Analysis of car parks in the city center: a case study of Constantine

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Abstract

This paper studies one of the problems that most cities in the world have suffered from, which is the difficulty of obtaining parking spaces in the city center when going to take advantage of its services. We present a spatial analysis of car parks in a city, using an analytical program, taking into account the type of parking, using the statistics during the day, and comparing it to the peak hour. With the study of the possibility of providing new, more practical car parks in the city center, to solve the problem and achieve the comfort and requirements of the citizen. We use data and surveys for 16 streets, selected by observation, which are the most parked streets. We included these statistics in the SPSS program in order to study the data and obtain concise and easy-to-use results. The implications of this study are multiple, namely to eliminate the chaos of car parks in the city center, in addition to finding practical solutions to organize them in order to make good use of them. In general, transport policy should seek to promote easy access to the city center for citizens or visitors to the city who own private cars, by providing a sufficient number of parking spaces without obstructing traffic.

Keywords: Parking, city center, rush hour, legal regulations, supply and demand, Constantine.

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1.   Introduction

In light of the idea of competition for car ownership among Algerians, we find that most Algerian cities suffer from a lack or absence of parking spaces, which creates chaos in the city center and therefore the imbalance between supply and demand for parking, which creates a crisis situation, especially at peak hour, and leads motorists to take refuge in unauthorized and prohibited positions.

Parking conflicts are among the most common problems facing public officials (Todd Litman, 2022). The problem of parking cars in the city center is one of the most complex problems that the city can suffer, because the city center is an attractive station for citizens, due to its diversity and the quality of its services and its proximity to each other (administrations, commerce, services, leisure, etc). The centrality of activities of all kinds in the city center has led to a very significant dynamic of mobility towards the center (Ahmed Saadi and Tayeb Sahnoune, 2019).

The parking problem is partially due to ineffective land use planning and miscalculations of space requirements during first stages of planning (Hossam El-Din I. S. Ahmed, 2017). The lack of dedicated parking spaces leads to occupying the roads and therefore blocking traffic. Thus, the blocked state is amplifiedby anarchic parking, just as the repressive policy of the police services fails to reduce (Ahmed Saadi and Tayeb Sahnoune, 2019). Traffic jams, wasting time looking for parking spaces, parking in prohibited places, are just a few examples of the problems that result from parking chaos. Less dense residential suburbs mightbe well equipped with parking lots with few opportunities for different use of such spaces, whereas shortages might be evident near mobility attractors in denser districts (Marco Diana and Andrea Chicco, 2022).

The objective of this article is to better understand the parking policy, discuss the problems it generates and find the necessary measures and procedures for its regulation. Ultimately, even solutions that replace street parking, parking it in designated parking spaces, will have effects and results. Only few studies attempted to estimate the potential savings of parking spaces according to the parking type (on-street, dedicated parking area) and in different city areas (Balac et al., 2017 in Marco Diana and Andrea Chicco, 2022). The case study in this work is the city of Constantine, located in the east of Algeria, which is the third largest city in this country. This study focuses on a set of streets in the city center, the closest to services and frequented by people.

This document is divided into six sections. After the introduction and background, the third section describes the case study. The fourth section deals with methodology and data. The fifth section presents the program specifications and the analysis method, while the fifth section presents the results. Finally, a sixth section contains the conclusions and discusses the main results and implications of this study.

2. Background

Several authors (Katherine A. Collett, et al. 2022; Marco Diana, et al. 2022)[1] have mentioned the problem of car parks in cities and the crises resulting from their lack of regulation. Current global parking trends and urban developments have changed the way cars are parked in city centers. All current studies are based on parking spaces only to avoid on-street parking.

Some studies deal with car parks by including the feature of sharing car ownership, which has become an adopted policy in most developed countries to reduce the number of cars, such as the study by Patrícia Baptista et al. (2014), Donna Chen (2016) and Jörg Firnkorn et al. (2011)[2]. Car sharing might produce a positive impact on daily central areas parking events (Marco Diana et al. 2022)[3]. Parking lot management should have strict policies that improve resource disposition and planning to avoid the various problems that arise from parking lots, especially in city centers.

