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Research Article

Rethinking Automobile Dependency in Sub-Saharan Africa: Toward Sustainable Urban Planning in Cameroon

Chianebeng Japhet Kuma[1, *], Samba Gideon[2], Nyiniwou Ismaila Kinyui[3]

[1]Department of Geography and Planning, The University of Bamenda, Bamenda, Cameroon
[2]Department of Geography-HTTC, The University of Bamenda, Bamenda, Cameroon
[3]Department of Geography, The University of Yaounde I, Yaounde, Cameroon

Abstract

Rapid urbanization and increased motorization are prevalent in Sub-Saharan African cities, where automobiles have become the primary mode of transportation. This reliance has resulted in significant challenges, including traffic congestion, air pollution, and limited access to public spaces. In response, there is an urgent need to reevaluate the role of automobiles in the sustainable urban planning of cities in the Global South. This paper (i) identifies the causes of automobile dependency in selected cities in Cameroon, (ii) examines the impact of automobile usage on the urban environment, and (iii) proposes solutions to reduce automobile dependency. Through 380 surveys and 15 in-depth interviews, the researchers gathered data from residents in four Cameroon cities: Yaoundé, Douala, Bamenda, and Bafoussam, and engaged city stakeholders, including mayors, transport syndicate leaders, and traffic officers to gain insights and perspectives crucial for effective urban transportation solutions. The findings highlight the necessity of reimagining transportation policies and infrastructure in Cameroonian cities to foster more livable, resilient, and inclusive urban environments. By challenging the perception of automobiles as symbols of progress, this research advocates for a holistic urban planning approach that prioritizes the needs of the community and the urban environment in Cameroon.

Keywords

Rethinking, Automobiles, Sustainability, Urban Planning, Cameroon Cities

1. Introduction

Automobiles have long been considered a symbol of progress and development in cities across the globe [40]. However, their role in urban centers has come under increased scrutiny in recent years as the socio-economic and environmental impacts of widespread car ownership become more apparent. In many cities across the globe, individual motorized transport has contributed to the degradation of urban living conditions [34]. Greenhouse gas emissions, air pollution, noise, traffic injuries, and congestion are just a few of the consequences of this reliance on cars [14]. In European cities, the rate of car ownership remains high, yet evidence suggests that the average annual distance traveled by cars has ceased to grow, a phenomenon referred to as "peak car" [13]. The same situation is witnessed in Sub-Saharan African cities where

*Corresponding author: chianebeng@yahoo.com (Chianebeng Japhet Kuma)

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rapid urbanization already presents an undesirable condition for the urban residents [39]. Countries like Cameroon, Nigeria, Ghana, and Kenya are already grappling with increasing congestion, vehicle emissions, limited transport infrastructure, and rising road accidents, injuries, and fatalities. [36]. This trend raises critical questions about the socio-economic sustainability of automobile use and the feasibility of achieving road safety targets by 2030. Consequently, city authorities are urged to rethink the role of automobiles in urban areas to safeguard the future of their cities [28].

In developed countries, research has shown that car usage reflects the unique role of automobiles in citizens' daily travel patterns [23]. On average, nearly half of all trips in German, Swiss, and Austrian cities are made by private car, with this figure soaring to 86% in American cities [4]. In the UK, two-thirds of all weekly trips, which accounts for three-quarters of the distance travelled by the average citizen, are made by car [15]. Urban areas in these countries generate approximately 85% of GDP [10]. At the same time, they are facing the challenge of reducing congestion, pollution and accidents due to the unprecedented rate of automobile ownership. Private motorized modes are noted for increasing congestion and greenhouse gas emissions across many of its urban areas [35]. As of 2016, the motorization rate in the European Union was 506 cars per 1,000 inhabitants, equating to one car for every two people [11]. In response to this situation, initiatives like the International Transport Forum have emerged, comprising 62 member countries with the goal of reducing car dependency in European cities to 50% by 2030 [14]. Countries like Germany, Austria, and Switzerland significantly reduced the car share of trips over the past 25 years in spite of high motorization rates. The key to their success has been a coordinated package of mutually reinforcing transport and land-use policies that have made car use slower, less convenient, and more costly, while increasing the safety, convenience, and feasibility of walking, cycling, and public transport [5].

In the Global South, the growth rate of car usage has been significant [9]. On the African continent, an unprecedented phase of urbanization is underway, with urban mobility emerging as a pressing challenge for planning and development in cities across the cities [41]. The urban population is projected to triple from 471 million inhabitants in 2011 to 1.34 billion by 2050, which will account for 21% of the world's urban population [51]. As demographic densities intensify, the rapid increase in vehicle ownership continues to exert pressure on existing infrastructure [50]. In many urban cities, car ownership is growing at an exponential rate [53]. The negative externalities associated with this increase in urban vehicles have prompted city planners and policymakers to prioritize initiatives aimed at reducing automobile use [55, 37], and [45]. The transport sector has been identified as a major contributor to various environmental externalities such as local air pollution and greenhouse gas emissions and traffic congestion particularly in urban areas [33]. Currently, transportation accounts for 23% of energy-related greenhouse gas emissions, with road transport responsible for three-quarters of global CO2 emissions [47]. Moreover, emissions from motor vehicles contribute to 37% of nitrogen oxides (NOx) and 18% of carbon monoxide (CO) [3]. Consequently, the rapid motorization and high emission rates from vehicles have led to significant adverse effects on both health and the environment [27].

Africa is currently grappling with a surge in greenhouse gas emissions, the highest road fatality rates in the world, pervasive air pollution, and transportation systems that inadequately connect residents to jobs, education, and essential services [29]. Urban sprawl exacerbates these issues in sub-Saharan African cities, leaving underserved communities with limited accessible opportunities and fueling the modal shift to private vehicles for those who can afford it [25, 42]. Research in Johannesburg reveals that 42% of residents struggle to access job locations [52]. Meanwhile, the motorization of personal, passenger, and commercial vehicles particularly the purchase of older, second-hand cars are accelerating in major African nations [7]. Between 2000 and 2016, transport emission rates from cars reached 84%, driven primarily by increases in passenger and freight transport activity [46]. The transport emissions rate from Sub-Saharan Africa countries alone increased by 75% from 2000 to 2016 to a level of 156 metric tons (Mt) CO_2, while transport emissions in Northern Africa increased by 95% during the same period (though at a lower absolute level of 135 Mt in 2016) [2]. Total transport CO_2 emissions increased in major economies of Africa between 2000 and 2016, including 161% in Algeria, 153% in Ghana, 123% in Kenya, 73% in Egypt, 40% in South Africa and 19% in Nigeria [46].

In Cameroon, the demand for urban mobility infrastructure and services is expanding rapidly, fueled by unplanned urbanization and rising population densities [17]. Most investments in road and transport infrastructure have primarily supported private vehicle use, with inadequate financing for sustainable mobility solutions and equitable access to opportunities for all residents. Public transport in urban areas is managed by a diverse array of private, informal, and largely unregulated operators [18]. While existing research addresses environmental impacts and infrastructure challenges, it often overlooks the local perceptions of car ownership and alternative transport modes within diverse community contexts. This highlights the need to explore the socio-cultural factors influencing transportation choices, which directly relates to the paper's objectives. By identifying these causes of automobile dependency and its impact on the urban environment, the study can provide a more nuanced understanding of how car dependency shape urban mobility in Cameroon.

2. Conceptual Framework

2.1. The Concept of Car Dependence

The concept of car dependence suggests that society has

become too reliant on automobiles for transportation, leading to social, economic, and environmental problems. The car dependency is currently considered a serious and growing international problem [19]. Car dependence has been attributed as the leading cause of urban sprawl, traffic congestion, air pollution, greenhouse gas emissions, and inefficient use of land which has negatively impacted public health, community cohesion, and social equity. The concept, however, advocate for shifting to more sustainable modes of transportation, such as walking, biking, public transit, and car-sharing, in order to reduce dependence on cars and mitigate the negative impacts associated with automobile usage. The term has a wide range of connotations: from trips and people to activities and communities and to the society at large. Different ways have been outlined to measure car-dependent places, persons, and trips [49]. Here, the term refers to car dependent people and focuses on its corresponding measurements. Several indicators have also been advanced concerning people dependence on cars which can be assessed by (that is, how much a person uses the car) and the relative ones (that is, what portion of the total travel is done by a car). Both sets of indicators can be in the units of the number of car journeys, time spent traveling by car, and distance traveled by car. However, this notion has long been rejected on grounds that car dependence is simply synonymous with the amount of usage [12].

