Vehicle Abandonment: Analysis of National and International Fleets and Their Irregular Disposal on Public Roads

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Abstract

People's need to get around has meant that motor vehicles now dominate cities. The increase in the fleet has triggered numerous problems, including their improper disposal. In this sense, the objective was to evaluate the national and international fleets of motor vehicles and their irregular disposal on public roads, in a context of growing demand. The methodology included a systematic review of Capes journals and the evolution of the national and international fleet, as well as those already discarded, and sought an analysis of the various realities. The results showed that the unbridled increase in fleets resulted in urban mobility, with relevant environmental impacts due to the abandonment of vehicles on the roads, necessitating actions from social actors, governments, automobile companies, and society to solve the problems highlighted.

Keywords: irregular disposal, vehicle abandonment, public policies, cities

1. Introduction

After the Industrial Revolution in England in the 18th century, other technological revolutions ensued, transforming cities and giving rise to market economies. Consumer goods, even if durable, began to be manufactured on a scale, and in this revolutionary context, the creation of the steam engine around 1789 gave rise to the emergence of the automobile (Eckermann, 2001).

The evolution of the growth of vehicle fleets in the international and national scenario demonstrates the presence of this type of mobility in urban centers, becoming, with the evolution of cities, the main means of locomotion, triggering problems, including irregular disposal.

Considering the constant increase in the vehicle fleet and the demand for renewal, it is believed that adequate public policies, associated with legislation and coercive and overt enforcement actions, can contribute to reducing the problem in question.

This article is justified, first by the lack of discussion and data on the subject, especially in the national scenario, and then by the need for better preventive and coercive policies on the irregular disposal of vehicles in cities. This has resulted in public disorder, urban pollution, and water accumulation, in turn serving as places for the proliferation of insects and mosquitoes that transmit diseases, shelters for criminals to commit small crimes, and disturbances to citizens in general.

Integrated with this reality, awareness actions are necessary for the population in the sense that the property deposited and abandoned on the public road generates a series of discomforts for citizens, as well as awakening in managers the elaboration of adequate policies so that the competent organs can take measures with practical effects for the community.

Given the urgency of the fact, the objective was to evaluate the literature that addresses the national and international fleets of motor vehicles and their irregular disposal on public roads, in a context of growing demand for mobility. To know more about the realities that surround us, scientific data and literature were sought, both in Brazil and abroad, to understand possible solutions or applicable public policies.

The article is structured with an Introduction, where the theme is presented. Following, the literature review analyses the origin of cities and their evolution, focusing on urban planning as an indispensable political tool in the face of the

unbridled growth of cities. Subsequently, it deals with the creation of the combustion vehicle, and the growth of national and international fleets, emphasizing the problem of irregular disposal. The methodology describes the phases of the research. The results were subdivided into an analysis of Capes articles dealing with the subject; fleet of vehicles and their environmental impacts. Lastly, some final considerations are offered and the references are outlined.

1.1 Literature Review

1.1.1 Cities: Origin and Evolution

Cities have complex origins, usually arising due to the need for humans to group to facilitate survival, defense, and trade. At first, people settled near water sources and fertile lands. Over time, agricultural and technological development allowed the growth of communities, leading to the formation of civilizations and, consequently, cities. The process varies in different regions of the world, but urbanization is a global phenomenon that continues to evolve.

According to the renowned historian and archaeologist Jared Diamond, in his work "Weapons, Germs and Steel", the first permanent settlements and the emergence of the first cities represent crucial moments in the trajectory of humanity. Diamond (1997) points out that the advancement of agricultural techniques, around 12,000 years before Christ, played a fundamental role in the transition to more stable communities. Early cities, such as those in the valleys of the Nile, Tigris, and Euphrates rivers, and India, witnessed human and cultural development, becoming cradles of ancient civilizations that shaped history for millennia. These observations offer a fascinating perspective on the events that paved the way for the complex tapestry of human society.

The earliest records of the appearance of cities date from fifteen to five thousand years before Christ, depending on the interpretation of what defines an ancient permanent settlement and a city. Regarding permanent settlements, they emerged approximately 12,000 years before Christ, as a result of the advancement of agricultural techniques. In antiquity, the first cities were established in the valleys of the Nile in Egypt and the Tigris and Euphrates in Mesopotamia around 3500 BC and 3000 BC, respectively. (Durant, 1935). The same author reports that later, around 2500 BC, the first cities appeared in the Indus River valley, in India, and around 1500 BC, in China (Kenoyer, 1998).

In Europe, the Greek and Roman civilizations, their cities became centers of power, where the civil and military relations of the state developed. The most important city of antiquity, Rome, was founded on the Italian peninsula in 753 BC. In classical Greece, the most sophisticated political form was the polis (city), and the cities of Athens and Sparta were its main representatives, appearing between 700 BC and 500 BC (Aristotle, 2004).

For the Greeks, the city is, above all, the polis, the political society that was notably treated by Aristotle (2004) seeking its detailed aspects, to establish its purpose:

Paragraph 1. We know that every city is a kind of association and that every association is formed with some good as its goal; because man only works for what he regards as a good. All societies, therefore, propose any and every good - especially the most important ones, since it aims at a greater good, involving all others: the city or political society (Aristotle, 2004, p.11).

