Computer Fraud and Security
ISSN (online): 1361-3723

Optimization of the Use of Urban Public Space: Analysis of irregular parking in lanes of central urban roads with one carriageway and two lanes. Case study San Juan de Pasto – Colombia,

Jorge Luis Argoty Burbano.

jlargoty@udenar.edu.co

https://orcid.org/0000-0001-6661-1398

Universidad de Nariño, Colombia.

Summary

The city of San Juan de Pasto, in Colombia, is one of the localities that have difficulties in urban movement, mainly in the use of parking spaces on its public roads. The aim of this analysis is to establish the effect of the distribution and use of parking on the traffic congestion that occurs in the city center, in order to provide alternatives that allow a better use of public space, a greater fluidity of traffic and mitigation of its effects on the quality of urban life.

A detailed calculation of the occupancy of parking lots at different times of the day in three sectors of downtown San Juan de Pasto is carried out. The visual counting method is used together with GPS and photographic capture of the vehicles to store the information that allows to know the dynamics of all the parking spaces. The results shown in Figure 3 indicate that at the critical hours of the morning and afternoon, the occupancy of the spaces stood at 80%, while at noon, which is the hour of least demand, occupancy remains at 20%.

It was possible to identify that the lack of regulated parking rates and non-permitted stations increase the traffic problem. The study also found that areas near shopping centers, as well as other areas of high economic activity were the most occupied, while peripheral areas had a lower degree of congestion.

The results suggest that the institution of controlled rates for the use of parking lots, the restriction of motorized traffic at certain times of the day, and the improvement of the road network are other elements to combat congestion and mobility. In this sense, the design proposes as a strategy to recover the public space to make it more efficient for the use of the roads in the city of Pasto to facilitate the sustainability and well-being of the population and tourists of this city.

Keywords: Urban parking, vehicular congestion, optimization of public space, urban mobility, parking regulation

1. Introduction

San Juan de Pasto, like several other intermediate cities in Colombia, has seen a substantial increase in population and motorized vehicles in recent decades. This incredible population growth, coupled with a lack of adequate road infrastructure, has resulted in considerable strain on urban transport networks, leading to increasingly observable traffic congestion, particularly in the central areas of the city. Within this scenario, a key factor that affects or facilitates the flow of traffic is the uncontrolled occupation of the spaces they use for parking, which greatly impacts the capacity of the roads to accommodate the volume of traffic. Not only does this issue affect the ease of traffic movement, but it also results in longer time to cover distances, increased pollution, and a more stressful journey for drivers.

San Juan's downtown has an exceptionally high volume of vehicular traffic due to a lack of adequate parking spaces that forces many drivers to park in undesignated areas. Thus, these vehicles block the lanes that are reserved for traffic. The systematic design and allocation of lanes for the movement of cars involves the planning of adequate parking spaces, a task that is critical and lacks viable solutions. Studies conducted in other urban areas

such as Sao Paulo and Mexico City have shown that inadequate vehicle parking significantly reduces the capacity of avenues, leading to sustained urban transportation problems. For example, in Sao Paulo, it was estimated that the paradigm of uninterrupted flow in traffic circulation caused vehicle maneuverability in the regions to drop by 15%, which increased travel times by 20% during peak hours. Likewise, in Mexico City, 12% of traffic congestion was attributed to the occupation of parking spaces in traffic lanes.

In the case of San Juan de Pasto, the absence of efficient public policies that regulate the use of road space, added to the scarce infrastructure of automatic parking, increases congestion by at least 80%. The main streets, as well as the commercial areas of the city, experience major bottlenecks, especially during rush hour. This is worse in areas with the highest demand and supply of parking. The horizontal by the pedestrianization of Corferias is a place within the center of Bogotá known for traffic congestion. This lack of control over vehicles greatly increases congestion and, at the same time, reduces the quality of life of citizens, who spend most of the day stuck anywhere, waiting for a better flow.

In this study, the purpose is to carry out an in-depth analysis of the occupancy of available public parking spaces in the city of San Juan de Pasto, focusing particularly on the interaction between irregular parking activity and road occupancy rates.

2. Context and Justification of the Study

The study was carried out in the socioeconomic context of San Juan de Pasto, the excessive demographic growth and the exaggerated vehicular expansion of the city, added to the insufficiency of the road infrastructure, have caused worrying levels of congestion. According to estimates by DANE and the mayor's office of Pasto, in 2021 the population of the city was close to 450 thousand; In addition, the number of cars on unemployment increases by more than 30% annually. The city is no longer only surpassing the mark (...) but also has a continuously growing metropolitan area. [...], This system promotes a high temperature and opaques the integrity of paved floors. This phenomenon requires the development of detailed studies that analyze the variability in land use and all its complex effects. From the studies focused on the change of land use in the monuments, the perfect lura and the improvement of the megalopolis allow us to observe all the misfortunes and live together with lands and tanks of dense population.

This specific strategic selection allowed for a more in-depth analysis of traffic patterns, taking into account current parking maneuvers, their effects on vehicle movements, and the overall efficiency of road management in this important area of the city.

The downtown area, where commercial, educational, and employment activities are concentrated, is experiencing a high level of uncontrolled parking in public spaces, affecting the already scarce supply of parking space and leading to increased congestion on major routes. This scenario has caused irritation to many residents and economic losses in terms of vehicle downtime, which calls for an effective and reasoned response.