A more sophisticated measure was proposed on individuals' mode choice perspective and quantified car dependence as the extent to which other travel options are excluded from the considered choice set [54]. Some scholars argue that car dependency is associated with high rates of car travel per capita and is characterized by car-oriented land use patterns, in combination with lack of alternative transport options [22]. To [30], car dependency is permanently leaning on the car as the only transport mode. The question, therefore, is whether it is possible to reduce the role of the car in urban mobility while maintaining a satisfactory level of accessibility to urban amenities (employment, housing, shops, education, etc.), especially for residents located at the city outskirts. To address this, it is necessary to focus not only on the factors influencing car dependence and travel time and transport choices of individuals, but also on the organization of the urban space from two different perspectives, that is from the "microscopic" approach to the consumption of road space by different transport modes on the one hand; and the "macroscopic" understanding of the impact of the car dependence on the urban form, on the other.

Three components of the car dependency theory are used in this work. They include Car dependence places; car dependence trips and car dependence persons are distinguished. It is shown that most car users are already multi-modal transport users with prior experience of other modes. The prospects for modal shift from inflexible drivers, complacent car users, malcontented motorists and aspiring environmentalists are given along with the different policy pulls and pushes required to impact on their car use.

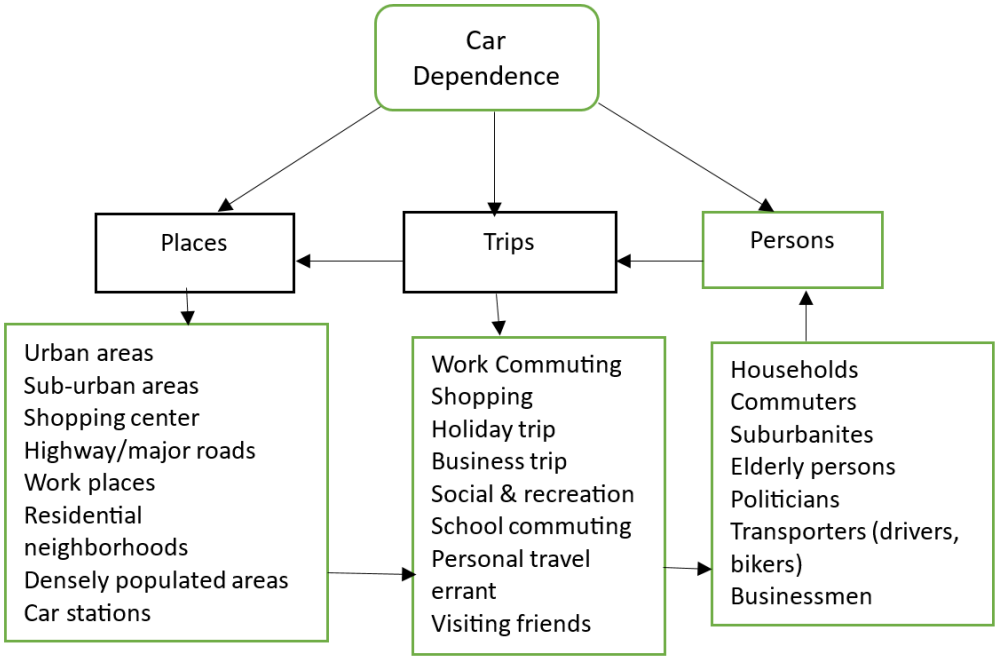


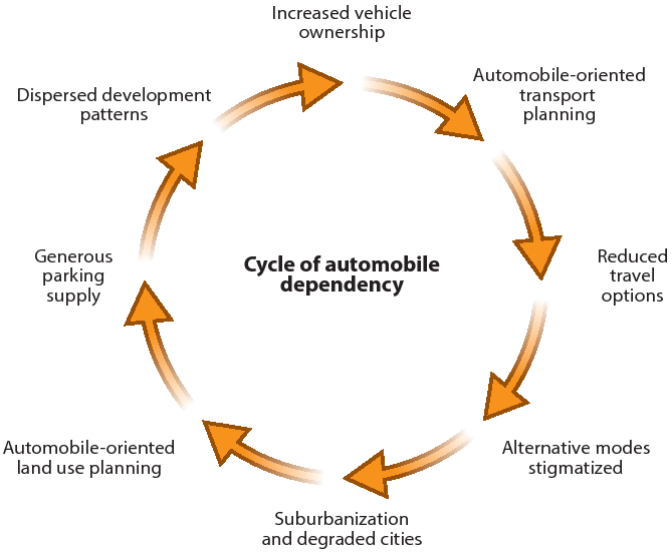
Figure 1. *Car dependency model.*

Figure 1 shows the summary model of the car dependence. It starts by identifying the car dependence places which categorize the most desirable where cars are likely to be found. Another indicator is the car dependence trips with a good

number of variables such as commuting, shopping trips, holiday to visiting trips and lastly, the car dependence persons where category of car owners are categorized such as households, commuters, suburbanites, and transporters.

2.2. Factors Contributing to Automobile Dependence

The growing dependence on vehicles such as buses, mini-buses, taxis, motorbikes, and private cars poses a significant challenge to sustainable mobility needs [26]. These modes of transport, while serving intra-urban mobility, contribute to increased negative environmental externalities, which contradict the goals of sustainable urban transportation [38]. In contrast, sustainable mobility emphasizes more environmentally friendly modes like walking and public transit [44], which can reduce the negative impacts of excessive vehicle use. Similarly, [1], argue that over-dependence on motorized transport undermines the implementation of eco-friendly infrastructure and public spaces, essential components of sustainable cities. Many factors contribute to automobile dependency ranging from direct, indirect and or complex factors. Many researchers have highlighted several diverse reasons for automobile dependence. For [20, 6], and [8], they assert that a number of transportation and land use market distortions tend to encourage automobile ownership and usage including underpricing, inadequate consumer choice, weak competition, bias in transportation planning and investment practices, and other public policies that favor automobile travel. [48], reported that when people live far away from their workplace and prefer driving, car dependence ensues. [24], noticed that the consequence of car dependence is not only the use of the vehicle, but also a belief that the activity will not be fully and properly done without the use of automobile. The factors can be best explained in Figure 2 which illustrate the vicious cycle of automobile dependency.



Source: Transformative Urban Mobility Initiative, 2019

Figure 2. *Vicious cycle of automobile dependency.*

From figure 2, each factor fuels car dependency and it is in a viscous circle of continual growth of the menace. Increased vehicle ownership as a show of affluence of the city in quest of travel convenience and time saving, results to automobile-oriented transport planning to a reduced travel option down to stigmatization of alternative modes of mobility, suburbanization and degraded cities. In view to remedy the situation, this leads to automobile-oriented land use planning, further to generous parking supply resulting into dispersed development patterns and invariably back to the increased car ownership. These causes continue to flow in a sequential manner reinforcing each other and adding to the problem.

2.3. Attributes of Automobile Dependency

Automobile dependency is a matter of degree. Table 1 compares various attributes of automobile dependency. There are few places in the world that are totally automobile dependent (that is, driving is the *only* form of transport). Even areas that appear to be highly automobile dependent often have a significant amount of walking, cycling and transit travel among certain groups or in certain areas, although use of these modes tends to be undercounted by conventional transportation planning.

Table 1. Attributes of Automobile Dependency.

Indicator	Description	Low	Medium	High
Popular Name		**Car free**	**Multi-modal**	**Automobile Dependent**
Vehicle Ownership	Per capita motor vehicle ownership (usually measured per 1,000 pop)	Less than 250 per 1,000 inhabitants	250-450	450+
Vehicle Travel	Per capita annual motor vehicle mileage	Less than 4,000 miles (6,500 km)	6,500-13,000 km	8,000+ (13,000 km plus)
Vehicle Trips	Automobile trips/ portion of total personal trips	Less than 50%	50-80%	80%+
Quality of Transportation Alternatives	Convenience, speed, comfort, affordability and prestige of walking, cycling and public transit relative to driving.	Alternative modes are of competitive quality.	Alternative modes are somewhat inferior.	Alternative modes are very inferior.
Relative Mobility of Non-Drivers	Mobility of personal travel by non-drivers compared with drivers.	Non-drivers are not severely disadvantaged.	Non-drivers are moderately disadvantaged.	Non-drivers are severely disadvantaged.
Land use patterns	Land use density (residents and jobs per acre) and mix (proximity of different land use types).	Very compact and mixed.	Moderately compact and mixed	Dispersed and homogenous
Transport system	Type of transportation facilities and services available.	Mainly non-motorized and public transit	Very mixed: non-motorized, public transit and automobile.	Mainly automobile (roads and parking facilities).
Roadway design	Design features of public roads.	Highly pedestrian oriented	Mixed.	Designed to maximize auto traffic speeds and volumes.
Shopping Options	Where retail and other public services are located	Along public streets	public streets near transit areas	In private malls, located along major highways
Market Distortions Favoring Automobile Use	Relative advantage provided to automobile transportation over other modes in planning, funding,	Minimal bias favoring automobile travel.	Moderate bias favoring automobile travel.	Significant bias favoring automobile travel.
Automobile commute mode split	How people travel to work and school.	Less than 35%	35-65%	More than 65%
Errand travel	How people normally travel to stores, professional appointments, recreation activities, etc.	Mostly walking, cycling and public transit.	Walking, cycling, public transit and automobile.	Mostly automobile.
Performance Indicators	How transport system performance is evaluated	Quality of walking, cycling and public transit	Multi-modal	Automobile-oriented