At the end of the Middle Ages, there was the rupture and fall of the feudal structure. In this context, with the increase in commercial activities and the rise of the bourgeoisie (merchants), commercial capitalism begins to take shape and there is the emergence of large medieval cities, with currency circulation and trade as a center of development (Carvalho, 2023).

The twentieth century was marked by the rapid and significant growth of cities around the world. With the advance of industrialization, urbanization intensified, driven by rural exodus and the search for employment opportunities in urban areas. Accelerated population growth, coupled with the development of infrastructure and technologies, has transformed many cities into densely populated urban centers. The expansion of urban industries and services has increased the supply of jobs and greater access to goods and services, further attracting migrants from the countryside.

This urban growth has brought significant challenges and impacts, such as the emergence of precarious neighborhoods, infrastructure problems, social inequalities, and environmental issues. However, it has also driven innovations, the emergence of social and cultural movements, and the diversification of landscapes. The growth of cities in the twentieth century has had a profound impact on social organization, the economy, and the urban environment, shaping the characteristics of known cities.

The agglomeration of people increasingly accentuated, and the demand for mobility brought motor vehicles to the

scene and, in the face of structural and conjunctural deficiencies, made this means of transport a priority in the formation of urban spaces, to the detriment of others.

1.1.2 Automobiles: The Emergence and Increase of the Fleet

The automobile history began with the creation of the steam engine capable of transporting humans, around 1769. The first cars powered by a gas-fuelled internal combustion engine appeared in 1807, which led to the manufacture in 1885 of the modern gasoline engine, or, gasoline combustion, the ubiquitous internal combustion engine. However, the year 1886 is considered the birth of the modern automobile, with Benz Patent-Motorwagen, German inventor Karl Benz (Eckermann, 2001, p.14)

From then on, the race for the production and sale of cars began, initiated by a French company known as Panhard and Levassor. In the USA, Henry Ford created the Ford Motor Company in 1903 and began to revolutionize the industry. Later, the "Fordism" mode of production would emerge, starting the production process on the assembly line, which was responsible for making that which was so desired at the time more accessible (Watts, 2005).

According to Fausto (2006), the history of the automobile in Brazil played a fundamental role in the transformation of society and the country's economy. The arrival of the first motor vehicles at the end of the 19th century brought with it changes, such as the modernization of transport, the development of the automobile industry, and the transformation of the urban landscape. From the 1950s, with the creation of the national automobile industry, the automobile became a symbol of status and mobility, in addition to driving the expansion of cities and roads.

In 1891, the inventor and later father of aviation, Alberto Santos Dumont, faced with the emergence of the first cars in France, decided to study the novelty and bring it to Brazil. The first industry to settle in Brazil was the Ford Motor Company in 1919, which had a small assembly line for the famous Ford T, later nicknamed The Ford mustache.

The automobile revolution in Brazil triggered in 1973, marked a transformation in the country's vehicle industry. Over the following years, we witnessed remarkable modernization in locally manufactured cars, with several models being replaced to meet growing demands. The 1980s brought with it a real fever for imported vehicles, with renowned brands such as Toyota, Honda, and Renault establishing their factories on Brazilian soil. This wave of internationalization contributed to the diversification of the market and the massification of car use, resulting in a significant increase in the fleet, and redefining the automotive landscape on Brazilian streets.

1.1.3 Irregular Disposal of Motor Vehicles

Faced with a scenario of more and more motor vehicles on public roads, replacing the old fleet with more modern vehicles, and of the increasingly intense conurbation of cities, the problem of irregular disposal of vehicles no longer needed or used arose.

On May 31, 2004, the Brazilian Association of Technical Standards (ABNT), through the Brazilian Registered Standard (NBR) no. 10.004, offered the following definition of solid waste:

Waste in solid and semi-solid states that result from community activities of industrial, domestic, hospital, commercial, and agricultural origin, including sweeping services. The sludge from water treatment systems is included in this definition, as well as that generated in equipment and plants for pollution control, as well as certain liquids whose specific characteristics become impossible to release in public sewers or water bodies or require technical solutions that are economically unfeasible in the light of the best available technology. (ABNT, 2004, P.1)

In Brazil, there is a legal provision concerning solid waste provided for in the National Solid Waste Policy (Law 12,305/2010), where garbage or waste is conceptualized as

XVI – solid waste: material, substance, object or good discarded resulting from human activities in society, whose final destination is carried out, proposes to proceed or is obliged to proceed, in solid or semi-solid states, as well as gases contained in containers and liquids whose particularities make their release into the public sewage network or water bodies unfeasible, or require technically or economically unfeasible solutions given the best available technology (Brasil, 2012, p. 11).

However, despite the generic legislation about solid waste, mainly concerning the irregular disposal of motor vehicles in public places, what is observed is that there is no federal provision on the subject, which makes each municipality of the federation responsible for legislating, as well as structuring its own legal framework according to the local reality. Given this reality, there is no universalization of the legal commandments on the irregular disposal of vehicles on public roads.

The practice of irregular disposal of vehicles in cities is a growing problem, affecting both the environment and people's quality of life. Neglecting to properly dispose of automobiles can result in negative impacts, including soil

and water pollution, public health hazards, and visual degradation of urban areas.

