

Parking Management in Urban Areas: A Case Study of Vadodara City

Pankaj S. Prajapati^{1*}, Aayushi Shah²

Abstract

The Indian cities are developing and spreading rapidly. The parking issue has become a major planning problem in urban areas of major cities because of rapid economical and vehicle population growth. It is stated that population growth and increasing living standards of people are responsible for the rise in the city's vehicular population. Affordable prices and subsidized parking fees are leading people to refer private vehicle over public transit as their travel mode. This study is carried out to investigate parking characteristics and to find the gap between parking guidelines and implementation. For the study, three different routes were identified which were critical in terms of parking facility. All the three routes were different in terms of land use, to study how the change in land use changes the parking behavior. For the survey, License plate method was opted, and survey was carried out during weekdays and weekends at peak hours. On-street and off-street parking characteristics were analyzed considering the parking statistics which includes parking accumulation, parking occupancy, parking load, average parking duration, parking index/parking efficiency. With the change in land use, all the parking statistics were also changing. During the study, it was observed that some areas, even having sufficient parking capacity suffered from congestion due to improper management and lack of availability of required signs, marking of bays and other smart techniques. Lack of coordination between different agencies was observed which led to poor implementation of the set policies and guidelines. Apart from these change in the land use, poorly maintained parking spaces, encroachment on the parking spaces were the major issues observed. Observing the study outcomes, some guidelines have been suggested for optimal utilization of available space. Formation of "parking management cell" under the purview of Vadodara Municipal Corporation (VMC) will be helpful in bringing the coordination and organized structure for the successful implementation. Also, formulation of parking area management plan (PAMP) was done with demarcation of all type of parking facilities.

Keywords: On-street parking, parking characteristics, parking management plan, policy guidelines

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INTRODUCTION

Rapid growth in vehicle density is leading to requirement of more parking space and ultimately putting enormous pressure in cities. Vehicles are getting parked at roadsides, footpaths and similar spaces in a much unorganized manner. A typical vehicle runs for 1 h on an average and is parked for 23 h in a day. It needs to be highlighted that even if we keep on creating more and more number of parking spaces, seeing at the present rate of growth of vehicles, there is always going to be a huge deficit. Increasing parking supply is not an effective solution. Instead, focused measures must be taken to reduce the number of private vehicles. Insufficient parking in the cities leads to high degree

of traffic congestion and high level of noise and air pollution. This tendency of increasing private vehicle ownership needs to be controlled. This issue can be addressed by appropriate parking policies and parking management schemes, which may result in valuable economic asset for the administration in terms of good opportunities and revenue out of such strategies that result in improving the livability of any town, while also supporting sustainable transport and the parking business itself. The city is dominated by use of private vehicles. Vehicular growth has been seen increasing at the rate of 8.5%. Due to which, the road network is experiencing heavy congestion. Consequently, air quality issues are also arising. In this study, the problematic parking locations have been selected in Vadodara to provide solutions which will help to reduce problems. Different field surveys on busy urban locations and parking inventories have been conducted to study various parking statistics [1].

LITERATURE REVIEW

With the growth of economy, automobile ownership has also increased. And so, parking problems in urban areas of metro cities have become increasingly prominent. Our streets are becoming congested, chaotic and so as our urban areas. Our mindsets are such that we only addressed parking issues when the problem arises. Land is limited and parking creates wasteful use of valuable land [2, 3]. Affordable prices of vehicles and subsidized parking fees are leading people to choose private vehicles over public transit as their travel mode (Janak Parmar, 2019). On-street parking is most common observed among personal vehicle users, and it has become major problem for CBD area of all metropolitan cities of India (Nandan Dawada et al) [4]. Parking is a matter of significance both at local and at strategic level planning (William, Russell & Michael, 2013) [5].

Parameters that help in deciding parking requirements are like geographical location, density, land use, transit accessibility, car sharing and parking pricing (Litman, 2021) [6]. The parking statistics including parking accumulation, parking occupancy, parking load, average parking duration, parking index/parking efficiency (Nandan Dawada et al, R. Pitroda et al, Priyanka Kolhar, 2012) [7] helps in analyzing parking characteristics. The improper parking management and unavailability of required signage, marking of parking bays and smart techniques result in congestion even though sufficient parking space is available. This ultimately leads to indecorous and haphazard parking and underutilization of parking spaces.