Source: Adapted from Victoria Transport Policy Institute, 2019

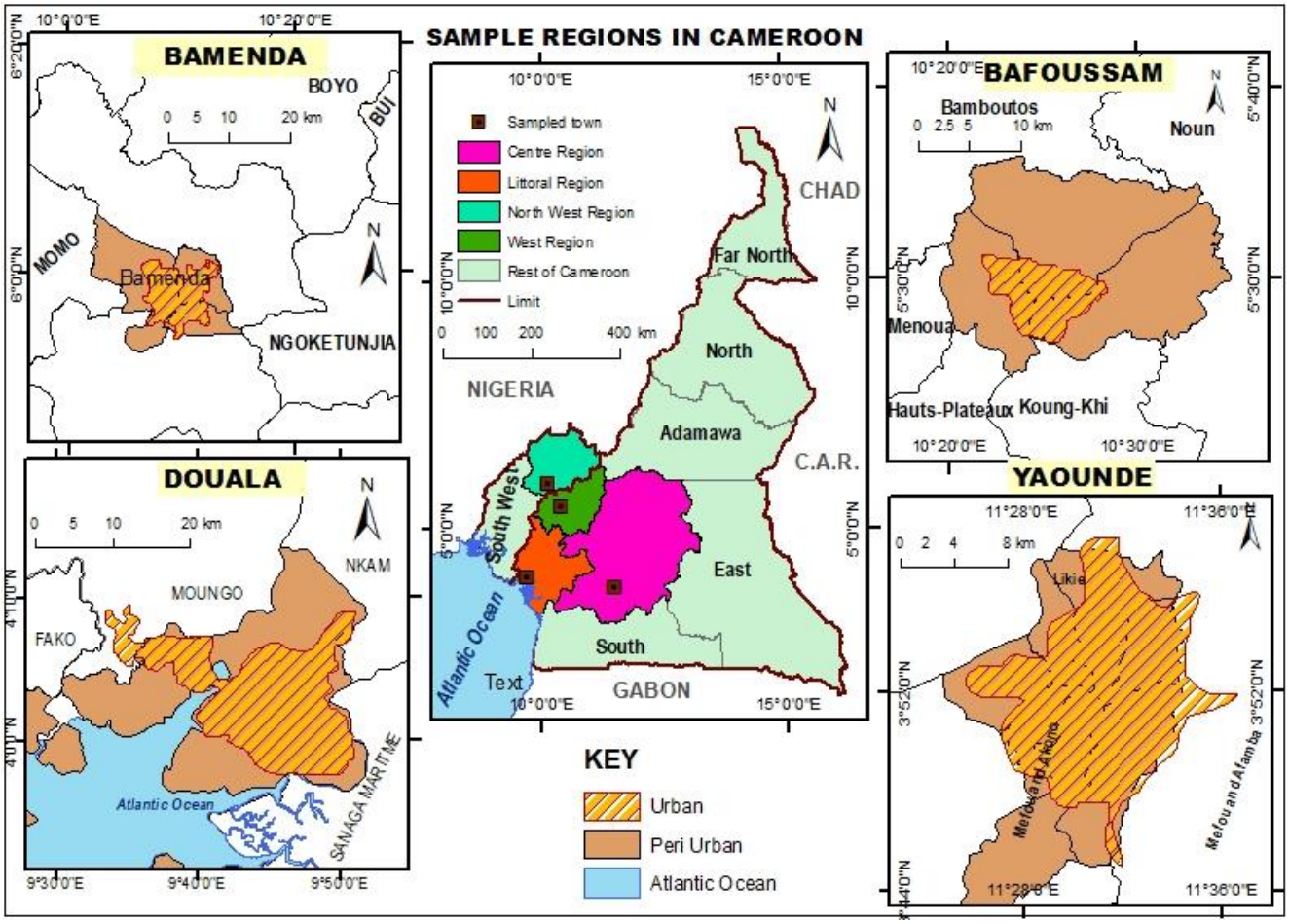
Some criteria have been developed by [21] to classify automobile dependent cities. His classification was based on land use pattern, the transportation system, the behavioral attitude of population, vehicle ownership etc. and rated cities as low, medium and highly automobile dependent. This has been simplified as shown on table 1.

3. Materials and Method

3.1. Study Area

The study is conducted in four Cameroonian cities: Yaoundé, Douala, Bamenda and Bafoussam cities. Douala and Yaounde are the largest cities in Cameroon, each with popu-

lation exceeding 4 million inhabitants, while Bamenda and Bafoussam are medium size cities with populations exceeding 500,000 residents. All the cities are well known for their automobile-oriented transportation and land use patterns that favor automobile access and provide relatively inferior alternatives (in this context, automobile includes buses, taxis, cars, trucks, and motorcycles). Consequently, urban residents find it challenging to access services and activities without using an automobile.



Source: Geo-database of Cameroon-2024, NIS, Yaoundé

Figure 3. *Location map of Bamenda, Bafoussam, Douala and Yaoundé*

The sample cities are both made up of urban and per-urban areas where mobility is defined by multi-modal transport. Mobility patterns in these cities include inter-city movements, inter-urban and inner mobility. The geographical coordinates and orientations of the cities are well established in the map. Both Bamenda and Bafoussam are Western highland cities of Cameroon, Douala a coastal or literal city while Yaoundé is a city of the seven hills situated at the center region.

3.2. Methods

This research employs an exploratory design that combines both quantitative and qualitative approaches to collect data on automobile dependence and its implications for the urban environment in selected study areas in Cameroon. The study utilized two research instruments: informant interviews and a series of survey questionnaires. Fifteen informant interviews targeted key stakeholders, including City Mayors (CMs), Transport Syndicate Leaders (TSLs), Delegates of the Ministry of Transport (DMT), and Road Traffic Officers (RTOs). These stakeholders provided valuable insights into governance challenges, urban planning policies, and the socio-economic implications of automobile reliance, as well as information about the operations of public and private transport sectors, regulatory measures, and safety protocols. Quantitatively, 380 survey questionnaires were designed to gather responses from urban residents and drivers in Douala, Yaoundé, Bamenda, and Bafoussam. Purposive sampling was employed to select areas within these cities that the researchers deemed most accessible. This selection was based on the research team's subjective judgment of the target locations. Accidental sampling was utilized to administer ques-

tionnaires to drivers, as their presence was unpredictable due to their mobile nature. Drivers encountered during the data collection process who agreed to participate were sampled immediately. Household participants at various target locations were sampled using a simple random sampling technique. Random numbers were generated to select the initial households from a comprehensive list, ensuring that the selection was free from bias. From the first household selected, every 10th household was subsequently chosen. Research participants were assured of the confidentiality of the information they provided, emphasizing that it was intended solely for research purposes. This assurance fostered trust, allowing participants to respond openly.

Table 2 presents the target cities of the study and the specific locations where questionnaires were deployed.

Table 2. *Target population breakdown per study location.*

Target city	Target Locations	No. of questionnaires deployed	No. of in-depth interview deployed
Douala	Garoutier Bonaberi	25	4 In-depth interviews: CMs, TSLs, DMT, RTOs
	Ndokoti	35	
	Rondpoint Deido	40	
	Poste Central	40	
Yaoundé	Carrefour Mvan	35	3 In-depth interviews: TSLs, DMT, RTOs
	Rondpoint Nlonkak	35	
	Mobile Nkwen	25	
Bamenda	City Chemist	30	4 In-depth interviews: CMs, TSLs, DMT, RTOs
	Hospital Roundabout	30	
	Ndiandam at Carrefour Total	25	
Bafoussam	Carrefour Le Maire	25	4 in-depth interviews: CMs, TSLs, DMT, RTOs
	Tamdja at Carrefour Beac	35	
Total		380	

4. Results and Discussions

4.1. Causes of Automobile Dependency in Selected Cities in Cameroon

Automobile dependence expressed through comparative levels of car ownership, usage, and transit service, varies widely and systematically across cities in Cameroon. Specifically, the cities of Yaoundé, Douala, Bamenda and Bafoussam reveal a multifaceted interplay of factors contributing to automobile dependency ranging from urban sprawl, cultural norms, and unreliable public transport to family size.