A study by Smith et al. (2018) demonstrated that improper disposal of vehicles contributes to soil and water contamination by toxic substances present in their components, such as oils, brake fluids, and batteries. These substances can seep into the soil and eventually reach underground aquifers, compromising the quality of available drinking water.

In addition, the decomposition of irregularly disposed vehicles releases heavy metals and other air pollutants. Johnson and Smith (2019) analyzed air quality in urban areas near places of irregular disposal of vehicles and found high levels of fine particles and harmful gases, such as sulphur dioxide and nitrogen oxides. This air pollution poses risks to the respiratory health of the local population.

In terms of visual impact, the presence of abandoned cars on streets and vacant lots contributes to the aesthetic degradation of urban areas. In a piece of urban landscape research carried out by Johnson et al. (2020), it was found that the presence of abandoned vehicles harms the perception of safety and the real estate value of the affected regions. The lack of maintenance of these vehicles creates an image of abandonment and carelessness, affecting the well-being and attractiveness of urban areas.

2. Method

This article was prepared in 2023 and is divided into stages:

The first section focused on the search for data on official websites to demonstrate the evolution of global vehicle fleets here in Brazil. We searched for materials that could portray the realities of places or cities in relation to vehicle abandonment.

In the same sense, the second stage was to search for content by a literature review in Capes journals, to subsidize this article with works that dealt with the theme. Initially, the keywords "abandoned vehicles" and "vehicle disposal" were used in the Portuguese language, but it was not successful in finding articles that dealt with the subject. Subsequently, the following terms were used: “abandoned vehicles”, cities, and “irregular disposal of vehicles”, which were listed by Boolean operators “and” and “OR”, using the “peer-reviewed” filter to improve the scientific validation of this research. Mentioning only the term “abandoned vehicles”, 30 articles were found, however, only 17 were peer-reviewed. After a thorough analysis of the thematic relevance, eight articles that met the selection criteria were selected, as detailed in Figure 1.

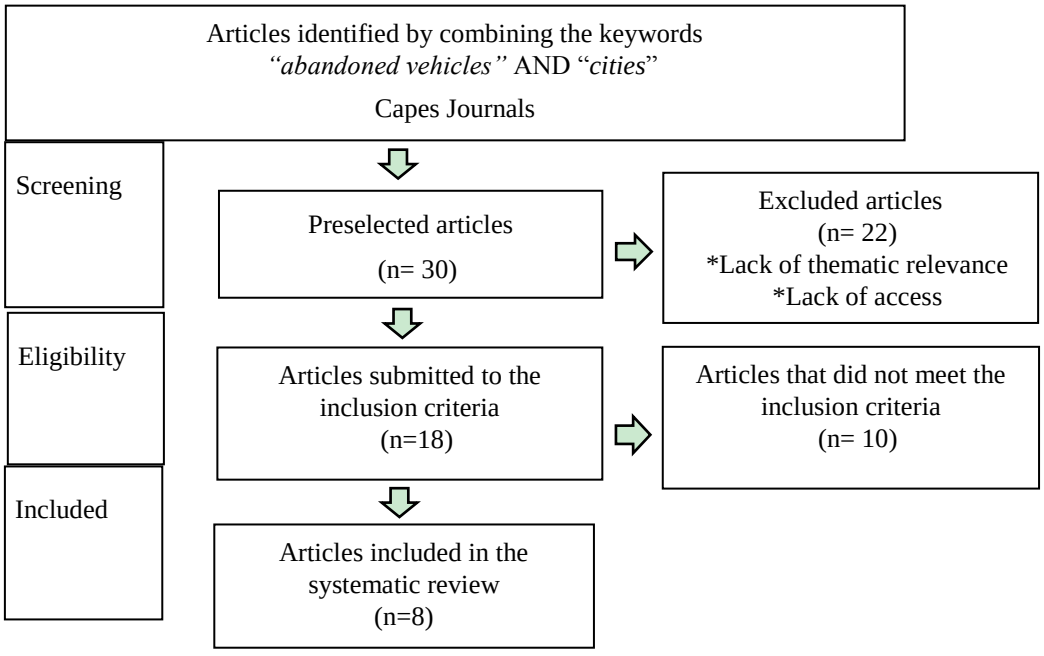

Figure 1. Flowchart of the article selection process in Capes journals, on the irregular disposal of vehicles in public places and cities.

Source: authors themselves, 2023.

The third stage involved collecting data on the vehicle fleet around the world, including Brazil, countries with the largest fleets, fleet evolution over time, national typification, regional distribution, and by state, until the electric vehicle fleet scenario in the market was clarified. The data were presented in figures and tables for better analysis and elucidation of the behavior of these variables.

3. Results and Discussion

3.1 Analysis of Articles From Capes Journals

Table 1 details the list of eight articles selected from Capes journals according to the inclusion criteria, with authors, titles, year and name of the journal where it was published, subjects related to the issue addressed in the article, organized in a decreasing scale in relation to the year of publication.