Parking management strategies like shared parking, more accurate and flexible standards, parking maximums, financial incentives, parking tax reforms etc. shall be introduced (Litman, 1999) [8]. Parking management helps to achieve more efficient land use development patterns with convenience to motorists and cost savings. With reduced congestion, it also leads to lowering the pollution problems of cities (Litman, 2021) [6]. The findings from the study suggest elimination of free parking from the areas having good access to public transport. Variable parking rates in weekdays and weekends when demand is high and low respectively, shall be introduced according to parameters like peak hour, duration of stay, and commercial importance of areas [2, 3]. Parking management needs local area approach which involves all the concerned groups like urban local body, traffic police department and local stakeholders. Parking policy shall also have objectives of improvement in pedestrian and NMT accessibility, prioritize public transport and livable and safe urban forms than just addressing the parking issues.

This study is aimed to provide the strategic solution for parking facilities through fair and enforceable system for the control and allocation of parking spaces in Vadodara city [9].

The study focuses on identification of areas which are suffering from major parking issues and understanding the different parking attributes through primary and secondary data collection. It also seeks to provide strategies for the identified zones to solve the parking issues. The study will be limited to few crucial identified zones. The study will not cover the issues of parking in housing society. Parking issues of privately owned vehicles (2-wheelers and 4-wheelers) will be covered [10].

METHODOLOGY

The procedure followed regarding the data collection is described in the further section of this study. The parking demand is directly associated to the land use of a particular area. It is obvious that commercial areas having offices will require large space for the parking because of employees coming in the offices by private vehicle, park their vehicle in nearby areas for the whole day and also the extra space needed for visitors; whereas marketplace will be having fluctuating demand throughout the day depending upon the requirement of the visitors. The demand for parking at weekend will be higher compared to weekdays. The different types of areas having different land use have been selected as study area [11].

Study Area

The location of this areas has been shown in the Figure 1. These areas suffer from problems of spill over, haphazard parking, violation of enforcement rules and illegal parking, parking on carriageway which mainly arises due to improper parking management, insufficient parking space at some locations, absence of required signs for parking, tendency to park the vehicle as near as possible to the final destination, inefficient utilization of the available parking space; so that these locations have been selected to analyze and evaluate the parking characteristics and also to suggest the parking guidelines.



Figure 1. Map showing selected study area in Vadodra city.

The study areas were selected based on its importance and type of activities.

Study area 1: L&T, Muktanand Road is mainly having commercial complexes, restaurants and food eateries, institutional buildings and bank. It has Gujarat Samachar office and VUDA office.

Study area 2: Khanderao market Road is one of the core CBD areas of Vadodara city. It is mainly known due to the oldest Khanderao market and Vadodara Municipal Corporation (VMC) main office. There are approximately 250 on street shops which are broadly characterized by mobile and electronics shops, kitchen appliances (Table 1) [6].

Study area 3: Waghodia Road which mainly has grocery stores, garment shops, stationery, and hardware shops. Apart from these, it also has hospitals, clinics and small food eateries.

Table 1. Details of selected locations.

| Details of L&T, Muktanand Road | |
|----------------------------------|-------------|
| Length of route (Studied) | 400 m |
| Right of way | 30 m |
| Width of carriage way | 15 m |
| Number of shops | 180 Approx. |
| Details of Khanderao Market Road | |
| Length of route (Studied) | 650 m |
| Right of way | 20–24 m |
| Width of carriage way | 12–15 m |
| Number of shops | 250 Approx. |
| Details of Waghodia Road | |
| Length of route (Studied) | 430 m |
| Right of way | 20–25 m |
| Width of carriage way | 15 m |
| Number of shops | 150 Approx. |

Data Collection

Primary data collection was carried out in three ways:

- First, to get the detail insight about the parking statistics of the selected three study areas, survey was carried out using license plate survey method. It was conducted during weekdays and weekends in the morning 11 to 1 and evening 6 to 9 or 5 to 8 depending upon the study area. The readings were taken at an interval of half an hour. In the license plate survey, each stretch was monitored at half an hour interval by recording the registered license plate number of each vehicle that occupy a particular space. This data helped in calculating the parking accumulation, duration for which the parking space is utilized, demand ratio for weekdays and weekends, share of vehicles.
- Second, questionnaire survey was carried out at different locations of Vadodara city to understand the citizen's perception about the current parking facilities in Vadodara city. The sample size is 350 and was done by random sampling method.
- Third, VMC officials and traffic police department were interviewed to understand their roles and responsibilities in the parking management and current institutional set up for this area.

The secondary data collection includes the study of the demography, vehicular growth and composition of Vadodara city. Parking policy of Vadodara city, GDCR, IRC code for parking have also been studied [8].

PARKING CHARACTERISTICS ANALYSIS

Parking demand during morning was seen higher after 11 am as the shops open at that time and the peak was observed during 12–12.30 in the morning during weekdays. In the evening parking accumulation was comparatively very high than morning.