Table 3 described the causes of car dependence identified among urban commuters in Yaoundé, Douala, Bamenda and Bafoussam. The analysis indicates that urban sprawl is among the highest contributing factor for car dependence across the case study cities, this view was accepted by 90,9% of the sample urban commuters in Yaoundé, 88,0% in Douala, 82,3% in Bamenda and 78,8% views came from Bafoussam. We observe that rapid urbanization has led to sprawling growth of these cities without adequate infrastructures to support public transport. Sample commuters expressed that due to unreliable public transport, 83,6% of Yaoundé urban population depend on cars for their mobility, 90,0% for Douala, 80,0% for Bamenda and 87,1% for Bafoussam. For instance, the research team observed that the study cities were expanding significantly to the city fringes especially Douala, Bamenda and Bafoussam, but the development of road network has not kept pace with the population growth. Poorly maintained roads and limited public transportation options compel the residents to rely on personal vehicles for their daily commutes. The situation is exacerbated by limited available sidewalks or biking as viable alternatives at neighborhoods. Field data indicate that limited accessible sidewalks contributed to car dependency by 62,7% in Yaoundé, 73,0% in Douala, Bamenda came highest with 83,3% reactions from the sample commuters while Bafousaam recorded 64,7%.

Increase income levels among urban residents also greatly contributes to automobile ownership especially in Douala

85,0%, Yaoundé 78,2%, Bamenda 75,3% and 61,2% for Bafoussam. The figures are high in Douala and Yaoundé because middle-class families view car ownership as a status symbol. We equally observed that cultural attitudes towards transportation in the cities greatly influence automobile dependency. Prevailing responses indicate 73,6% cases for Yaoundé, 72,0% for Douala, 65,8% for a medium city like Bamenda and 69,4% for Bafoussam. Other contributing factors such as traffic condition, literacy level, safety and comfort and family size were also significant contributor of automobile dependency. The highest views in this category came from Yaoundé with 67,2% for traffic congestion and the least view came from Bafoussam with 20,0% for Literacy level.

From the descriptive analysis, we summarized that automobile dependency in Cameroonian cities is rooted in a complex blend of urban planning challenges, socio-economic trends, cultural perceptions, and transportation system deficiencies. Addressing these issues requires a multifaceted approach that focused on improving urban infrastructure, promoting sustainable transport options, transforming cultural attitudes towards public transport.

Table 3. *Causes of automobile dependence in selected cities in Cameroon.*

Causes of automobile dependence	Yaoundé		Douala		Bamenda		Bafoussam	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Urban sprawling	100	90,9	88	88,0	70	82,3	67	78,8
Unreliable public transport	92	83,6	90	90,0	68	80,0	74	87,1
Limited accessible sidewalks	69	62,7	73	73,0	71	83,5	55	64,7
Per capita income of house hold	86	78,2	85	85,0	64	75,3	52	61,2
Cultural norms	81	73,6	71	72,0	56	65,8	59	69,4
Traffic conditions	74	67,2	66	66,0	50	58,8	45	52,9
Literacy level	56	50,9	49	49,0	40	47,1	17	20,0
Safety and comfort concerns	67	60,9	65	65,0	48	56,4	43	50,5
Family size	50	45,4	52	52,0	47	55,3	22	25,8

Source: Fieldwork, 2024

4.1.1. Modal Share of Automobile Dependence

Table 4 indicates the estimated modal share of automobile dependency in the case study cities. The modal share identified include bus services, mini buses for intra-urban services, taxi, motor-bikes, private cars and walking. All these modes used the urban roads networks in the cities and no specific demarcation for each mode. The percentages of the modal share shows that taxi services represent the highest mode across all the roads in the cities, with 48% in Yaoundé, 40% in Douala, 30% in Bamenda, and 28% in Bafoussam. The second modal share is walking with highest share in Bamenda 39%, Bafoussam 37%, Douala 35% and Yaounde 25%. Private cars also make use of the urban roads in the cities, with Yaoundé at the forefront with 18%, Douala 5%, Bafoussam 4% and Bamenda 2%. Walking is the second most prevalent mode, with the highest share in Bamenda at 39%, followed by Bafoussam at 37%, Douala at 35%, and Yaoundé at 25%. Private cars also utilize the urban roads, with Yaoundé leading at 18%, followed by Douala at 5%, Bafoussam at 4%, and Bamenda at 2%. Bus services, particularly those provided by limited transport companies (agencies), command a fair share of the urban road network, accounting for 4% in Yaoundé, 3% in Bamenda, and 2% in both Douala and Bafoussam. Mini buses (paratransit) operations in Douala occupied 3%, and Yaoundé and Bafoussam 1%. It is worth noting that the majority of the vehicle fleets used on these roads are old ones, with some vehicles dating back as far as 15 to 20 years.

Table 4. Estimated Modal share of automobile dependence.

Modal share	Percentages of modal share (%)			
	Yaoundé	Douala	Bamenda	Bafoussam
Bus services	4%	2%	3%	2%
Mini buses (Paratransit)	1%	3%	0%	1%
Taxi (Paratransit)	48%%	40%	30%	28%
Motor-bikes	4%	15%	11%	13%
Private cars	18%	5%	2%	4%
Walking	25%	35%	39	37%
Vehicle fleet	Majority old secondhanded	Majority old secondhanded	Majority old secondhanded	Majority old secondhanded

Source: Author's fieldwork compilation.

4.1.2. Vehicle Ownership Among Households

The analysis of vehicle ownership among households in Yaoundé, Douala, Bamenda and Bafoussam provides valuable insights into urban mobility across cities in Cameroon. Figure 4 reveal a notable trend in the vehicle ownership pattern. From the dataset, it is found that Douala, as the economic hub of Cameroon, has the highest vehicle ownership rate, with approximately 56,0% of households owning at least one vehicle. This is attributed to city's extensive commercial activities and greater access to financial options. In contrast, Yaoundé, which is the political capital, exhibits a slightly lower ownership rate around 51,8% of households owning at least one car. Factors influencing this include higher urban densities of low-income households. Bafoussam show significant high ownership rate at approximately 55,3% while Bamenda show some considerable concern with 50,5% of car ownership rate by households. The Bamenda situation is unique given the socio-political instability and unreliable public transport options. Households in Bamenda tend to have their personal car for fear of insecurity choosing public transport means. This has increased the rate of car ownership especially among civil servants and businessmen.

Furthermore, for households with two or more cars, Douala top the list with ownership rate of approximately 21,0%, this is followed by Yaoundé with 19,1%. Factors accounting for this including economic growth leading to more households affording financial investments and also status symbol, showcasing wealth and social standards mostly by the political class. For households with no car, the rates varied across the case study cities with 40,0% for Bamenda, 29,4% for Bafoussam, 29,1% for Yaounde and 23,0% for Douala. However, the aspirations of those without cars in all the cities was 100,0% expression to own a car.

4.1.3. Mode Share by Trip Purpose for Various Transport Systems

Residents in the study areas expressed concern about automobile dependency, as they use cars for most trips, leading to transit-oriented development that incorporates mixed modes of transportation. Car-free development promotes minimal driving. This is supported by a case study survey conducted in the city of Yaoundé, which focused on different transport modes and their purposes among urban residents.

As shown in table 5, trip purposes were categorized into automobile dependent, transit-oriented development and car free. The trip purpose influenced the choice of transportation mode. The trends observed indicate that, for total trips purposes, automobile dependency accounted for 23% of total car trips, transit-oriented development represented 24% of car trips, and car free indicated 12% for total car trips. For transit-oriented trips, the results showed that automobile dependent was 4% for total transit trips, transit-oriented development 8% for total transit trips, and car free was 13% for total transit trips. In contrast, total non-motorized trips recorded 3% for automobile dependency, 6% for transit-oriented development, and 16% for car-free.