3. Objective of the Research

The main objective of this study is to analyze the utilization of parking space in different commercial, office and residential sectors within the city of San Juan de Pasto to evaluate its contribution towards traffic congestion. This study aims to understand utilization patterns and changes throughout the day when there is peak and low demand. Subsequently, evidence-based solutions will be recommended to maximize urban public space, improve traffic flow, reduce travel time, decrease environmental pollution, and improve overall living conditions for citizens. In addition, the possible use of parking regulation policies, such as charging fees or redistributing street space, will be evaluated in order to reduce traffic congestion and facilitate more effective and sustainable transportation within the city.

4. Theoretical Framework

Urban mobility is a multifaceted concept that encompasses the movement of people and goods within a city. Piattoni (2015) states that mobility is not limited to transport infrastructure; instead, it also includes socioeconomic, cultural, or technological factors that affect transportation choice. Along with the expansion of cities, it is imperative to consider these factors to achieve an efficient, inclusive, and sustainable transportation system. Traffic jams are a clear sign of the mismatch that exists between the road network provided and the number of vehicles that need to be accommodated.

Several scholars, including Ruth and Paez (2009), have advanced the idea that congestion results from more than just excess vehicular traffic. It is also caused by the misuse of road space, particularly with regard to parking. Traffic congestion has an adverse consequence on urban living standards because it takes longer to reach its destination, increases stress levels in drivers, and leads to a higher degree of pollution. Thus, the effective use of road spaces becomes an important aspect of mitigating congestion and improving urban mobility.

Traffic congestion involves not only the amount of traffic on the road, but also the mismanagement of road space. Improper use of lanes, for example, violation of lane discipline that leads to vehicles parking on the road, reduces the capacity of the roads and decreases the level of traffic service in the area. In this sense, research from different countries has shown that irregular parking of vehicles in moving lanes has some level of correlation corresponding to traffic congestion.

For example, a study conducted in São Paulo in 2018 determined that improper stopping of vehicles in moving lanes significantly reduced the capacity of the city's main avenues by 15 percent, increasing the average travel time by 20 percent. Likewise, in Mexico City, it was reported that lane control by parking vehicles in public places added 12 percent to traffic congestion, particularly in commercial and residential areas with high traffic.

Vehicle fleets are of key importance within the road structure of cities with high population density. García (2016) indicates that effective control of parking lots helps to optimize public space, reduce urban congestion and traffic flow in general. Despite this, many cities currently do not have parking control mechanisms that help solve congestion, which is a very serious situation. The absence of reasonable regulations and inadequate infrastructure to meet the demand for parking leads to the overloading of official areas, which blocks traffic.

Parking control management models such as those in Bogotá, where paid parking zones known as "blue" were established (Bogotá Mayor's Office, 2015), have been effective in controlling the use of public space, as well as in controlling vehicular flow and congestion in these areas. These models exhibit the effort that the state can make through the improvement of urban planning.

Public space will be overloaded without an adequate balance between the available parking spaces and the demand for them. From an economic point of view, it is essential to strike a balance between supply and demand for a specific market segment by adjusting the price of parking to suit each urban area. Thus, Holguín-Veras et al (2012) suggest a model for the differentiation of parking rates through the zoning of parking spaces. This approach has been used successfully in other European and North American cities, for example, London and New York, where area restrictions for certain specialists solved problems of street space utilization and traffic jams. Creating parking zones is a way to control the movement of vehicles into particular congested areas.

In evaluating the use of space on streets or highways, one of the most commonly used indices to measure parking performance is the parking occupancy rate. This index allows estimating the degree of saturation of parking areas and their contribution to traffic congestion, which is very critical in the planning and improvement of road infrastructure. The basic formula for calculating this index is as follows:

$$IO = \frac{N_v}{N_s}$$

Where:

- IO is the occupancy rate.
- Nv is the number of vehicles parked in a given area.
- Ns is the total number of available parking spaces.

This value is calculated to determine the regions that experience the greatest overflow and those that require action in the management of parking facilities. Therefore, decision-makers can make logical decisions about changing road systems and unforeseen policies for parking control.

These cities demonstrate that parking within traffic lanes can limit the productivity of avenues by up to 20%, which worsens mobility and pollution, and these effects can be observed in the irregular use of road lanes that were designed for car traffic. For example, São Paulo and Mexico City. Thus, for the problem of traffic obstruction

in major urban areas caused by cars competing for building space, there is a need for strict order in car parking along with proper provision that allows for the free movement of vehicles within the city. Always with the study of the modification of the circulation system of the city core.

In intermediate cities, such as San Juan de Pasto in Colombia, urban parking management is a particular problem due to rapid population growth and the low level of road infrastructure. These cities often experience vehicle overcrowding and a low quality of life for residents, resulting from poor strategic planning for the allocation of parking areas. Unlike metropolitan centers, intermediary cities do not automatically have robust public policies that manage parking supply and spatial distribution, which contributes to increasing urban mobility challenges.

In summary, urban parking management needs to be improved to achieve a better national mobility system and more effective public space in cities. Through the application of zoning, tax regulation and occupancy rates, it is possible to reduce traffic congestion and improve the quality of life in the city. International experiences, such as those of Bogota, London and New York, show that proper parking space management can help reduce congestion and improve traffic flow. If these models are applied to San Juan de Pasto, an intermediate city, there is reason to believe that there would be a significant improvement in the effectiveness of the use of road space and, consequently, an improvement in urban mobility.