Cost-effective parking management programs can usually reduce parking requirements by 20-40% compared with conventional planning requirements, providing many economic, social and environmental benefits (Todd Litman, 2022)[4]. Ultimately, parking requirements can make driving more difficult because all the cars engendered by the required parking spaces clog the roads and congest traffic (Donald Shoup, 2018)[5]. Especially in the key areas of the city center, the phenomenon of parking disorderly is very serious and a large number of bicycles' paths, walking and living leisure space are used for parking motor vehicles (Wang Yan- ling et al. 2016)[6]. The lack of legal parking places, leads to parking on the street, which makes traffic worse, distorts the image of the city and reflects poor management. For example, the study by Yong Wenlin et al. (2016), which focuses on the city of Beijing, found that the number of cars in the city of Beijing reaches 5 million cars, compared to 2 million parking spaces, and this difference in the number of more than double, explains the great parking shortage that Beijing suffers from. Quality transport, which extends up to 800 meters from residential buildings, has an impact on car ownership, and therefore on the percentage of parking demand. According to the study by Chris De Gruyter et al (2020)[7], the provision of 10% of public transport services, It leads to a decrease, of between 0.9 and 1.2%, in the demand for parking lots. The cost of parking plays a major role in driving the transport service, as it limits the acceleration of car ownership among the population and thus avoids traffic jams and many problems related to transport and the environment in general.

John Gollas et al. (2002) state that the cost of parking is the most important factor that pushes the citizen to choose to park off the street instead of choosing to stop on the street. Cities in Algeria suffer from a significant lack of parking spaces, as the number of cars there is high, reaching 6,418,212 cars in 2018, especially Constantine which is one of the largest Algerian cities. According to a study conducted by Ahmed Saadi et al. (2019), it was found that there is a shortage of car parks estimated at 2000 spaces, as these statistics are from 2012, so this deficit has doubled in recent years due to the rapid increase in the number of cars.

According to the study conducted by Abdul Razzaq, M. (2016) that the multi-storey car park, located in thecenter of the city of Constantine and which can accommodate 500 cars, remains occupied throughout the day at 90% by employees and traders who work in the city center, and therefore only a small percentage of those who come from outside can take advantage of it. The head of the transport committee of the municipality of Constantine (2016) said in an interview with Al-Nasr newspaper that the city of Constantine has a deficit of 3,000 parking spaces.

3.　Case study

Constantine is located in the eastern part of Algeria, 390 km from the capital (Fig. 1). It is the third largest city in Algeria, a very important cultural and educational center in Algeria. It is called the City of Hanging Bridges because it contains 9 bridges, the oldest of which is the Bab al-Qantara Bridge, which dates back to 1792, and the newest is the Saleh Bay Bridge, which began to be used in 2014 (Siham, G. 2016).

The city of Constantine is formed by parts separated from each other, where it was located at the beginningof its creation on a steep rock, then spread beyond its borders on a set of heterogeneous terrains of a plateau, of scattered hills and plains. The sand valley separates the city into eastern and western parts and runs from north to south of the city for a length of 2,800 meters (Google Earth). The city of Constantine includes a forestwealth over an area of more than 18,900 hectares, which represents 8.49% of the total area, according to what was mentioned in the Governorate of Forests (Trade and Export Promotion website). The highest point in the city is Jebel Bougarb, with a value of 1,314 meters, and the lowest point is Wadi Al-Rimal, whose depth varies between 50 and 200 meters.

The area of the city of Constantine is 2297.20 km², distributed over this area, 938475 inhabitants (National Office of Statistics, 2008), with a population density estimated at 408.35 inhabitants/km², but according to the newspaper Al- Nasr (2019), after a report presented by the Committee of Reconstruction and Preparation of the Region in the Wilayat Center, the population of the city of Constantine has doubled to more than one million inhabitants. The rate of urban concentration in the city of Constantine reaches 75.6% (Zainab, G. 2006).