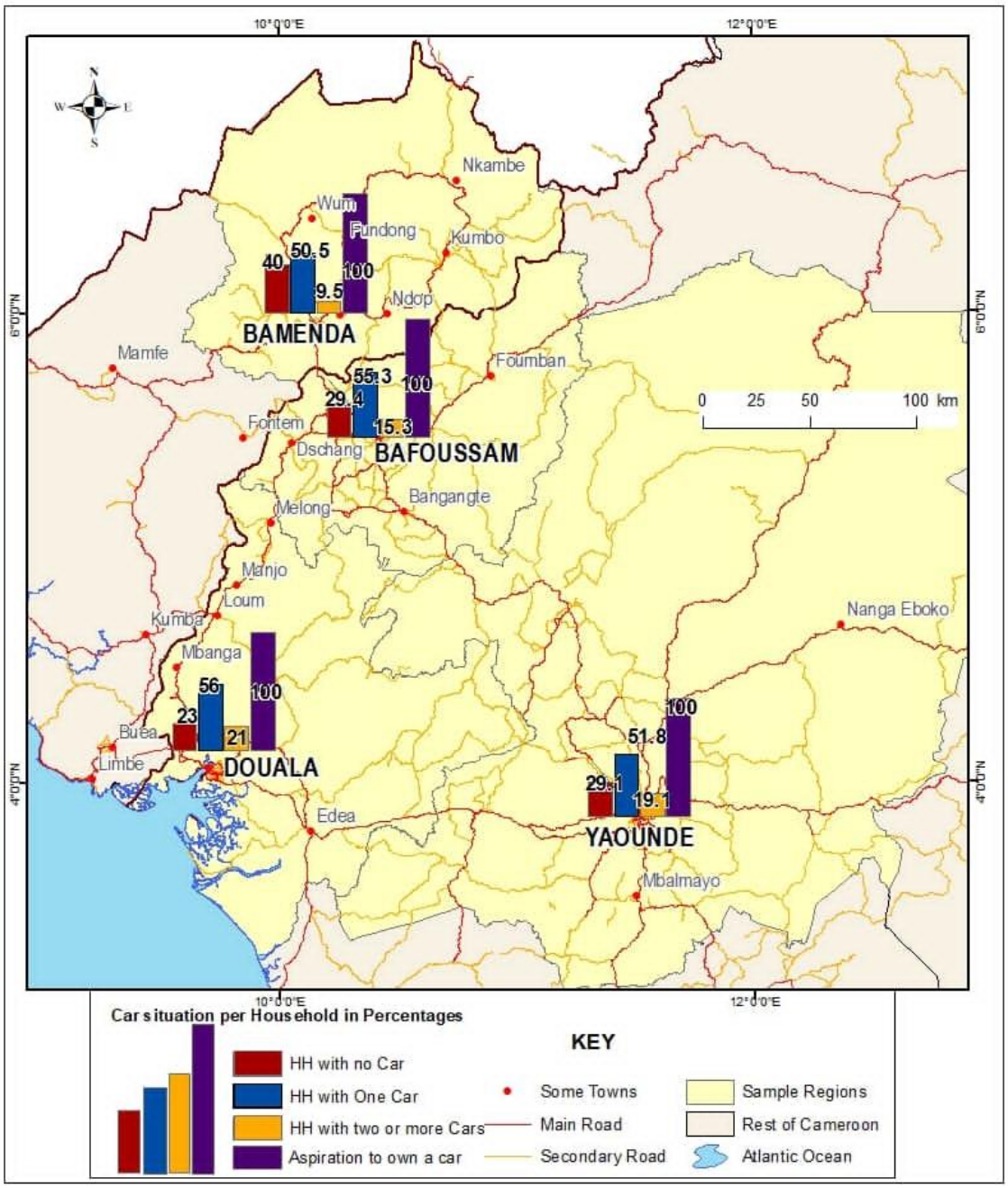


Figure 4. *Vehicle ownership among households in Yaoundé, Douala, Bamenda and Bafoussam.*

Table 5. *Typical mode share by trip purpose for various transport systems in Yaoundé*

Trip Purpose	Automobile Dependent	Transit Oriented Development	Car free
Work commuting			
School commuting			
Work-related business			
Personal travel (errands)			
Social and recreation			
Percentage (%) cover by trip mode			
Total car trips	*23*	24	12

Trip Purpose	Automobile Dependent	Transit Oriented Development	Car free
Total transit trips	4	8	13
Total non-motorized trips	3	6	*16*
Total trips	30	38	36

Source: Field survey, 2024

4.2. Impact of Automobile Dependence on the Urban Environment in the Study Areas

Figure 5 present findings on the selected cities focusing on air quality, unsafe transport modes, noise pollution, congestion and unplanned urban sprawling. Results indicates that automobile dependence are significant sources of air pollution across the cities. In cities like Yaoundé and Douala, motor vehicle ownership has escalated due to economic growth and air quality has deteriorated. This view is supported by 87,2% commuters in Yaoundé, 78,0% for those in Douala, 82,0% in Bamenda and 67,3% in Bafoussam. Unsafe transportation modes were very high in all the cities with high rates as far as 96,3% in Douala. This is because of lack of specific infrastructure for different modes, the roads are vulnerable for traffic accidents, congestions and road crime wave. Another significant impact was noise population due to heavy traffic on the urban roads, especially in Douala city with 88,0% adverse impact on resident's health. Most of the residents complain that traffic noise primarily from motorcycles often reached 80 dB in some areas of the city especially in Ndokoti, Rondpoint Deido, which is significantly above 55 dB recommended for residential areas by World Health Organization. Consequently, prolong exposure to such noise lead to health issues including stress, sleep disturbances, and head ache. The impact was significantly high for Bamenda and Yaoundé reaching 80,0% and 81,0%. Traffic congestion was also recorded as a significant impact emanating from increase vehicle ownership in all the four cities, manifesting more severely in Douala, the commercial hub of the country.

The traffic situation in Douala impacted 90,9% of urban residents, while in Yaoundé it affected 85.0%. In Bamenda and Bafoussam, while traffic congestion is less pronounced at 47,0% to 63,0%, urban planning must proactively address the anticipated rise in automobile usage. All the cities are significantly experiencing unplanned urban sprawl, which residents perceive as a major cause of increased car ownership. Urban expansion has increased distances to the city center, and populations in the peri-urban areas rely more on personal transportation. The development of urban sprawl in these cities does not align with transportation development, resulting in longer distances to workplaces, business centers, and social amenities, thus increasing car dependency. The highest rates of impact were recorded in Douala at 93.6%, followed by Yaoundé at 78.0%, Bamenda at 75.0%, and Bafoussam at 60.0%.

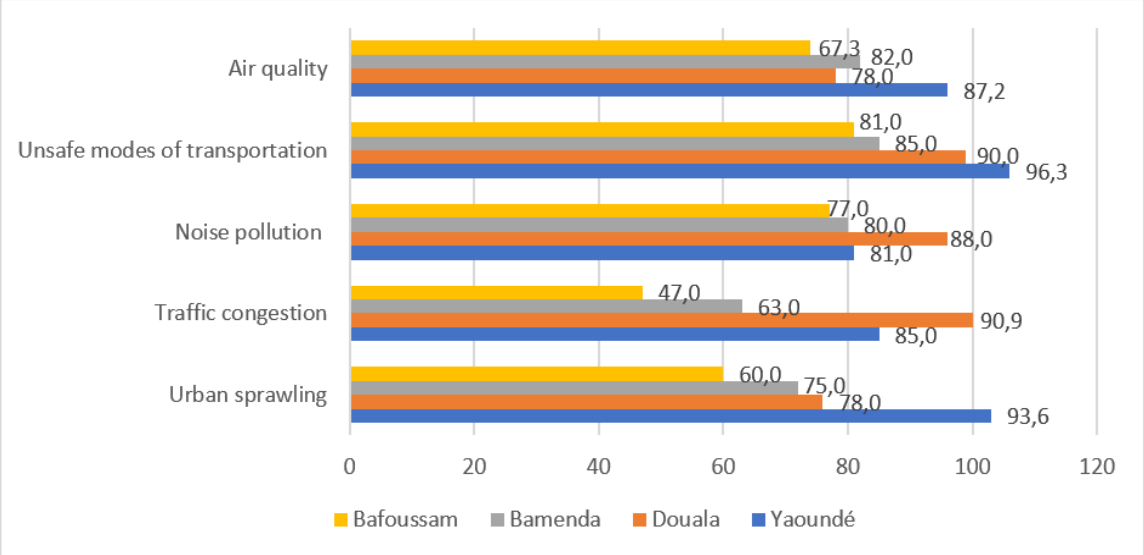


Figure 5. *Impact of usage on environment of Yaoundé, Douala, Bamenda and Bafoussam.*

4.3. Reversing Automobile Dependency in Cameroon Cities

Cameroon cities are experiencing spontaneous growth of urban traffic with automobile dependency growing every day. Managing this phenomenon is vital for improving the cities livability. To sustainably manage the future of Cameroon cities free from over dependence on car use, state government, urban planners and municipal authorities must start thinking of alternatives ways to automobile ownership in order to reduce car-dependency, regardless of how they are powered or who drives them. This section provides some guiding principles for reversing car dependency, which could enable urban residents carry out their daily activities with minimal concentration or thinking of using a car and not having to rely on cars to satisfy their transport demands. The question for policy makers is how to ensure an adequate level of car-free accessibility through other travel options including public transport, cycling, shared micro-mobility and walking. Encouraging the use of non-car transport modes requires safe walking and cycling infrastructures. It also involves adequate parking for vulnerable groups especially disabled residents who have to rely on private vehicles for equitable access. Significantly, reducing the modal share of private vehicles in urban mobility implies significant long-term change in the spatial form of cities. In the short to medium-term, it means re-allocating space away from roads and parking. In the longer-term, it implies changes in land-use patterns to maintain high levels of accessibility with lower overall levels of mobility.