Chart 1. List of articles selected in Capes journals on the problem of vehicle abandonment in cities

Year	Author	Journal	Title
2023	Muhammad Syafiq Sulaimana, Dzuraidah Abd Wahaba and Zambri Haruna	ScienceDirect	Preliminary study on End-of-Life Vehicles recycling rate for Malaysia. Estudo preliminar sobre a taxa de reciclagem de veículos em fim de vida na Malásia
2023	Sidharth S. Mishra, Abhaya Gupta	Indian J Community Med	Abandoned vehicle – What next for the drive of your life? Veículo abandonado – O que próximo na viagem da sua vida?
2023	Vânia Ceccato, Omkar Parishwad, Ned Levine	Elsevier	Defecation, littering, and other acts of public disturbance in pandemic times. Defecação, lixo e outros atos de perturbação pública em tempos de pandemia
2022	Genie N.L. Stowers	Sagepub journals	Back to Basics: City Services and 311 Service Requests De volta ao básico: serviços municipais e 311 solicitações de serviço
2020	Iain Hall, Anne McDonald	Shima	THE ABANDONED CARS OF POHNPEI: Reflections on a small island economy and environment OS CARROS ABANDONADOS DE POHNPEI: Reflexões sobre a economia e o meio ambiente de uma pequena ilha
2015	Rehman Hafiz Ur	South Pacific Studies	Environmental Degradation (Dumped Vehicles) in Major - Islands of the Federated States of Micronesia Degradação ambiental (veículos descartados) em grande escala - Ilhas dos Estados Federados da Micronésia
2006	Sue Cassells, John Holland & Anton Meister	Journal of Environmental Policy and Planning	End-of-life vehicle disposal: Policy proposals to resolve an environmental issue in New Zealand
2003	Melissa Smith, Jessica Jacobson, and Barry Webb	ScienceDirect	Abandoned vehicles in England: Impact of the End of Life Directive and new initiatives, on Likely Future Trends Veículos abandonados na Inglaterra: Impacto do Directiva sobre o fim da vida e novas iniciativas, sobre prováveis tendências futuras

Source: authors themselves, 2023.

Considering that the proposed theme is, so far, very little debated, exploratory research was sought as an approach since it allows a more comprehensive analysis, as well as the feasibility of new specific studies that deal with the subject.

In Malaysia, Muhammad Syafiq Sulaimana, Dzuraidah Abd Wahaba, and Zambri Haruna (2023) describe a preliminary study presented at a conference in France on end-of-life vehicle recycling. It highlights the lack of regulations for the proper disposal of recycling in the country and the introduction of measures, such as the National Automotive Policy and an Authorized Treatment Center, to improve management. Initial results indicate a 90% recycling rate at the Authorized Automotive Treatment Facility (AATF), suggesting advances in the recycling of abandoned vehicle materials and components.

In another broader approach, V ânia Ceccato, Omkar Parishwad, and Ned Levine (2023) analyzed public disturbances arising after the pandemic in Stockholm. The findings indicate a significant increase in public disturbance records after the 2020 pandemic restrictions, with parks, transport hubs, and schools associated with these disturbances, as well as vehicle abandonment in public places. Urban life is a series of performances in which individuals continuously manage impressions of themselves, in which public spaces act as a stage for such performances (Goffman, 1959). Wilson and Kelling (1982) suggest that "physical deterioration and acts of public disorder (e.g., vandalism, abandoned cars) function as symbols of the extent to which a place is in decline."

Analyzing the article published by Genie N. L. Stowers (2022), which addressed service request systems in 29 cities, known as 311 systems, with real data from these systems available on the cities' open portals. This analysis found a typology with thirty categories of types of services and several hypotheses were tested, including the relationship between the city's population and the number of service requests. The findings indicate that as the city's population increases, so does the number of service requests. The most common types of services requested include garbage collection/recycling, code enforcement requests, parking, bulk collection, and retrieval of abandoned vehicles.

Authors Iain Hall and Anne McDonald (2020) from Sophia University in Tokyo explore the sustainability challenges faced by small islands, especially developing states where resources are limited but the challenges are many. The specific focus was on abandoned vehicles on Pohnpei, an island in the Federated States of Micronesia, highlighting that the island had more than a thousand abandoned cars along the roads. The article sought to understand the economic conditions that led to this situation, the environmental problems arising from these abandoned vehicles and the barriers faced in dealing with the problem.

In the same vein, the article written by the author Rehman Hafiz Ur (2015) highlights the problem of environmental degradation due to urbanization on the main islands, such as Pohnpei and Weno Island in the state of Chuuk, in the Federated States of Micronesia (FSM). The specific focus was the disposal of abandoned vehicles, which became a growing problem for future generations of these islands. The islands of Pohnpei and Weno are the most populous, representing about 40% of the population of the WSF (Federated States of Micronesia). Due to the lack of a regular bus or public transport system, the local population depends mainly on private vehicles to get around. However, due to poor road conditions and lack of proper repair shops, many vehicles are abandoned after a few years.

Rehman Hafiz Ur (2015) points out that the lack of adequate regulatory measures from the government sector and the lack of a vehicle scrap program contribute to the indefinite permanence of these abandoned vehicles on the islands, thereby harming the tourism industry. The study proposes suggestions to address the problem and protect the environment, including the implementation of a public transport system, the creation of a vehicle scrap program by the public sector or private companies, and other measures that can improve the situation and attract more foreign tourists to contribute to the country's revenues.