The geographical location of the city directly affects its own weather conditions. According to meteorological statistics carried out by the Meteublou site over a period of 30 years for the city of Constantine, the maximum temperature was recorded in the months of July and August with an average of 36°C during the day and 20°C at night, while the lowest temperature was recorded during the month of January with an average of 14°C during the day and 4°C at night. The average precipitation reaches 31 mm, the highest precipitation was recorded in April, with a value of 46 mm, and the lowest precipitation was recorded in July, with a value of 10 mm.

The parking policy in Constantine has a long history, and many studies have emerged by experts, engineers, design offices and graduate students to improve these policies and reflect the good technical management of parking lots, especially in the city Centre.

Stopping a car inside Constantine city center is possible, but the time must be appropriate for this, i.e. before the start of official working hours, if it exceeds eight o'clock in the are defying the prohibition laws, so you find vehicles parked on the sidewalk, where a sign has been hung saying "The sidewalk is for pedestrians", and despite this, many drivers don't care, under the pretext of going to quickly transfer their work to one of the neighboring institutions (Sami, H. 2019).

The city of Constantine has been trying for many years to regulate traffic by controlling parking. According to an article published by Al-Nasr newspaper (2010), it was found that the city of Constantine had announced a large program of construction of parking lots in several areas of the city, which became an example of a traffic jam. It plans to open a multi-storey car park at rue Larbi Ben M'hidi, which is one of the most important main arteries in the city. She said the authorities mainly wanted to organize the movement on rue Larbi Ben M'hidi, rue France Didouche Mourad and June 19, which adjoin the old town.
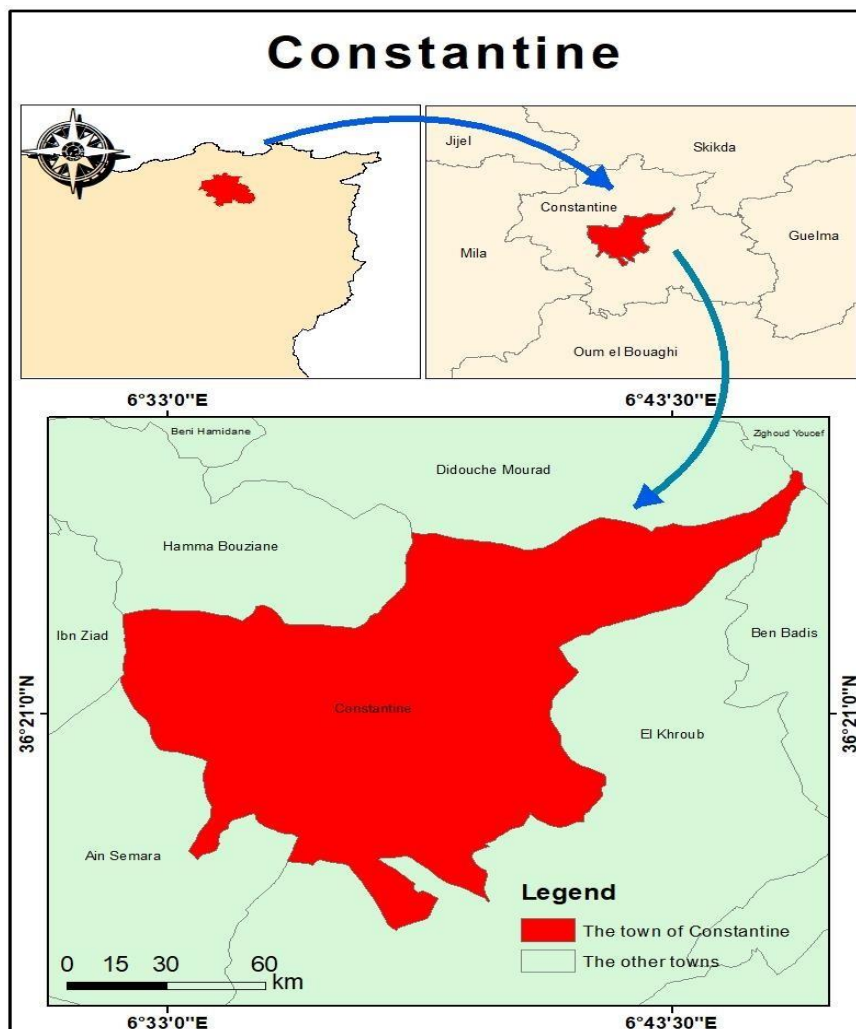
Fig. 1. The location and map of Constantine.