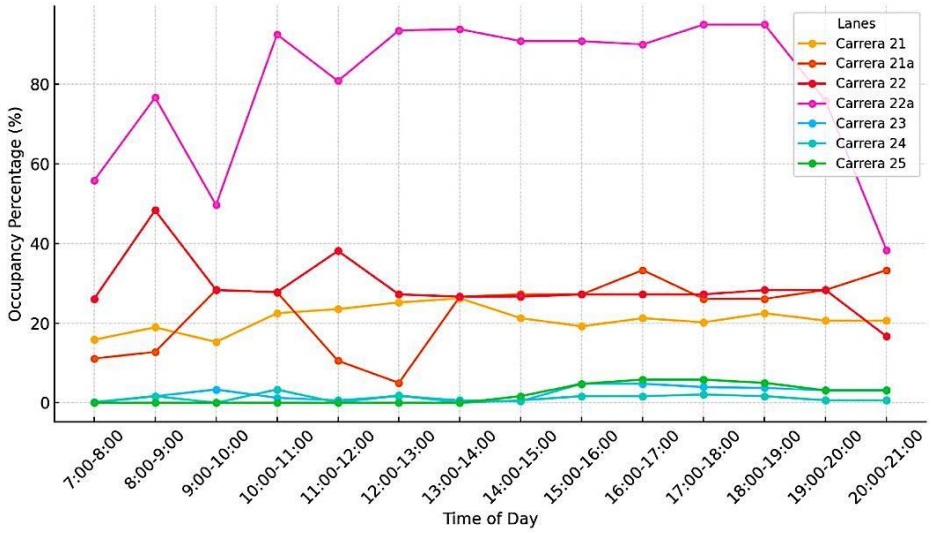
5. Methodology

The methodological design of this study was developed to obtain relevant information on the occupancy of parking lots in San Juan de Pasto in three sectors of greatest importance. A descriptive method and a quantitative approach were used for the research. The work focused on obtaining data on the occupancy of parking lots and the use of the road in San Juan de Pasto through a vehicle capacity and the percentage determination of occupancy. From these data, the variation is calculated by 15-minute intervals and graphs are constructed to identify areas of high and low occupancy. The descriptive method also allows us to observe how road space affects mobility, providing a precise idea of the problem situation and its consequences. Being able to measure and analyze the traffic and parking situation in the city is possible thanks to this approach.
1. Phase of Identification and Selection of the Study Area. The urban center of San Juan de Pasto was chosen as the study area, considering the 38 blocks of the area. The unit of analysis was the blocks, and the vehicular traffic count was carried out by block with intervals of 15 minutes. Three days of the week (Wednesday, Thursday and Friday) were analyzed in order to obtain representative data on the parking demand phenomenon.
2. Data Collection Phase. During this phase, the researchers conducted three parking counts per block, noting how many spaces were occupied on each of the three days. Data were collected every 15 minutes within the entire occupancy period. This method was useful in acquiring the data needed to calculate occupancy rates and parking trends.
3. First Stage of Calculations: Occupancy by Time Intervals. The percentages of occupancy of parking spaces for each 15-minute interval were calculated. The three counts for each block were combined to obtain an average occupancy value. This phase provided the preliminary information needed to understand parking lot occupancy trends throughout the day.
4. Second Stage of the Calculations: Occupation in the Rails of the Track. The occupancy of the lanes of the road is analysed taking into account both directions of traffic flow. Occupancy was studied within the races and streets of the study area, within roads 21-25 and in streets 13-21. This made it possible to determine the spatial distribution of traffic and its consequences on road capacity in relation to traffic direction.
5. Third Stage of the Calculations: Midpoint of Occupancy per Hour. At this stage, the average occupancy rates for each street and for each hour of the day were calculated. Graphical matrices were created for analysis based on a scheme of multicolored indicators (green for low, red for high), visually marking the times of day when there was greater traffic congestion in the area.
6. Subsequent Stage: Graphical representation of midpoints of occupancy to provide an intuitive indicator of high and low concentration areas. In addition, compliance with traffic regulations was verified by merging traffic counts with traffic signals in the area.
Final Phase: Analysis of results. The results obtained are graphed and the analysis of the occupation of the lanes used for the irregular parking of vehicles in the study areas considered in this research was carried out

6. Results

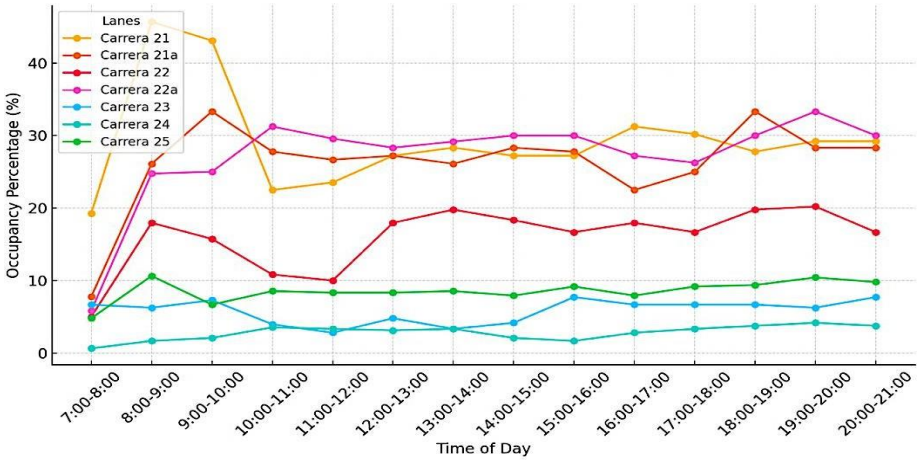
The results obtained in the development of this research are presented, in graph 1 a notorious behavior is observed in the occupation of the left lane in the time of day. The most outstanding was Carrera 22a which, at certain times