In New Zealand, Sue Cassells, John Holland & Anton Meister (2006) emphasize that the disposal of vehicles at the end of their useful life has become a growing waste management problem. This paper, conducted by Massey University's Department of Finance, Banking and Property, addresses the issue, quantifies the problem of abandoned vehicles, and identifies contributing factors. In addition, end-of-life vehicle management approaches are examined in the Netherlands, Germany, Sweden, and the United Kingdom, with an evaluation of their effectiveness. In the article, policies such as extended producer responsibility and recycling targets are discussed, considering the New Zealand economy without domestic producers and with limited opportunities for economies of scale.

In England, Melissa Smith, Jessica Jacobson, and Barry Webb (2003) were already concerned about the significant increase in abandoned vehicles. The paper looks at the current situation and identifies four main factors contributing to the problem: declining scrap prices, weaknesses in the vehicle licensing system, a growing market for cheap used vehicles, and rising car transport costs. However, several initiatives, both from central government and local authorities, such as increased enforcement against untaxed vehicles and the rapid removal of abandoned vehicles, aim to counter this trend.

3.2 Vehicle Fleet and Its Environmental Impacts

According to the International Energy Agency (IEA, 2021) report on global mobility, the global fleet of motor vehicles is estimated to have surpassed the 1.4 billion-unit mark in 2020. China is the country with the largest fleet, followed by the United States and Japan. In addition, the IEA forecasts that the global vehicle fleet will continue to grow, reaching approximately 2.7 billion vehicles by 2050, driven primarily by increased demand in developing countries.

3.2.1 International Fleet

There is a remarkable and incessant growth in the worldwide fleet of motor vehicles. This phenomenon is driven by a combination of factors, including increased urbanization, economic development, and increasing accessibility to automobiles. With the rapid growth of urban areas, the demand for personal mobility has reached unprecedented levels. Automobiles have become symbols of independence and practicality, leading an increasing number of people to purchase their own vehicles.

In addition, the increase in income in several regions of the world has allowed more individuals to realize the dream of owning a car. Table 2 presents a simplified overview in absolute numbers of the global fleet of vehicles.

As for the predominant vehicle types, the IEA report highlights that passenger vehicles make up the majority of the world's fleet, with a significant share of vehicles powered by fossil fuels such as gasoline and diesel. However, the share of electric vehicles is increasing rapidly, driven by government incentive policies, advances in battery technology, and environmental concerns.

Table 2. Panorama of countries with the highest number of vehicles in absolute numbers

Countries	Vehicle fleet (millions)
China	292
United States	287
Japan	79
Brazil	58
Russia	55
Germany	48
France	38
United Kingdom	33
Canada	33
India	22

Note: These are the countries with general information about the size of the fleet of cars that run in their territory, other countries would perhaps enter the statistics but do not disclose this information.

Source: Gasgoo, 2021; Finances Online,2021; Statistician,2023; Ministry of Infrastructure,2022; Ceic Data,2023; EuroStat, 2023;

According to the International Renewable Energy Agency (IRENA, 2021), the global fleet of electric vehicles exceeded 10 million units in 2020.

3.2.2 Overview of the National Fleet

The growth of the national vehicle fleet is a phenomenon observed in many countries and has significant implications in terms of mobility, infrastructure, and the environment. In the national context, the growth of the vehicle fleet can be analyzed taking into account different factors and trends. One of the main drivers of the growth of the national vehicle fleet is the increase in the income of the population and the expansion of the middle class. As more people have access to financial resources, the demand for personal vehicles increases. This growth can be observed in different vehicle categories, such as passenger cars, motorcycles, and commercial vehicles.

Another factor that contributes to the growth of the national fleet is economic development and urbanization. As cities expand and economic activities diversify, there is greater demand for transportation of people and goods. This results in an increase in the fleet of vehicles used for commercial purposes, such as trucks and delivery vans.

Table 3 shows the evolution of the vehicle fleet from 2006, a period in which the IBGE (Brazilian Institute of

Geography and Statistics) began to measure the real numbers of cars in circulation in the country.