4.   Methodology and data

This document covers sixteen (16) representative samples of parking lanes. The length of the corridors was chosen so that the time to be covered by the investigator does not exceed twenty (20) minutes, to enable him to redo the circuit within the next half hour. The streets covered by the survey are : Kykaya Amar Street, TobaHocine Street, Rue Rymonde-Reschards, Rue Salami Slimane, The S, The S, Mohamed Belouizdad Street, rue, mohamed belouizdad, rue mohamed belouizdad, rue mohamed, belouizdad, Chettab Allel Street, Rue Aouati Mustapha, Rahmani, Ashur Street, Rahmani Ashur Street, Rue Larbi ben m'hidi, Rue Larbi ben m'hidi,it corresponds to it in graphs C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16 in order. We chose these lanes after carrying out a study which showed that they are the most frequent parking lanes for cars, in addition to the fact that the city center is the most requested place to park because it contains the most administrative and commercial places. Parking, in fact, in the city center and at certain locations in outlying areas, even for a few minutes, is becoming more and more problematic for ordinary people (Watan, 2016).

Fig. 2. Streets of the study area.

This article uses recent data from the Transportation Directorate of the wilaya of Constantine. From a review of the literature, we know that the built environment plays an important role in the problem of parking.In this study, we follow a global approach. The data also shows the need to deepen the analyzes and conclusions and to work on them in order to address the various problems and to better understand the car parks in the city center.

First of all, during this study, the statistical analysis program spss is used in order to facilitate the study, to clarify the differences and to extract the different points that help us in the study. And also to count the large number of various data. Therefore, we present a methodology that takes into account the daily repeated demand for parking spaces according to the study street. In a second step, we count the available offer or we count the number of places available in the same street. Third, we calculate the occupancy rate of parking lots on the same street in order to find out whether it is possible to park more cars, especially during rush hour, which is the busiest time of the day in various urban transport facilities, and provide parking service. Finally, we count all the data during the day for the study area, and feed it into the spss program in a new data form so that we can count the demand, supply and occupancy level of parking lots in accordance to legal regulations, that is to say, according to authorized, prohibited, reserved and alternative places during the day and at peak times.

Although the data goes back to the year 2012, it is still valid for our study because the car parks and services in the city center have not changed, and therefore the supply and demand for parking spaces are still the same. In addition to having an effect on travel, the availability or not of parking also has an impact on the economic dynamism of an area. This management is all the more important in the city center, where the density of occupation and the demand for parking are higher, the traffic more important and the constraints more binding (Direction des Transports de la Province de Constantine, 2013).

Survey of demand by noting the registration numbers of each vehicle parked on the selected circuits by half-hourly segment at different times of the day (from 7:00 a.m. to 6:30 p.m.) in order to determine the spatial distribution and the hourly fluctuation, the road occupancy rate, as well as compliance with the regulations in force. The sample of sections (16 in number) is representative of all parking regulations and has an acceptable sampling rate of the total parking supply at the city center level.

4.1. Analysis of parking spaces in each street separately in the study area: according to supply, demand and the percentage of occupancy of the street

This study takes into account both supply and demand for car parks. There are several differences in the study of parking lots in downtown Constantine, depending on the street and its occupancy rate. For example, the occupancy level of chettab allel street during peak hours reaches 100%, while the occupancy level of rahmani achour street during peak hours reaches 49%.

The survey took place in two stages: the first step, consists of defining the scope of the study by noting the number of parking spaces (offer) and determining the applicable regulations, the second step, consists of determining the demand for parking within which registrations of each vehicle parked on the selected streets for a full day (07:00 - 19:00).