of the day, mainly in the morning, has 80% invasion of the left lane. Just as there is a high improper use of this lane, Carreras 21, 21a and 22 maintain irregular parking percentages that are around 20% of occupancy during almost the entire day. As for Carreras 23, 24 and 25, they are based on a study of low occupancy, with variations that in most hours are less than 10%, which describes little use of these lanes as an irregular parking site. The most relevant results of the city show that the occupancy of the lanes is higher the closer they are located to the city center, the occupancy of Carrera 22a presents a clear relationship with peak hours, while the peripheral routes do not exceed the average.



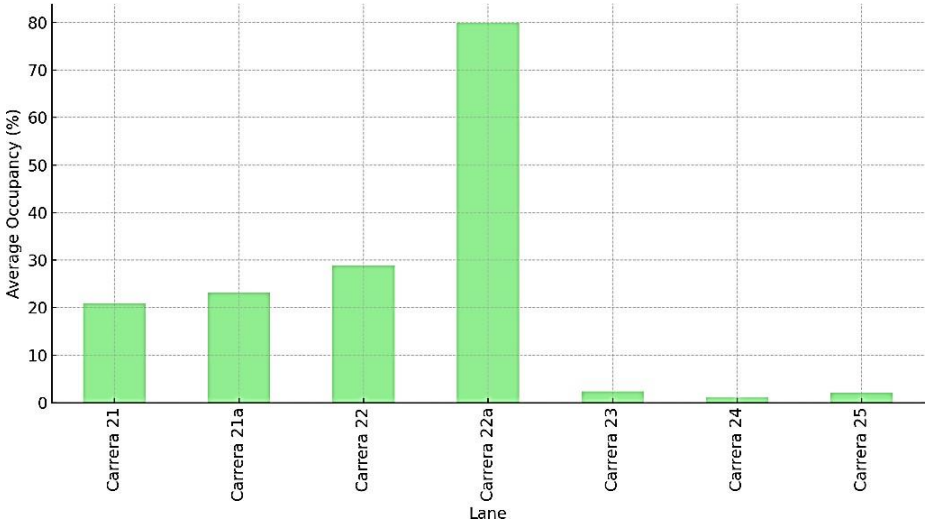
Graphic 1. Left Lane Occupancy by Hour.
Source: present research

Graph 2 shows how the occupancy of the right lane varies during the day. It is observed that Carrera 21 experiences a significant increase in occupancy between 7:00 and 9:00 hours, reaching more than 40% and maintaining a variable behavior during the rest of the day, which indicates a pattern of intensive use as an irregular parking area in the early hours of the morning. On the other hand, Carrera 22a shows a similar behavior, with a peak in the morning hours, although with a drastic drop later, which could be related to the redistribution of traffic as the day progresses. Races 21a and 22 have an invasion of this lane, hovering around 20-30% throughout the day. In contrast, Carreras 23, 24, and 25 maintain a fairly low occupancy, below 10%, which suggests that these lanes have a better behavior in terms of vehicular capacity offered to users. This occupancy pattern reflects how the distribution of parking invasion in left lanes in the different areas of the city varies, with a greater concentration on the main routes and less occupancy on the peripheral roads of the downtown area of Pasto.



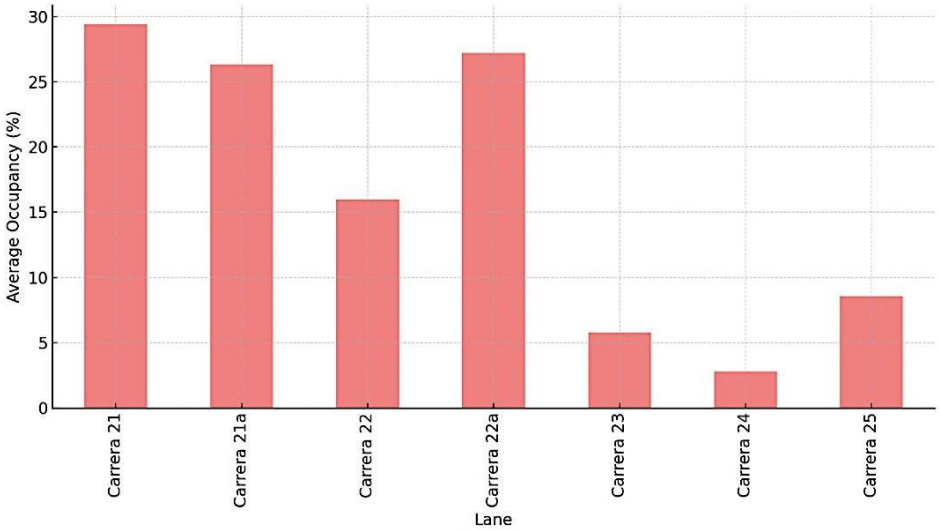
Graphic 2. Right Lane Occupancy by Hour.
Source: present research

Graph 3 illustrates the average occupancy of the left lane in races, where it can be noted that the most used lane is that of Carrera 22a, which is close to 80 percent. On the other hand, the 21st, 21st and 22nd races exhibit a more uniform behavior, with occupancy rates of around 10 to 20 percent. Carreras 23, 24 and 25 have almost no road invasion, which suggests that they are routes where mobility will be greater as there are no parked vehicles that hinder the vehicular flow. These data suggest that there is a clear concentration of irregular parking on the main arterial roads of the city and that peripheral races could serve to redistribute the movement of vehicles.