The following approaches could help the city authorities, and policy makers in Yaoundé, Douala, Bamenda and Bafoussam as well as other cities in Cameroon by extension, to better sustainable mobility and reduce reliance on automobiles for daily commuting.

4.3.1. Review of the Street Space and Urban Land Share Allocated for Cars in the Cities

The city authorities in Yaoundé, Douala, Bamenda and Bafoussam urgently need to review the current quantity of roads and parking spaces allocated for different transport modes in the cities. This is because automobiles tend to occupy disproportionally more space than their modal share. Re-allocating Road and parking spaces to public transport, cycling and walking increases mobility options for non-drivers, thus, encouraging users to shift from cars to more space-efficient modes and thereby helping to achieve equity and efficiency objectives. The introduction of shared micro-mobility could increase the demands for redistribution of mobility spaces in the cities through expansion of dedicated cycling lanes to accommodate e-scooters, e-bikes and similar micro-vehicles which are easy to use and have the ability to navigate congested urban areas more effectively than traditional vehicles. This will do much to make the urban roads safer, and also perceived as safe, thus making micro-mobility a much more attractive alternative to cars, as such, cities would witness a drastic reduction in car dependency.

4.3.2. Road Space Allocation as Panacea to Effective Traffic Management

Reallocation of road space and changes to road layouts that give more space to cyclists and pedestrians should be used as a strategy to manage car use. A growing body of evidence suggests that a well-planned reduction of road space for private cars does not add to congestion. On the contrary, reduced road capacity can lead to “disappearing traffic” at a short run, at the long run the road may jamb back to capacity with intense traffic flow. Car drivers adapt to changed conditions in many ways, often too complex for computer models to predict. Empirical evidence from measures implemented is therefore as important as modelling for decision-making. However, public space improvements and livability associated with reallocation of road space cab generally benefit retailers through increased footstep and associated sales. Citizens and local administrations are less prone to contesting road space reallocation than road pricing, as no cash payments are involved. Reallocation of road space can reduce access to urban centres for car-dependent households living on the periphery and in suburban areas that lack efficient public transport connections. Park and Ride schemes have proven to give a good solution to satisfy transport needs in a sustainable manner in many cities on the African continent by allowing car-dependent households to park in secure locations and complete their journey into the city centre by public transport. The vast majority of Park and Ride sites are situated outside the urban areas of city centres and are designed to relieve congestion along the roads leading into the city centre. The city authorities in Douala, Yaoundé, Bamenda and Bafoussom could implement this option by developing projects road space allocation. This encompasses urban renewal projects that are being carried in the cities with little fruits on traffic reduction.

4.3.3. Implementation of Integrated Transport Planning and Land-Use Development

City authorities should work towards promoting compact urban development schemes which could be at the core of any long-term development strategy to reduce car dependency. This can be achieved through aligning transport networks in high-density residential and commercial corridors for a long period of time. This can be recommended for long term projects. Accessibility indicators have proved useful for coordinating land-use and transport planning and for identifying areas for development. A city like that of Douala and Yaoundé high density could follow this example to invest in rail transit to manage urban growth by extending rail lines to less developed areas of the city especially at the peri-urban fringes to steer up spatial expansion of the city with less car.

4.3.4. Re-Examine Land-Use Regulations That Hinder Compact City Development Patterns

Evidence suggests that relaxation of density regulations can reduce car use and emissions. Specifically, restrictions on building height or floor area ratios hamper densification. Policies that allow population density to increase can also sometimes curb growth in the cost of housing. This can be done by targeting compact built areas in cities of Douala and Yaoundé while preventing further construction of this development pattern in medium size cities of Bamenda and Bafoussam and other cities in Cameroon that are rapidly growing up.

4.3.5. Provision of Convenience and Effective Quality Alternatives to Private Cars

Providing quality public transport options at affordable prices is central to encouraging modal shift. Improving service quality has a stronger influence on demand than lowering ticket prices. Reducing crowding, increasing comfort and enhancing reliability are particularly effective. Peak pricing should be considered for public transport, with or without concomitant road pricing, especially where fares are low and use is high. This will help balance demand with supply and fund additional peak-time services. By reducing crowding and delays, peak pricing on public transport could contribute to reducing congestion on the road as some commuters switch to better managed public transport.

4.3.6. Promote Moderate-Cost Infrastructure Projects with High Social Benefits

There are several moderate-cost projects that can significantly help to enhance mobility in Cameroon cities. Making pedestrian travel easier and safer is a crucial issue that can be addressed through the implementation of safety programmes and the construction of dedicated facilities such as passageways and walkways. These limited-cost infrastructure improvements are extremely valuable. Identifying the predominance transport system is necessary. In the case of Yaoundé, Douala, Bamenda and Bafoussam, the predominance transport modes in these cities are motror-taxi (paratransit) and motorbikes. It is therefore necessary for the city authorities to create a specific model based on this reality. To underscore this, platformisation and the integration of transport services using mobility as a service model can be consider in the long run to integrate of different modes of transport into a single mobility service through the adoption of the mobility model app. Platformisation is a global trend that is observed even in some African countries, where the number of local and international initiatives is rising. Regardless of the type of vehicle used, mobility service platforms can enhance the transport system, provided that they take into account the needs of existing operators. In the ride-hailing sector, there is a proliferation of international applications like Uber and Yango, along with an increasing number of local initiatives. These services aim to improve user comfort and reduce the costs associated with private transportation, including taxi fares.

4.3.7. Data-Driven Approaches to Optimize Transport Operations

The collection and analysis of data provide greater insight into the traffic patterns in the cities, particularly by making it possible to produce a map of the informal transport network, for which information tends to be incomplete especially in the cities of Douala and Yaoundé. A good understanding of traffic flows is a prerequisite for implementing effective transport policies. In many African cities for example, they analyzed data collected from users' smartphones to chart their informally run transport routes. In Accra, a map of the city's trotro minibus network was created with the help of the French Development Agency (AFD). Cameroon government can proffer to adopt a similar network in it rapidly growing cities. Data analysis is also a tool for reducing urban congestion. Collecting traffic data allows real-time congestion management by redirecting users to alternative routes. Analyzing data over longer periods of time with congestion measures, such as the TomTom Traffic Index, could help to improve understanding on traffic trends in different urban areas based on real-time data and historical records to plan urban roads more efficiently.

5. Discussion

The discussion of the findings has been done in line with the objectives which the research paper seeks to attain. The paper sort to identify the causes of car dependency in Cameroon cities of Yaoundé, Douala, Bamenda and Bafoussam, examining the impact of the car dependence on the urban environment and proffer solutions on reducing dependency on automobile use in the case study cities. The concept of car dependence was applied which enhance our understanding of the subject matter in question. Three aspects from the theory helped the researchers to distinguished car dependency into potential variables which was used during field work. This included: car dependence places; car dependence trips and car dependence persons. These three aspects together provided a full picture of car dependence in terms of causes, ownership, modal share, and impacts. The models in this paper help reveal how the three aspects are interconnected to each other, but the model results do not rely on this conceptualization. The complexity of car dependence and its measurements echoes the complexity of the motives of car ownership and car usage, as the symbolic and emotional motives of car use as well as its instrumental motives are identified by many scholars. The theory advocates that human society has become too reliant on automobiles for transportation, leading to social, economic, and environmental problems [19]. This has been tested and proven in the study cities. Vehicle ownership

by households in Yaoundé, Douala, Bamenda and Bafoussam is significantly high especially among households with at least one car, even the households without cars have the desire to own one. This ties with the theory on society's perception towards car dependence. In the same light, the theory postulate that the widespread availability and use of cars has contributed to urban sprawl, traffic congestion, air pollution, greenhouse gas emissions, and inefficient use of land which has negatively impacted public health, community cohesion, and social equity. This corroborates with the current finding where car dependency generates a lot noise, affect air quality, traffic congestion and promote unplanned urban sprawling especially in core cities like that of Douala and Yaoundé.