Table 3. Vehicle fleet growth (million), by type, in Brazil 2006-2022

Indicator	2006	2007	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Vehicle	**45,029,257**	**49,644,025**	**59,361,642**	**64,817,974**	**70,543,535**	**76,137,191**	**81,600,729**	**86,700,490**	**90,686,936**	**93,867,016**	**97,091,956**	**100,746,553**	**104,784,375**	**107,948,371**	**111,446,870**	**115,116,532**
Type																
Automobile	27,700,608	29,851,610	34,536,667	37,188,341	39,832,919	42,682,111	45,444,387	47,946,665	49,822,709	51,296,982	52,916,160	54,715,488	56,652,190	58,016,405	59,242,869	60,459,290
Tram	216	210	137	126	93	62	48	46	45	44	43	42	42	42	42	42
Truck	1,761,659	1,847,225	2,026,269	2,143,467	2,274,947	2,380,780	2,488,680	2,588,984	2,645,992	2,684,227	2,720,548	2,766,097	2,826,343	2,879,080	2,947,856	3,022,315
Truck Tractor:	278,468	304,918	367,189	412,473	457,954	492,640	541,118	578,765	593,892	606,679	623,112	655,047	697,732	735,748	796,166	849,372
Pickup Truck	1,932,907	2,560,451	3,835,242	4,285,690	4,762,943	5,238,656	5,731,997	6,245,837	6,588,813	6,880,333	7,192,441	7,555,090	7,968,682	8,297,242	8,706,441	9,078,740
Van	2,408,134	2,116,649	1,704,130	1,859,043	2,066,383	2,288,427	2,516,967	2,732,871	2,908,233	3,053,759	3,207,786	3,415,049	3,595,810	3,727,448	3,894,572	4,102,821
Chassis platform.	7,079	6,913	4,620	3,801	3,261	2,972	2,291	2,079	1,942	1,877	1,806	1,765	1,722	1,700	1,672	1,650
Moped	83,306	83,615	89,350	95,259	107,919	127,324	142,857	159,705	223,755	338,470	370,361	387,458	404,343	415,291	430,347	452,778
Mini-bus	196,578	214,483	249,016	270,693	296,761	318,762	340,928	361,501	375,274	383,325	390,235	398,839	412,046	420,105	426,229	434,708
Motorcycle	7,881,199	9,410,110	12,415,764	13,950,448	15,579,899	16,910,473	18,114,464	19,242,916	20,216,193	20,942,633	21,608,568	22,339,110	23,165,586	23,862,010	24,732,701	25,746,762
Scooter	1,348,219	1,661,260	2,183,564	2,444,471	2,739,603	3,023,859	3,317,325	3,599,581	3,833,159	3,990,558	4,147,822	4,339,226	4,571,968	4,778,607	5,048,469	5,372,584
Bus	351,913	375,669	424,068	451,989	486,597	514,980	547,465	574,125	590,657	601,522	612,534	627,058	647,376	660,394	672,930	688,880
Quad cycle	149	151	152	153	154	154	154	155	157	163	182	201	252	268	276	282
Trailer	525,876	573,344	679,968	782,421	866,508	961,795	1,070,606	1,185,242	1,296,184	1,399,298	1,501,219	1,608,078	1,722,890	1,852,654	1,993,536	2,119,968
Semi-trailer	455,998	497,454	588,327	612,040	670,309	722,572	789,614	843,404	873,106	896,354	920,504	960,352	1,016,350	1,075,545	1,154,738	1,226,863
Sidecar	6,600	7,825	8,405	8,418	8,491	8,505	8,509	8,510	8,519	8,524	8,524	8,525	8,526	8,542	8,561	8,576
Bulldozer	78	94	115	155	179	203	208	208	208	208	208	208	211	211	211	234
- Wheel Type Tractor	13,227	14,656	18,711	21,679	24,666	27,026	28,363	29,516	30,372	30,896	31,363	31,948	32,973	33,894	34,934	36,433
Tricycle	2,305	2,881	6,417	10,258	14,838	19,052	22,615	25,518	28,417	30,903	32,769	34,795	36,934	38,595	40,503	42,421
Utilitarian	71,139	111,524	216,415	269,217	340,747	407,685	482,027	563,861	637,211	707,152	791,763	887,042	1,005,535	1,125,451	1,290,380	1,441,234
Others	3,599	2,983	7,116	7,832	8,364	9,153	10,106	11,001	12,098	13,109	14,008	15,135	16,864	19,139	23,437	30,579

Source: Ministry of Infrastructure, DENATRAN – National Traffic Department cited by IBGE (2022)

It is important to note that the growth of the national fleet presents challenges. The increase in the number of vehicles on the roads leads to traffic congestion and the need for improvements in road infrastructure, such as the construction of new roads and the expansion of public transport networks. In addition, the increase in the vehicle fleet is associated with greenhouse gas emissions and air pollution, which requires the implementation of policies and technologies aimed at reducing these environmental impacts.

To deal with the challenges related to the growth of the national vehicle fleet, it is important to adopt an integrated approach. This includes investments in transport infrastructure, such as roads and efficient public transport systems, as well as encouraging the use of more sustainable vehicles, such as electric and hybrid vehicles. Policies to encourage sustainable mobility and promote car sharing are welcome strategies.

The distribution of the vehicle fleet by federation unit in Brazil reflects a complex intersection of economic,

demographic, and geographical factors. More populous and economically developed states, such as São Paulo and Rio de Janeiro, lead in absolute terms, presenting challenges related to traffic and urban mobility. However, there is considerable heterogeneity with states in the North and Northeast regions, usually with smaller fleets. This disparity suggests a link between economic development and vehicle ownership and highlights the influence of public transport and road infrastructure policies.

The Midwest, driven by agricultural growth, emerges as a region where the increase in the vehicle fleet is remarkable. The analysis of this distribution highlights the need for differentiated approaches to traffic management and the development of mobility policies, considering the particularities of each federative unit.

Even with the disparity between regions, with easier access to financing and programs to encourage the purchase of vehicles, more Brazilians were able to fulfill the dream of acquiring a car. In turn, the rise of the middle class has contributed significantly to higher demand for vehicles, boosting automakers' sales. The economic growth observed during this time played a crucial role, providing a favorable environment for investments in the automotive sector. Road infrastructure has been improved, making the use of vehicles more convenient and attractive to the population. Table 4 shows the detailed figures for the evolution of the fleet of vehicles per unit of the federation.