Graphic 3. Average Occupancy of Left Lanes.
Source: present research

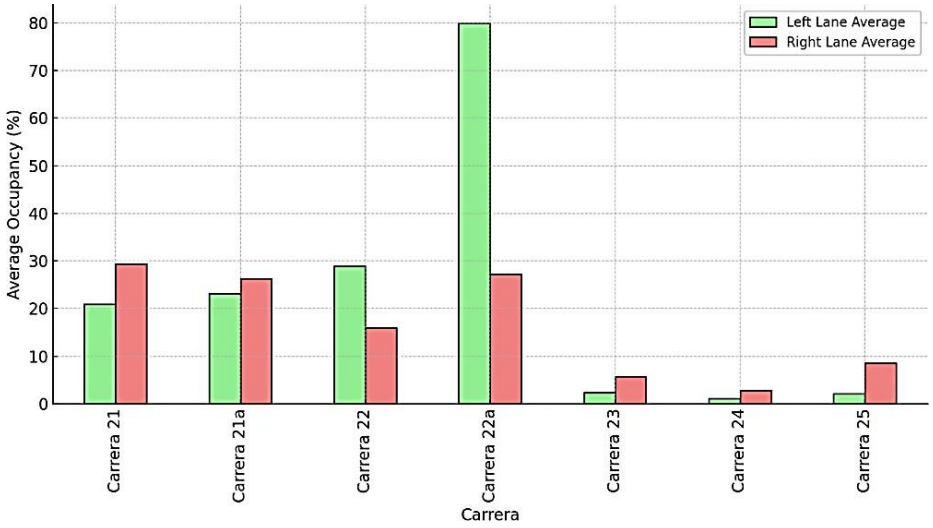
Graph 4 reflects the average invasion of the right lanes, where it highlights that Carreras 21 and 21a have almost 30% of irregular occupancy of vehicles, which indicates a high use of these lanes in parking places compared to the other roads. Carrera 22a seems to have an occupancy estimate exceeding 25 percent. Races 23, 24, and 25, on the other hand, have a much lower invasion.



Graphic 4. Average Occupancy of Right Lanes
Source: present research

Graph 5 shows the average use of the left and right lanes for races. Carrera 22a exhibits an occupation of the left lane that is considerably higher than other relevant occupations, reaching a worrying 80%, which is drastically higher for the left lane; however, right-hand lane occupancy is considerably lower, at around 25%. For 21st and 21st Races, the occupancy pattern of invading vehicles appears to be nearly the same, within the range of about 20% and 30% for both left and right lanes.

On Carreras 23, 24 and 25, the levels of irregular occupancy of vehicles are even lower, which suggests that there is less invasion of those on the left and right sides intended for vehicular traffic. From this information, it can be postulated that the main arteries that serve the central area, such as Carrera 22a, receive about 80% of the irregular parking in the traffic lane



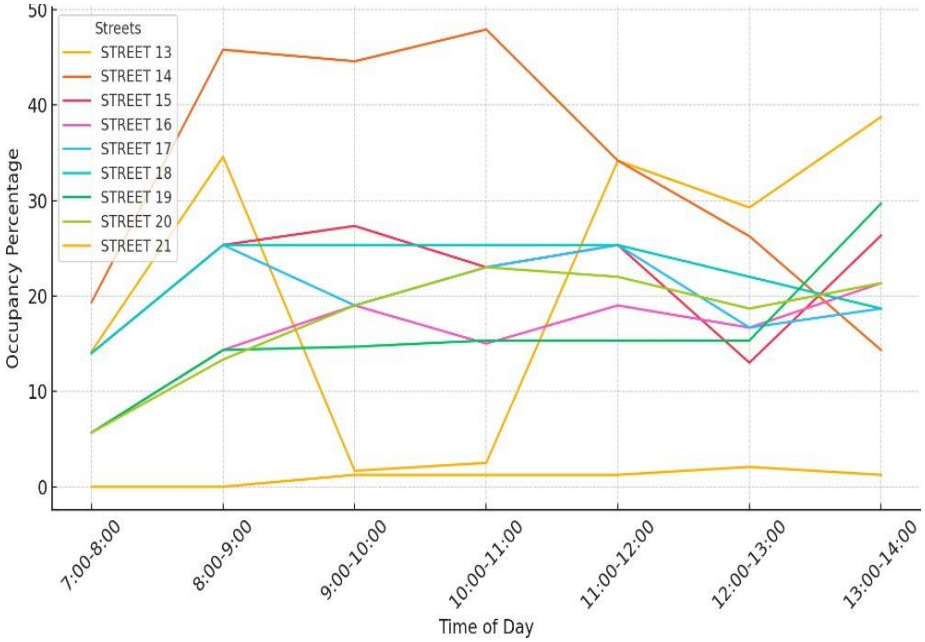
Graphic 5. Average Occupancy of Left and Right Lanes by Carrera
Source: present research

Table 1 summarizes the average occupancy of the left and right lanes by race, where it is observed that Carrera 22a has an average invasion in the left lane of 80%, which significantly exceeds the other races. As for the right lane, Carrera 22a also has a considerable occupancy, although lower, with 27%. Carreras 21 and 21a have moderate values in both lanes, with averages close to 20-30%. On the other hand, Carreras 23, 24, and 25 have very low occupancy, especially in the left lane, with occupancy values below 10% in most cases.