The findings on the growing automobile dependency in Cameroonian cities corroborate with similar challenges observed in South African urban centers. In Johannesburg, for example, a study by [31] highlighted how the city's reliance on private cars has led to increased congestion, air pollution, and limited accessibility for those without vehicle ownership. Both studies emphasize the need for alternative mobility solutions, such as public transportation, cycling, and walking infrastructure, to address the rising car dependency. Like Cameroon, South Africa also grapples with the need for equitable access, particularly for vulnerable groups, and the reallocation of urban spaces away from cars [32]. This comparison highlights a broader African trend where unregulated urban growth and vehicle dependence challenge the pursuit of sustainable urban mobility. Similar observations from other urban centers in Africa, for instance, Oyesiku (2010) noted that vehicle dependence in Nigerian cities like Lagos and Abuja exacerbates air pollution, traffic congestion, and noise pollution due to increased motorization, similar to what is observed in Douala and Yaoundé [43]. Both studies highlight the adverse effects of unregulated urban sprawl, where city expansion outpaces the development of adequate transportation infrastructure, forcing residents to rely on personal vehicles. Additionally, [16], emphasized how unplanned urban growth in Ghanaian cities leads to traffic congestion and noise pollution, which resonates with findings from Bamenda and Bafoussam. These comparisons reveal a consistent pattern of urban challenges across African cities driven by vehicle dependence, poor infrastructure, and urban sprawl, all of which undermine the goal of sustainable urban development.

Although our findings majorly align with the car dependence model general findings, confirming the role of car ownership in cities and the negative externalities associated with it. This notwithstanding, there are still possibilities to draw a line between certain findings of the model with the current findings, and discuss some discrepancies between observed effects of variables on car dependency. Firstly, the theory ascertains that car dependency in cities has cause negative impacts, the theory then advocates for shifting to more sustainable modes of transportation, such as walking, biking, public transit, and car-sharing, in order to reduce dependence on cars and mitigate the negative impacts associated with automobile use [49]. Secondly, the theory also made use of many indicators concerning people dependence on cars which can be assessed by how much a person uses the car, and the relative ones that is to say at what portion of the total travel is done by a car. Both sets of indicators can be in the units of the number of car journeys, time spent traveling by car, and distance traveled by car. A more sophisticated measure is even proposed on individuals' mode choice perspective and quantified car dependence as the extent to which other travel options are excluded from the considered choice set [54]. Some scholars also argue that car dependency is associated with high rates of car travel per capita and is characterized by car-oriented land use patterns, in combination with lack of alternative transport options [22].

While the theory may have been developed following Western conception of cities, in developing countries cities like Yaoundé, Douala, Bamenda and Bafoussam, some aspects of the theory would have a long way to adapt since most Cameroon cities where not planned before construction. The haphazard built-up spaces were constructed without allocating enough spaces for transport infrastructure. To restructure these cities with transportation demand would entail massive destruction in the name of urban renewal. Some aspects of the car dependency theory proposed by [6] and [8], such as transportation and land use market distortions, underpricing, inadequate consumer choice and weak competition which they asserted as factors that encourage automobile dependency did not find place in the current study. Our finding strongly urged the Cameroon government, urban planners and municipal authorities to start thinking of alternatives ways to automobile ownership to sustainably manage the future of Cameroon cities free from over dependence on car use in order to reduce car-dependency, regardless of how they are powered or who drives them.

6. Conclusion

Cities are growing faster despite negative externalities they generate on the urban environment spearheaded by population influx in search for better living conditions. This situation in Sub-Saharan African cities is becoming worrisome given the unpresented growth and expansion of the city's fringes which does not match with infrastructural development. While the issues of access to and use of the car continue to receive much scholarly attention in the urban contexts characterized by deregulated informal transport systems, high modal shares, noise pollution and degraded urban landscapes, policy makers need to focus concern in this domain if cities must achieve it Sustainable Development Goal 11 (SDG, 11) by 2030. This paper focus attention in four Cameroonian cities: Yaoundé, Douala, Bamenda and Bafoussam where the phenomenon of automobile dependency on the urban landscape has passed threshold. The wanton exploitation of the informal transport, urban sprawling, limited public transport and sidewalks and income disparity has promoted automobile dependency. The

adverse effects are many, the case study cities are undergoing air quality deterioration, unsafe transportation modes, traffic congestion, noise pollution and unplanned expansion of settlements. All these culminate to give rise to car ownership which the city authorities are fighting to contain with. The paper end by proposing alternatives ways to automobile ownership in order to reduce car-dependency. It actions are taken to implement the alternative measures, it is hoped that car dependency would have cut by halve by 2030 there by realizing one of the road safety agenda which is to promote safe and sustainable transportation in all Cameroon cities which is to upgrade the transport infrastructures, strengthen transport legislations, promote public transportation systems, foster active mobility by creating environments that facilitate walking, cycling, thus promoting non-motorized transport options that are safer and more sustainable. This ultimately reduces automobile dependency.

Abbreviations

CMs	City Mayors
DMT	Delegate of Ministry of Transport
NIS	National Institute of Statistics
SDG11	Sustainable Development Goal 11
TSLs	Transport Syndicate Leaders
RTOs	Road Traffic Officers

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Abubakar, I. R., & Alshammari, M. S. (2023). Urban planning schemes for developing low-carbon cities in the Gulf Cooperation Council region. *Habitat International*, *138*, 102881.

[2] Anochiwa, L. I., Agbanike, T. F., Chukwu, A. B., Ikpe, M., & Otta, N. N. (2022). Urbanization and carbon emissions: looking at the role of mobile phone adoption in Sub-Saharan African countries. *Environmental Science and Pollution Research*, *29*(52), 78526-78541.

[3] Bischoff, Joschka, Michal Maciejewski, and Alexander Sohr. (2015). "Analysis of Berlin's Taxi Services by Exploring GPS Traces." 2015 International Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS). Budapest, Hungary.

[4] Buehler, R. (2009), "Determinants of Automobile Use: Comparison of Germany and the United.

[5] Buehler, R. Pucher, J., Gerike, R., Gotschi, T. (2016) 'Reducing car dependence in the heart of Europe: lessons from Germany, Austria, and Switzerland', *Transport Reviews, 37(1), pp. 4–28. https://doi.org/10.1080/01441647.2016.1177799*

[6] Brown R. J., Morris E., and Taylor B. D., (2009). Planning for Cars in Cities: Planners, Engineers, and Freeways in the 20th Century, *Journal of the American Planning Association, Volume 75(2), pp161-177 https://doi.org/10.1080/01944360802640016*

[7] Davies, M., Schiller, T., (2018). Navigating the African Automotive Sector: Ethiopia, Kenya and Nigeria, Deloitte Africa Automotive Insights. Deloitte, Johannesburg.

[8] DiMento F. C. J, Ellis C., (2012). Changing Lanes: Visions and Histories of Urban Freeways. *Urban and Industrial Environments, https://doi.org/10.7551/mitpress/9374.001.0001*

[9] Dimitrou, H. T. and Gakenheimer, R. (2011). Urban transport in the developing world: A handbook of policy and practice. Cheltenham: Edward Elgar.

[10] European Commission, (2017). "Sustainable urban mobility: European policy, practice and solutions", Directorate General for Mobility and Transport at the European Commission, Brussels, https://ec.europa.eu/transport/sites/transport/files/2017-sustainable-urban-mobility-european-policy-practice-and-solutions.pdf

[11] Eurostat (2019), "Transport statistics at regional level", Statistics Explained, Kirchberg, 14 April 2020, https://ec.europa.eu/eurostat/statistics-explained/pdfscache/14273.pdf

[12] Goodwin, P. (1997). Mobility and Car Dependence. In Traffic and Transport Psychology (T. Rothengatter and E. Carbonell, eds.), Pergamon, Amsterdam, Netherlands, pp. 449–464.

[13] Goodwin, P. and K. Van Dender (2013), "Peak car: Themes and issues", Transport Reviews, Vol. 33/3, pp. 243-254, www.tandfonline.com/doi/abs/10.1080/01441647.2013.804133

[14] ITF, (2021). Reversing Car Dependency: Summary and Conclusions, ITF Roundtable Reports, No. 181, OECD Publishing, Paris.

[15] Jones, P. (2011). Conceptualising car dependence', Lucas, K., Blumenberg, E. and Weinberger, R. (Eds.), Auto Motives, Emerald Group Publishing Limited, pp. 39-61.

[16] Kien, A. H. (2018). *A gender perspective of municipal solid waste generation and management in the city of Bamenda, Cameroon*. Langaa Rpcig.