Table 4. Fleet of vehicles (millions) per unit of the federation

Major regions and states	TOTAL	AUTOMOBILE	TRUCK	PICK-UP TRUCK	VAN	MOPED	MICRO BUS:	MOTORCYCLE	SCOOTER	BUS	UTILITY
Brazil	109,527,493	59,980,959	2,997,429	8,942,941	4,027,760	445,646	431,131	25,368,540	5,259,116	682,286	1,391,685
Relative Value	100.00%	54.76%	2.74%	8.17%	3.68%	0.41%	0.39%	23.16%	4.80%	0.62%	1.27%
North	**6,033,615**	**2,019,681**	**168,196**	**587,108**	**124,006**	**16,055**	**16,162**	**2,362,489**	**643,352**	**49,387**	**47,179**
Acre	320,902	100,564	8,124	31,491	4,904	885	441	138,565	32,762	1,433	1,733
Amapá	225,017	95,342	4,634	26,179	5,326	951	517	73,831	15,331	1,508	1,398
Amazonas	1,021,510	443,992	22,164	100,026	28,943	2,102	3,729	325,610	77,374	10,442	7,128
Pará	2,357,383	710,116	70,125	194,233	48,704	6,080	7,434	1,034,976	243,164	21,423	21,128
Rondônia	1,094,682	327,523	32,540	119,191	15,971	3,114	1,482	439,181	141,714	6,985	6,981
Roraima	252,029	89,363	6,013	34,114	5,922	986	772	88,493	23,138	1,385	1,843
Tocantins	762,092	252,781	24,596	81,874	14,236	1,937	1,787	261,833	109,869	6,211	6,968
Northeast	**19,548,101**	**7,733,463**	**507,752**	**1,446,688**	**477,417**	**202,657**	**98,962**	**7,557,669**	**1,165,718**	**140,158**	**217,617**
Alagoas	979,488	411,726	24,976	65,291	26,328	14,171	7,510	358,475	51,069	9,646	10,296
Bahia	4,663,009	2,073,662	132,560	432,827	139,258	20,527	32,543	1,492,668	247,369	44,840	46,755
Ceará	3,508,046	1,285,749	78,974	226,900	70,688	10,853	13,174	1,550,551	203,381	19,306	48,470
Maranhão	1,959,166	511,947	46,671	149,279	29.126	11,324.	5,670	982,339	196,274	10,811	15,725
Paraíba	1,481,340	603,194	31,280	98,338	32,794	33,880	5,394	567,110	82,104	8,377	18,869
Pernambuco	3,309,403	1,447,177	96,843	212,199	102,990	45,210	20,592	1,190,646	139,066	21,972	32,708
Piauí	1,346,138	412,854	33,465	107,119	20,155	6,744	4,742	626,270	114,403	8,999	11,387
Rio Grande do Norte	1,439,859	622,512	39,892	103,677	36,357	29,485	5,731	493,993	74,695	7,968	25,549
Sergipe	861,652	364,642	23,091	51,058	19,721	30,463	3,606	295,617	57,357	8,239	7,858
Southeast	**52,773,528**	**32,331,679**	**1,310,870**	**3,985,752**	**2,234,874**	**160,386**	**227,614**	**9,695,694**	**1,828,954**	**314,755**	**682,950**
Espírito Santo	2,112,886	1,063,644	80,228	202,427	70,801	2,159	9,226	504,358	133,196	16,270	30,577
Minas Gerais	12,367,362	6,914,027	370,362	1,174,054	414,724	52,014	51,168	2,828,301	350,161	86,777	125,774
Rio de Janeiro	7,273,824	4,839,119	149,039	391,986	342,750	45,382	40,781	1,113,687	215,905	42,361	92,814
São Paulo	31,019,456	19,514,889	711,241	2,217,285	1,406,599	60,831	126,439	5,249,348	1,129,692	169,347	433,785

South	**21,030,255**	**12,779,571**	**711,610**	**1,869,342**	**864,038**	**20,438**	**61,798**	**3,437,318**	**865,057**	**113,812**	**307,271**
Paran á	8,048,355	4,860,320	294,269	768,165	295,503	9,866	25,318	1,302,809	345,414	48,567	98,124
Rio Grande do Sul	7,402,461	4,652,403	249,897	625,944	322,558	7,739	22,615	1,168,399	212,070	42,720	98,116
Santa Catarina	5,579,439	3,266,848	167,444	475,233	245,977	2,833	13,865	966,110	307,573	22,525	111,031
Center-West	**10,141,994**	**5,116,565**	**299,001**	**1,054,051**	**327,425**	**46,110**	**26,595**	**2,315,370**	**756,035**	**64,174**	**136,668**
Federal District	1,967,774	1,379,284	26, 610	147,553	99,446	1,354	6,475	226,871	25,540	13,456	41,185
Goi ás	4,151,344	2,059,380	123,545	430,767	120,647	33,207	11,097	976,926	321,592	25,382	48,801
Mato Grosso	2,329,863	859,009	88,625	286,856	59,028	7,658	4,499	703,410	279,851	14,581	26,346
Mato Grosso do Sul	1,693,013	818,892	60,221	188,875	48,304	3,891	4,524	408,163	129,052	10,755	20,336