STREET	LEFT LANE AVERAGE (%)	RIGHT LANE AVERAGE (%)
Carrera 21	21	29
Carrera 21a	23	26
Race 22	29	16
Carrera 22a	80	27
Carrera 23	2	6
Race 24	1	3
Carrera 21	2	9
Carrera 21a	21	29
Race 22	23	26
Carrera 22a	29	16
Carrera 23	80	27
Race 24	2	6
Race 25	1	3

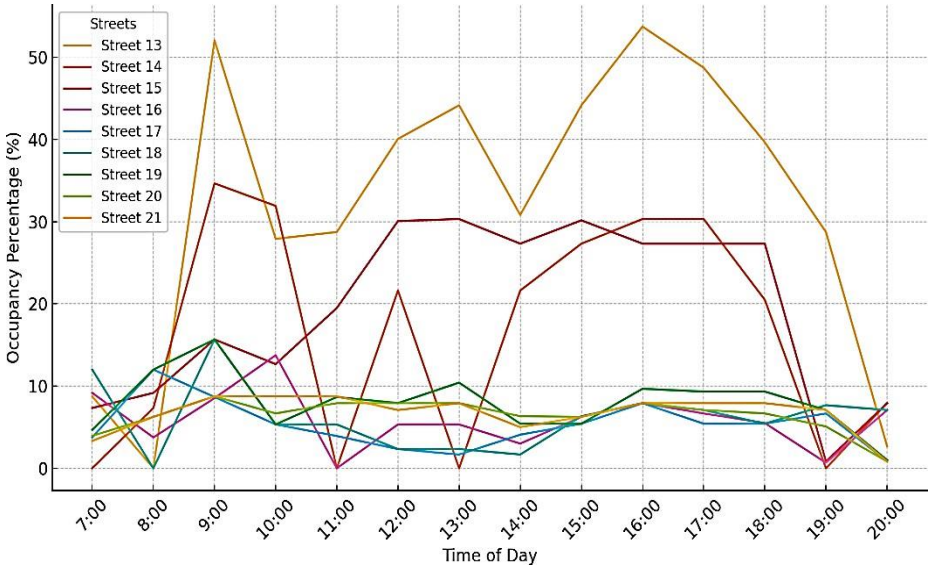
Table 1. Summary of Occupancy Percentages in Right and Left Lanes across Streets
Source: present research

The study of the use of the zones for each section occupied by vehicles on the various streets reveals significant differences in the invasion of cars parked on the road throughout the day, with a concentration of traffic during peak hours from 8:00 to 9:00 AM and also from 12:00 to 1:00 PM, particularly observed on 13th Street and 14th Street. which seem to be congested with vehicles by up to 50%. In statistical terms, these streets are highly variable, which means that the traffic observed on these streets is erratic and indicates that there is a need for better traffic management. On the other hand, 21st Street is characterized by low occupancy, which may suggest that the area suffers little street encroachment or that there is good traffic control. These findings demonstrate the need for effective traffic control systems and to improve congestion-ridden streets that are often traveled by many vehicles.



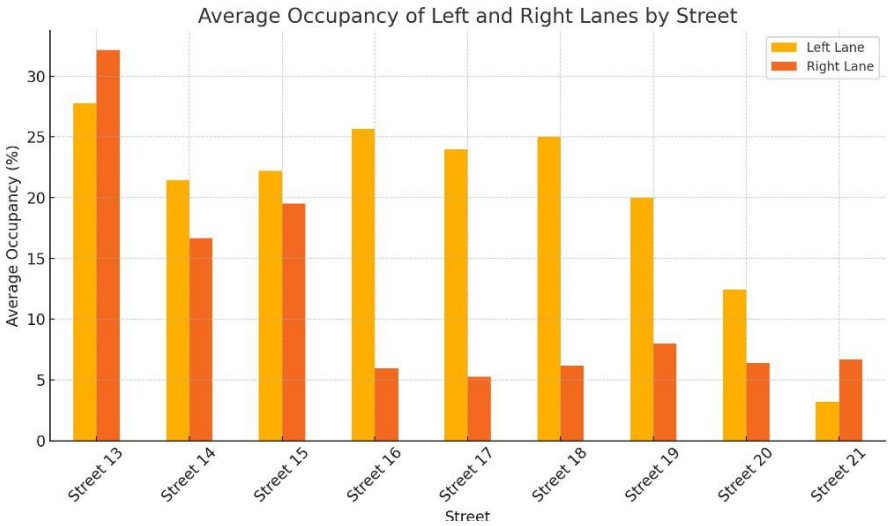
Graphic 6. Left Lane Occupancy by Hour on street
Source: present research

Graph 7 shows a significant variability in right-hand lane occupancy throughout the day for the streets studied, with peaks of high occupancy at specific times, such as at 9:00 a.m. and 5:00 p.m. The streets with the greatest fluctuation in occupancy are Calle 13 and Calle 15, showing occupancy percentages above 50%.