The data that has been studied contains data for each street separately and in detail. Street names have beenentered into the spss program with numbers from 1 to 16 instead of names so that the program can process them clearly. Two databases were used in the program, the first is related to streets in terms of supply and demand variables and the occupancy level of each street separately during peak hour, and the second database studies supply and demand and the level of occupancy according to legal standards. Regulations, i.e. car parks: prohibited, alternative, authorized and reserved at peak times And throughout the day. After recording the supply and demand in the study area, we calculate the occupancy rate in each street through the following equation: Street occupancy rate = demand * 100 / supply, then we enter all the values in the spss program inorder to analyze them.

$$\text{Street occupancy rate} \quad \square \quad \square \ 100$$
Demand

Supply

5. Results

The following table represents data for 16 streets during peak hours. We obtained it after analyzing the firstdatabase through the SPSS program. We analyze the data by finding the maximum and minimum for each variable with the calculation of the mean.

Table 1. Data for 16 streets

	N	Minimum	Maximum	Moyenne
Circle_number	16	1	16	-
Number_of_places_offered	2050	70	200	128,13
Number_of_Vehicles	1660	64	176	103,75
Occupancy_rate	100%	49%	100%	83%

We find the average supply estimated at 128 places, the lowest value was recorded rue Mohamed Belouizdad with a value of 70 places, while the highest value was estimated at 200 places and was recorded rue Larbi Ben M hidi. As for the demand for parking spaces, the highest value reached 176 and was recorded on Al-Arabi Ben M'hidi Street. As for the lowest demand value, it was recorded on Salami Suleiman Street, which was estimated at 64 cars. The average parking demand in the study area during rush hour reached 104 cars. The average occupancy of car parks in downtown Constantine at peak times reaches 83%, i.e. almost the majority of car parks are occupied, since the values of the supply and demand for car parks are quite close, thetotal supply reaching 2050 places and the total demand being 1660 cars.

It can also be noted that rue Larbi Ben M'hidi is the street with the widest width of parking lots, and the highest demand value was recorded there, but the occupancy rate there only reaches 88%, while Mohamed Belouizdad and Chattab Allal streets have an occupancy rate of 100%.
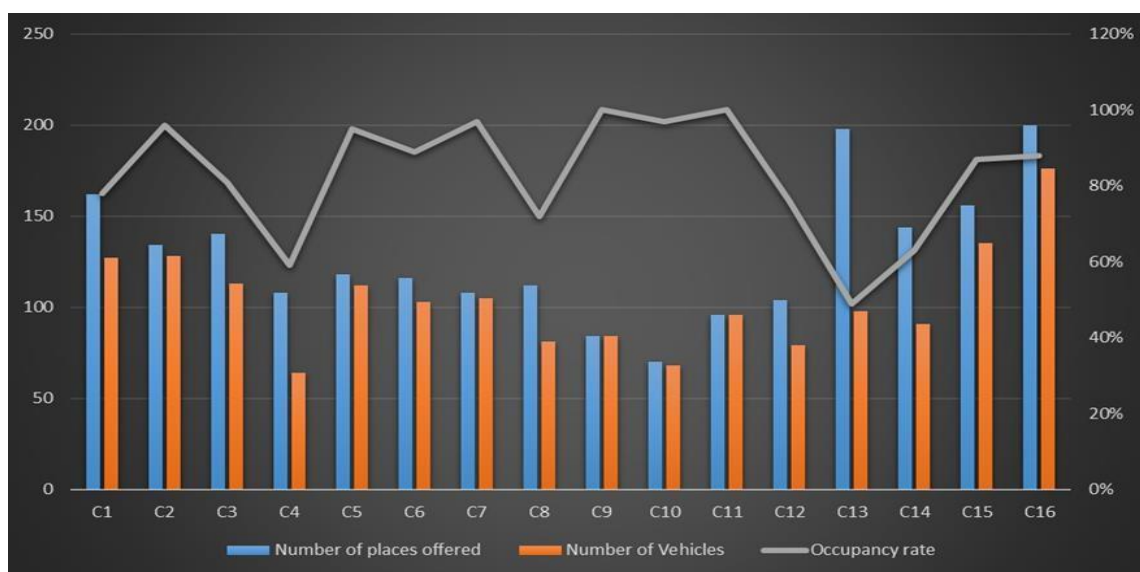
The curve becomes clearer because we notice three categories of columns: the first includes C16 and C13. The second includes each of C1, C3, C14 and C15. The third category includes the rest of the streets, so each category includes similar values in parking supply and demand. However, the occupancy rate curve decreases significantly at rue C13, due to the large gap between supply and demand. Heterogeneity was observed in the spatial distribution of parking demand on the streets surveyed.