Source: Ministry of Infrastructure, DENATRAN – National Traffic Department cited by IBGE (2022)

The increase in traffic in the largest cities raises environmental concerns related to the emission of polluting gases. Regarding the environmental impacts of the vehicle fleet, studies have shown that greenhouse gas emissions from the transport sector are one of the main causes of climate change. According to the report of the Intergovernmental Panel on Climate Change (IPCC, 2014), road transport is responsible for approximately a quarter of global energy-related carbon dioxide (CO2) emissions. Efforts to reduce emissions from the transportation sector include promoting electric vehicles, developing biofuels, and improving the energy efficiency of conventional vehicles. In this sense, Brazil has sought sustainable alternatives and invested in cleaner technologies, such as electric and hybrid vehicles, to face the growing demands of mobility.

As a result of this unbridled increase, the abandonment of vehicles in cities generates negative impacts that affect both the environment and people's quality of life. This practice contributes to the degradation of urban areas. One of the main impacts is the visual pollution of cities, as abandoned vehicles on the streets, parking lots, and vacant lots generate an impression of abandonment and carelessness, affecting the aesthetics and perception of safety of the places. This visual degradation can reduce the real estate value of areas and affect the well-being of the community.

In the same area, vehicle abandonment can cause public health problems. Discarded cars accumulate rainwater and become breeding grounds for mosquitoes, exposing people to the risk of diseases transmitted by these vectors, such as dengue, Zika, and Chikungunya, and/or attract rodents and other animals that transmit diseases. Another important impact is related to environmental pollution, that is, abandoned vehicles contain dangerous fluids, such as oils, coolants, and fuels, which can leak and contaminate the soil and nearby water bodies. These substances infiltrate the soil, reach groundwater, and pollute rivers, lakes, and aquifers, compromising the quality of drinking water and affecting local ecosystems.

In addition, materials from abandoned vehicles, such as plastics, glass and metals, can take decades to decompose and become sources of contamination. When exposed to adverse weather conditions, these materials can wear out and release fine particles into the air, contributing to air pollution.

4. Conclusions

The irregular disposal of vehicles in cities is a complex and worrying problem that affects both the environment and people's quality of life. Based on the information and analyses presented, conclusions and recommendations can be drawn on this issue and should be widely discussed, so that it can serve as a support in the elaboration of effective public policies on the subject.

1) Improper disposal of vehicles contributes to soil, water, and air contamination due to the presence of toxic substances in vehicle components. The result is damage to ecosystems, environmental pollution, and risks to human health. In the same sense, the presence of abandoned cars on streets and vacant lots causes visual deterioration in urban areas, negatively affecting residents' perception of safety, real estate value, and quality of life.

2) Abandoned vehicles can become breeding grounds for mosquitoes and attract disease-carrying animals, posing public health risks. In addition, air pollution caused by the irregular disposal of vehicles can affect the respiratory health of the population. In addition, the recurring situation of these vehicles serving as places for drug users, and shelters for criminals who hide to commit crimes, directly affects the neighborhood that is forced to live with these situations.

Therefore, effective action by social actors on this issue is recommended:

1) Vehicle owners have a responsibility to dispose of them properly, and not abandon them on public roads, following legal and environmentally responsible procedures. This includes the search for authorized locations for the disassembly and recycling of vehicles or the sale, as well as the dismemberment of vehicles that are no longer fit for circulation, correctly in accordance with current regulations.

2) Government authorities have the key role of establishing clear and effective regulations for the disposal of vehicles. This includes the definition of guidelines for the dismemberment, recycling, and proper final disposal of components, as well as the implementation of inspection and punishment mechanisms for irregular disposal. It is essential to have robust and up-to-date legislation that specifically addresses the issue at hand. Legislation should establish clear guidelines on the responsibility of owners, the management of waste generated by vehicles, and penalties for those who fail to comply with the standards. In addition, it should encourage sustainable practices, such as recycling and reuse of vehicle components.

3) Addressing the problem of vehicle abandonment requires close cooperation between different actors, including governments, the auto industry, recycling companies, and civil society organizations. Strategic partnerships can strengthen efforts to implement effective policies and practices, as well as promote awareness and education about proper disposal of vehicles.

3) The dissemination of information and awareness of the population about the negative impacts of irregular disposal of vehicles are fundamental. Education campaigns can help increase understanding of the importance of responsible disposal practices and encourage correct actions by vehicle owners.

4) To deal with this problem, it is crucial to promote the adoption of sustainable practices, such as collection and recycling programs for disused vehicles, implementation of partnerships between governments, car manufacturers, and recycling companies.

In short, the irregular disposal of vehicles in cities is a challenge that requires comprehensive actions, from raising awareness among the population to implementing sustainable policies and practices. Only through joint efforts is it possible to minimize the negative impacts of irregular vehicle disposal and promote a cleaner, healthier, and more sustainable urban environment.

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Dr. Antonio Pasqualetto was responsible for the design and review of the study. João Peres Teodoro Rodrigues was responsible for collecting data and writing the final manuscript. All authors read and approved the final manuscript.

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