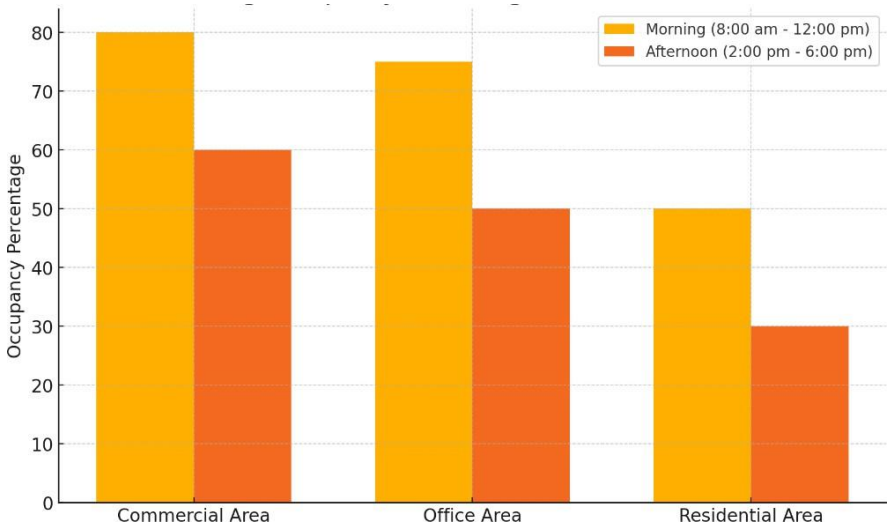
Graphic 7. Right Lane Occupancy by Hour on street
Source: present research

In graph 8 showing the average occupancy of the left and right lanes of the streets studied, streets 13, 14 and 15 have the highest average occupancy in both lanes, with values above 20%, which indicates a high invasion of vehicular space in these sectors during the period analyzed. On the other hand, 19th, 20th and 21st streets have significantly lower lane occupancy. The behavior of 13th and 14th streets, with up to 30% lane occupancy in both directions. This particular distribution requires specific measures in those areas of high street interference due to undocumented parking, in order to improve traffic congestion in the city.



Graphic 8. Average Occupancy f left and Right Lanes by street
Source: present research

The final result is the percentages of irregular parking in streets and careers studied, related to commercial, office and residential areas. The results showed high occupancy during peak hours (80% at some key points), which contributes to congestion on the main roads in the city center. During off-peak hours, occupancy was 20-30%. The results obtained are presented in Figure 9.



Graphic 9. Parking Occupancy Percentage in Different Sectors
Source: present research

The results of the graph show a high occupancy during peak hours, reaching up to 80% at key points, which contributes to congestion on the main roads in the city center. On the other hand, during hours of low demand, occupancy decreases considerably, standing between 20% and 30%. The analysis, based on the data, reveals that the sectors near shopping centers and offices have a greater invasion of one of the lanes. In the morning, the commercial area has a maximum with 80% occupancy, followed by the office area with 75%, while in the residential area it shows 50% occupancy of the roads. During the afternoon, all sectors experience a reduction in the invasion of the streets by irregularly parked vehicles, in the commercial area there is a 60% invasion of poorly parked vehicles, in the office areas a 50% occupancy and in the residential area an occupancy of 30%, which reflects a general decrease in the invasion of poorly parked vehicles as the day progresses.

7. Conclusions

The results of the investigation demonstrate a significant occupation of the lanes in the most central streets, especially on Carrera 22A, where the parking violation in the prohibited zone in the left lane reaches up to 80% at peak hours, which indicates that the road is being misused. On the other hand, peripheral streets such as 23, 24 and 25 have low occupancy levels, that is, below 10%. This pattern indicates that there is a connection with higher occupancy in the central areas of the city during peak traffic hours, suggesting that the main routes are the most sensitive to illegal parking.

The analysis shows metrics of right-side lane occupancy, where major arteries, particularly 21st and 22A avenues, violate occupancy by up to 40% during peak hours and cause heavy congestion. Routes 21A and 22 maintain a constant occupancy of 20% to 30%, while exterior routes 23, 24 and 25 have low occupancy levels, around 10%. This pattern indicates that the flow of traffic to peripheral roads should be analyzed as an option to improve mobility in the city, since this would alleviate the most congested areas in the city center.

The analysis of lane utilization reveals a worrying trend of illegal parking along the main arteries, with special concern for Carrera 22A which has an occupancy of 80% in the left lane and 25% in the right. This results in a marked level of congestion. Main roads 21 and 21A have a more moderate level of invasion than other main roads, but the peripheral routes, 23, 24 and 25, remain largely intact. Such trends justify the need to move some traffic from central areas to peripheral routes and to control and manage road space in the most congested areas to effectively increase traffic flow in the city.

The absence of regulated rates in certain vital areas greatly aggravates the situation by overloading parking space, especially in areas adjacent to shopping malls and office buildings. The introduction of a regulated pricing structure can, to some extent, ensure proper use of land space or its structures, particularly during rush hour. In addition, normalizing parking fees for vehicles in highly congested areas can result in more equitable control of traffic flow in those areas.

A large part of the data shows that Carrera 22A has the highest degree of lane invasion, since it has an occupancy of 80% in the left lane, while the right gets only 27%. Races 21 and 21A have a moderate use (20-30%) of both lanes, while peripheral routes, such as Races 23, 24 and 25, seem to have a much lower use, especially in the left lane. This indicates that these areas are less congested.

The results obtained in the analysis on the streets show a high variability in the occupancy of the lanes, particularly in 13th and 15th streets, which present saturation levels above 50% at key times such as 9:00 and 17:00. This pattern, together with the significant average occupancy on streets such as 13, 14 and 15, indicates an overload of road space in specific sectors, underscoring the need for targeted interventions to improve traffic flow.

