaud Mathieu, Lannoy Arnaud, 2015. Intermodality in everyday life. An overview of intermodal mobility in France. CEREMA - IFSTTAR. Mobility in transitions. Knowing, Understanding and Representing, Study and Research Report. CEREMA, pp.131–142, halshs-01386613

Sander Agnès, 1993. Les points de réseaux transport: une bibliographie, GDR Réseaux, RATP Unité Prospective, 23 p.

Sander Agnès, 2007. "Making the city with network nodes" in Bourdin A. (ed.), Mobility and Urban Ecology, Paris, Descartes, pp. 79–99

SOTRAL, 2015. SOTRAL Activity Report, 20 p.

Varlet Jean, 1992. L'interconnexion des réseaux de transport en Europe: éléments de géographie prospective, Paris, Institut du transport aérien, 198 p.

Varlet Jean. Dynamics of the interconnections of rapid transport networks in Europe: the future and spatial diffusion of a geographical concept. In: Flux, n°41, 2000. pp. 5–16