[17] Kuma J. C, Gideon S., and Kimengsi J. N., (2021). Urban Transport Infrastructure and Population Dynamics in Sub-Saharan Africa: Evidence from Bamenda City, Cameroon. *Journal of Geography, Environment and Earth Science International V24(9): pp 1-12, https://doi.10.9734/jgeesi/2020/v24i930249*

[18] Kuma C. J, and Ngwah E. C, (2024). Covid-19 restrictions and transport sector in Sub-Saharan Africa: insights from Douala City, Cameroon. Proceedings of the Institution of Civil Engineers – Transport, https://doi.org/10.1680/jtran.23.00093

[19] Lewis S., and Grande del Valle, (2019). San Francisco's neighborhoods and auto dependency, Vol. 86, pp 11-24, https://doi.org/10.1016/j.cities.2018.12.017

[20] Litman, T., 1999. Transportation Market Distortions – A Survey. Working paper, Victoria Transport Policy Institute, Victoria, Canada. See on: http://www.vtpi.org/distort.p

[21] Litman, T. (2011) The First Casualty of a Non-Existent War: Evaluating Claims of Unjustified Restrictions on Automobile Use, and a Critique of 'Washingtons War On Cars and the Suburbs' Victoria, Transport Policy Institute http://www.vtpi.org

[22] Litman, T. and Laube, F. (2002). Automobile Dependency and Economic Development, Victoria Transport Policy Institute. http://www.vtpi.org/ecodev.pdf

[23] Macea, L. F., Márquez, L., & Soto, J. J. (2023). How do the affective and symbolic factors of private car driving influence car users' travel behavior in a car restriction policy scenario?. *Transport policy*, *140*, 100-113.

[24] Mackett, R. (2002) Increasing Car Dependency of Children: Should We Be Worried? Proceedings of the Institution of Civil Engineers-Municipal Engineer, 151(1) pp. 29-38.

[25] Mahendra, A., Seto, K. C., (2019). Upward and Outward Growth: Managing Urban Expansion for more Equitable Cities in the Global South. *The World Resources Institute Ross Center for Sustainable Cities Working Paper, p. 31*

[26] Maheshwari, T., & Axhausen, K. W. (2021). How will the technological shift in transportation impact cities? A review of quantitative studies on the impacts of new transportation technologies. *Sustainability*, *13*(6), 3013.

[27] Maji, S., Ahmed, S., Kaur-Sidhu, M., Mor, S., & Ravindra, K. (2023). Health risks of major air pollutants, their drivers and mitigation strategies: a review. *Air, Soil and Water Research*, *16*, 11786221231154659.

[28] Mavlutova, I., Atstaja, D., Grasis, J., Kuzmina, J., Uvarova, I., & Roga, D. (2023). Urban transportation concept and sustainable urban mobility in smart cities: a review. *Energies*, *16*(8), 3585.

[29] Mbandi, A. M., Malley, C. S., Schwela, D., Vallack, H., Emberson, L., & Ashmore, M. R. (2023). Assessment of the impact of road transport policies on air pollution and greenhouse gas emissions in Kenya. *Energy Strategy Reviews*, *49*, 101120.

[30] Merom, D. Humphries, J. Ding, D. Corpuz, G. Bellew, W. Bauman, A. (2018) 'From ar dependency to desirable walking-15 years trend in policy relevant public health indicators derived from Household Travel Surveys', Journal of Transpot and Health, 9(2018), pp. 56-63.

[31] Miner, P., Smith, B. M., Jani, A., McNeill, G., & Gathorne-Hardy, A. (2024). Car harm: A global review of automobility's harm to people and the environment. *Journal of Transport Geography*, *115*, 103817.

[32] Moghaddam, S. N. M. (2024). Introduction—Navigating Pandemics in Urban Spaces: Challenges, Strategies, and the Future of Urban Planning. In *Making Sense of Planning and Development for the Post-Pandemic Cities* (pp. 1-26). Singapore: Springer Nature Singapore.

[33] Mohan, A., Bruchon, M., Michalek, J., & Vaishnav, P. (2023). Life Cycle Air Pollution, Greenhouse Gas, and Traffic Externality Benefits and Costs of Electrifying Uber and Lyft. *Environmental Science & Technology*, *57*(23), 8524-8535.

[34] Mouratidis, K., De Vos, J., Yiannakou, A., & Politis, I. (2023). Sustainable transport modes, travel satisfaction, and emotions: Evidence from car-dependent compact cities. *Travel behaviour and society*, *33*, 100613.

[35] Mun Ng, K., Wah Yuen, C., Chuen Onn, C., & Ibtishamiah Ibrahim, N. (2024). Urban Mobility Mode Shift to Active Transport: Sociodemographic Dependency and Potential Greenhouse Gas Emission Reduction. *SAGE Open*, *14*(1), 21582440241228644.

[36] Nemakhavhani, M. G. (2023). *Assessment of air quality compliance in the City of Tshwane Metropolitan Municipality* (Doctoral dissertation, Cape Peninsula University of Technology).

[37] Otuoze, S. H., Hunt, D. V. L., & Jefferson, I. (2021). Neural network approach to modelling transport system resilience for major cities: Case studies of Lagos and Kano (Nigeria). *Sustainability, vol. 13, no. 3.;* https://doi.org/*10.3390/su13031371*

[38] Palmentieri, S. (2021). Smart cities and the sustainability of urban transport: Strategic directions for the metropolitan city of Naples. *Journal of Urban Regeneration & Renewal*, *15*(1), 83-94.

[39] Radoine, H., Bajja, S., Dakyaga, F., Çelik, A., Kamana, A., Yakubu, H., & Chenal, J. (2024). Modelling the dynamics of urbanization for urban sustainability in West Africa. *Journal of Urban Management*.

[40] Rahman, M. M., & Thill, J. C. (2023). Impacts of connected and autonomous vehicles on urban transportation and environment: A comprehensive review. *Sustainable Cities and Society*, *96*, 104649.

[41] Remy, S., Melissa J. P., Claude, N., (2012). Transport and mobility in sub-Saharan African cities: An overview of practices, lessons and options for improvements. *The international journal of urban policy and planning,* https://doi.org/*10.1016/j.cities.2011.11.005 pp183–189.*

[42] Reyna, A. J., (2023). Rethinking Urban Planning for a Sustainable Future. https://doi.org/*10.13140/RG.2.2.15444.78724*

[43] Saleh, K. T., Musa, A. A., Malami, S. I., Levent, Y. S., & Dulawat, S. (2024). AI-Based Green Transportation: A Sustainable Approach. In *Artificial Intelligence for Future Intelligent Transportation* (pp. 269-302). Apple Academic Press.

[44] Selzer, S. (2021). Car-reduced neighborhoods as blueprints for the transition toward an environmentally friendly urban transport system? A comparison of narratives and mobility-related practices in two case studies. *Journal of transport geography*, *96*, 103126.

[45] Shao, W. Zhang, X. (J). Cao, J. Yang (2022). Nonlinear and interaction effects of land use and motorcycles/E-bikes on car ownership Transportation. *Research Part D: Transport and Environment, Vol. 102,* https://doi.org/*10.1016/j.trd.2021.103115*

[46] Slocat, (2018). Showcasing the Critical Role of the Transport Sector to Achieve the SDGs] [All SDG Knowledge Hub coverage of HLPF 2018.

[47] Smit, R. (2023). An independent and detailed assessment of greenhouse gas emissions, fuel use, electricity and energy consumption from Australian road transport in 2019 and 2050. *Air Quality and Climate Change*, *57*(2), 30-41.

[48] Stage, L., (2009). Transportation Research Part A: Policy and Practice. In: Car Use: Lust and Must. Instrumental, Symbolic and Affective Motives for Car Use, pp. 147- 162.

[49] Stradling, S. G. (2002). Reducing Car Dependence. In Integrated Future and Transport Choices (J. Hine and J. Preston, eds.), Ashgate, Brookfield, U. K., pp. 100–115, Sustainable Transport in the United States: From Rhetoric to Reality? http://www-dcrp.ced.berkeley.edu/bpj Volume 19, pp. 19–36;

[50] Timilsina and Dulal, (2011). Urban Road Transportation Externalities: Costs and Choice of Policy Instruments. World Bank Research Observer, https://doi.org/10.1093/wbro/lkq005

[51] UN-Habitat, (2014). The State of African Cities. Re-imagining sustainable urban transitions. Nairobi:UN-Habitat, *http://unhabitat.org/?wpdmact=process&did=MTEzMi5ob3RsaW5r*

[52] Venter, C. (2013). The lurch towards formalisation: Lessons from the implementation of BRT in Johannesburg, South Africa. Research in Transportation Economics, 39, 114-120.

[53] Verma, M. Manoj, A. Verma (2016). Analysis of the influences of attitudinal factors on car ownership decisions among urban young adults in a developing country like India *Transportation Research. Part F, Traffic Psychology and Behaviour, Vol. 42, pp. 90-103,* https://doi.org/*10.1016/j.trf.2016.06.024*

[54] Zhang, M. (2002). Conditions and Effectiveness of Land Use as a Mobility Tool. PhD dissertation. Massachusetts Institute of Technology, Cambridge.

[55] Zhao, X., Yan, X., Yu, A., & Hentenryck, P. V. (2020). Prediction and behavioral analysis of travel mode choice: A comparison of machine learning and logit models. Travel Behaviour and Society, https://doi.org/10.1016/j.tbs.2020.02.003