These evidences are clear results that, at least for the commercial area during peak hours, where the relevance of shopping centers and offices the concentration of high lane occupancy is uniform at maximum demand, reaching up to 80% in the commercial area, producing some congestion on the most important roads in the center. On the other hand, at times of low demand, lane occupancy has a marked decrease, standing between 20 and 30%. The need to improve control over road space in the most congested sectors is highlighted to avoid the oversaturation of vehicular traffic.

The most sought-after parking spaces are located in the vicinity of shopping and office centers, indicating a high demand for these areas. However, in periods of low demand, there is a substantial drop in use, indicating that the establishment of pedestrian areas can be advantageous. This would not only alleviate traffic congestion, but also improve the overall quality of public space.

The system of controlled parking zones, which exists in other cities, is perfectly applicable to the center of Pasto. These measures would mitigate the level of congestion during peak travel times. In addition, residents are positively inclined toward introducing fees for parking lots, as long as the charges are within sensible and logical limits.

To achieve a more comprehensive solution to the mobility problem, it is necessary to integrate parking management with policies aimed at non-motorized transport and public transport. Improving the quality of public transport use, as well as reordering the urban environment, could reduce dependence on cars. This would

contribute to the co-creation of a more environmentally friendly city, with an improved quality of life and a substantial reduction in traffic jams.

Bibliography

1. Mayor's Office of Bogotá. (2015). *Draft Agreement No. 281 of 2015 on the Blue Zones in Bogotá*. Bogota, Colombia.
2. Alcántara Vasconcellos, E. (2010). *Analysis of urban mobility: Space, environment and equity*. Bogotá D.C.: Editorial ABC.
3. García, E. (2016). *Management of urban public space and parking in areas of high demand*. National University of Colombia.
4. Lefèvre, J. (2011). *Study of parking management in European cities: The case of Paris*. Transport Policy, 8(2), 128-135.
5. Piattoni, S. (2015). *Urban mobility in the 21st century: Challenges and solutions.* University Press.
6. Turner, T., & Zupan, J. (2004). *Transportation systems planning: Methods and applications*. McGraw-Hill.
7. Salazar, A., et al. (2014). *Capacity of urban roads and their relationship with vehicular flow.* Journal of Urban Transport.
8. Holguín-Veras, J., et al. (2012). *Parking management models in intermediary cities*. Journal of Traffic Engineering, 6(4), 256-267.
9. Ruth, M., & Paez, A. (2009). *Traffic congestion and its impacts on the environment.* Urban Studies Review, 12(3), 110-125.
10. Ocampo, L. A., & Jiménez, L. H. (2018). *Determination of the occupancy rate between streets 13 and 21 and races 21 to 25 in the city of Pasto*. University of Nariño, Faculty of Engineering.
11. Bellet, C., & Ferrer, J. (2007). *Innovative solutions for urban parking management in intermediary cities*. Journal of Urban Development, 19(2), 34-45.
12. Cervero, R. (2016). *Transport and land use: A symbiotic relationship*. Urban Transport Policy, 5(1), 75-92.
13. Shoup, D. (2018). *The high cost of free parking*. American Planning Association.
14. Martínez, F., & González, M. (2012). *Parking Regulation Strategies: Lessons from Latin American Cities*. Journal of Latin American Urban Studies, 3(1), 58-72.
15. Cid, J. (2010). *Urban planning and sustainability: A comprehensive approach.* Editorial Planeta.
16. González, J., & García, T. (2014). *The influence of parking on traffic congestion in medium-sized Colombian cities*. Journal of Urban Mobility, 22(3), 110-125.
17. Díaz, R., & Peña, V. (2017). *Improving the efficiency of urban transport: The case for public transport and parking*. Transport Economics Journal, 5(2), 45-62.
18. Banister, D. (2008). *Transport planning and the environment.* Routledge.
19. Santos, A., & Silva, F. (2019). *Parking Management in Dense Cities: A Critical Review.* Environmental Planning Review, 34(4), 77-92.
20. González, F., et al. (2015). *Planning and management of urban public space in Latin American contexts*. National Autonomous University of Mexico.
21. Miró, J. (2011). *Mobility and its impacts on urban development.* City and Territory Journal, 45(1), 15-28.
22. Pérez, L., & Ramírez, C. (2013). *The regulation of road space: A view from modern urbanism*. Urban Policy Research, 12(3), 120-134.
23. Silva, A., et al. (2010). *Urban transport systems: Technologies and management models*. City Transport Journal, 4(2), 40-56.
24. Ferreira, M., & Rojas, E. (2014). *Urban strategies to improve road traffic in intermediate cities.* Urban Planning Review, 18(2), 40-59.
25. Pérez, E. (2017). *Urban economy and the impact of unregulated parking.* Journal of Economic Studies, 21(1), 99-114.
26. Pérez, M., & Pérez, R. (2018). *The impact of traffic congestion on urban sustainability*. Environmental Urban Studies, 26(3), 100-115.
27. Gómez, A., et al. (2013). *Urban development and transport in medium-sized cities.* Urban and Transport Planning Journal, 7(2), 88-102.

28. Sánchez, A., et al. (2012). *Parking management strategies in large cities.* Journal of Transport Management, 19(4), 66-80.
29. Torres, L., & Díaz, F. (2016). *Public policies for the management of public space: A comprehensive approach.* Public Policy Journal, 15(3), 41-53.
30. Díaz, J., & Ruiz, P. (2019). *Mobility, parking and sustainability: New trends in urban planning*. City Mobility Journal, 11(1), 10-25.