5.1. Use of car parks in accordance with legal provisions

According to legal regulations in Algeria, we have 4 types of parking spaces: authorized, prohibited, alternative and reserved. We have created a new database in the spss program according to the legal regulations for each of the supply and demand and the percentage of street occupancy in the whole day, in addition to the demand and the percentage of street occupancy during rush hour and after parsing through the program, we obtained the following table:

Table *2.* Data on the study area according to the legal regulations

	per day			Rush hour	
	Parking offer	Station request	Average occupancy rate	parking request	occupancy rate
Alternate	4462	2327	52%	237	61%
Authorized	9499	7267	77%	735	89%
Not allowed	7199	5609	78%	526	84%
Reserve	2415	1756	73%	162	77%

It can be noted that the highest supply/demand ratio was recorded at the level of approved car parks, whether during the day or during peak hours. It is followed in second place by prohibited car parks, where the occupancy rate during the day is 78% and at peak times 84%, then followed by the reserve car park with an occupancy rate of 73% during the day, then the alternative, considered the least visited or the least used.

Thus, these results allow us to conclude that there is strong pressure on parking in the city. In addition to not respecting parking regulations, especially with regard to the use of prohibited parking lots.

6.   Conclusions and final discussion

Analyzing the accessibility of parking within the city center is extremely important in order to balance supply and demand without bottlenecks, especially in an active area such as the city center, which is an attractive point for the city's citizens and residents of neighboring cities.

This article aims to understand parking patterns and their use, and to discuss measures to improve their management in the city center. It uses two spss program databases that were created through surveys in the study area. Obviously, car parks are sensitive to several factors, including the city center, legal regulations, supply and demand, and street occupancy.

This study shows that the city center of Constantine suffers from strong pressure in the need for car parking. Especially since the parking crisis is clearly apparent during rush hour. This study shows that parkinglots in downtown Constantine are occupied with a high percentage and sometimes completely, especially at peak times.

Specifically, the demand for car parks exceeds the supply, especially on major streets that contain services. This is what has prompted citizens or visitors to the city center to resort to unauthorized or prohibited parking lots. Parking plays an important role in getting to the city center and availing its services repeatedly. We reliedon the analysis of the spss program because it analyzes many different data and gives accurate results relatedto each other that reflect reality. On the other hand, the presence of multi-storey car parks, for example, withinthe limits of the city center, can positively affect the orientation of citizens towards the city center. The city center and the services it provides play a major role in urban transport, in particular in the parking lot movement.

This discussion must play an important role in the management of parking lots in the most sought -after streets in the study area. Chaos in racing car parks does not want citizens to visit the city center and the streets therefore lose their vitality. It is important for the city to favour transport policies that promote environmentally friendly modal choices (Sven Müllera, Lucia Mejia-Dorantesb, Elisa Kerstenc, 2020). This type of analysis can be used to inform the city's urban transport authorities about the details of the problems that hinder the proper management of urban transport and its promotion to more efficient degrees.

As we highlighted at the beginning of this paper, the availability of population and land use data at fine spatial and temporal resolution remains a major barrier to conducting accessibility analysis at the city or region level.

This discussion needs to be part of a fairer social infrastructure planning ("Daseinsvorsorge"). Also, our study prolongs the desire to research more on the same subject, but changing the streets, for example, or changing the style of study, or focusing on different variables. Finally, in view of the results, the city of Constantine is already suffering from a parking crisis and affecting the comfort of citizens and the provision of necessary services. Therefore, parking lots must be arranged and managed in an orderly manner, or if it Wenotice that the parking lots are too numerous and uncontrollable, then we resort to reducing the number of private vehicles, which is the last policy to resort to in most cities of the world.

The analysis presented in this paper can also be carried forward in different directions of the city center or different areas of the city. We also see potential improvements that can be achieved by leveraging geospatial data sources for parking.

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Acknowledgement