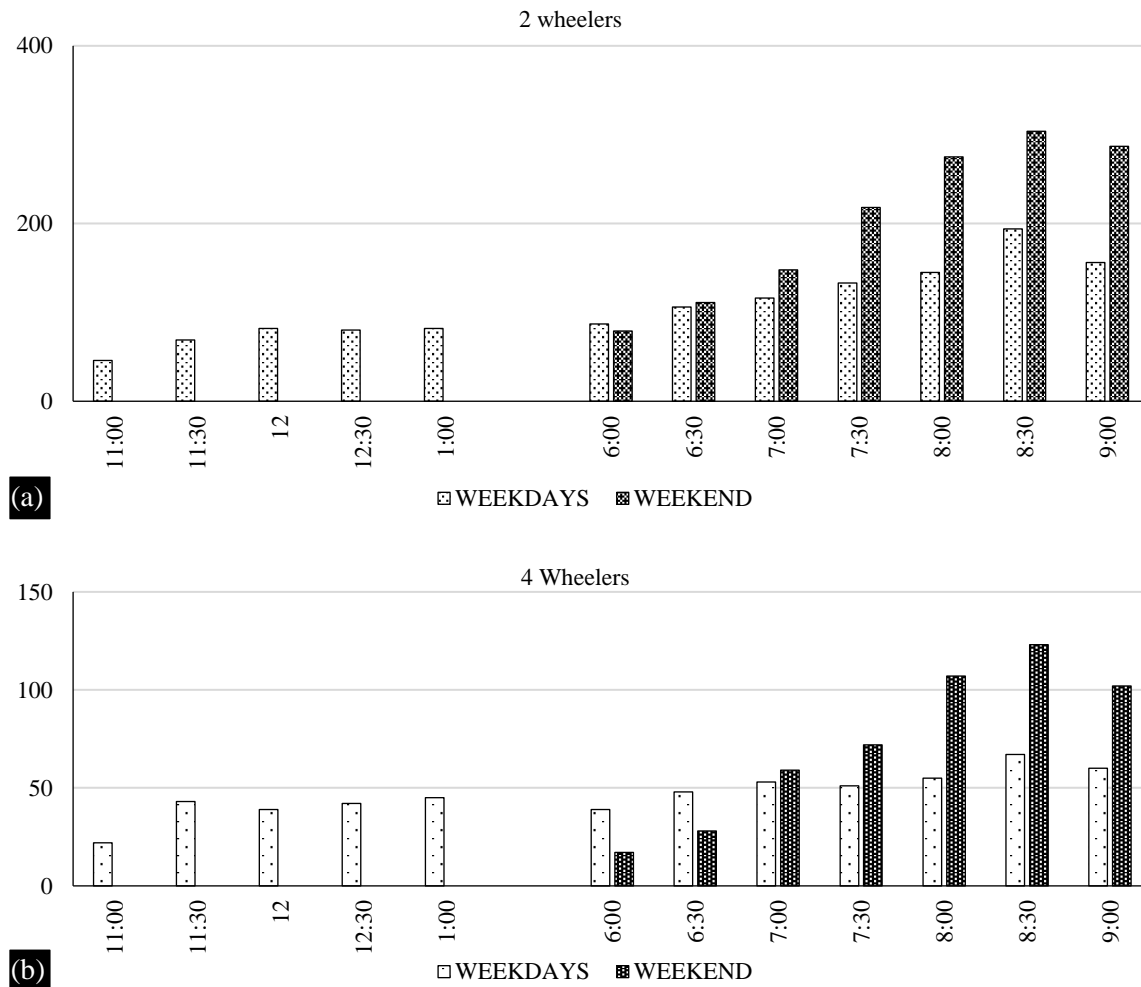
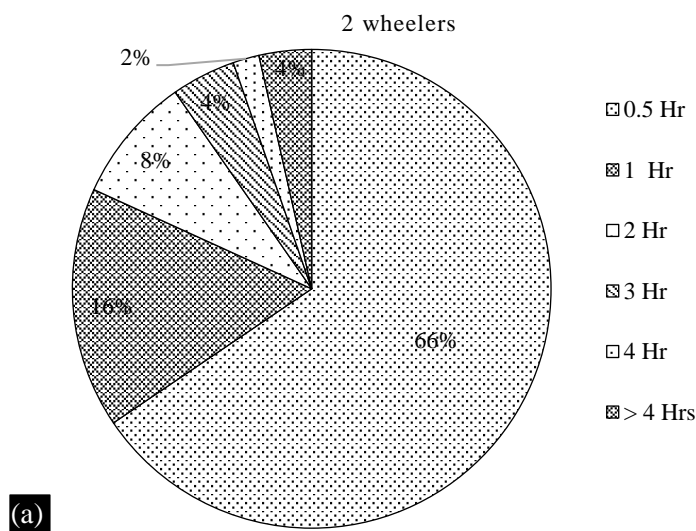
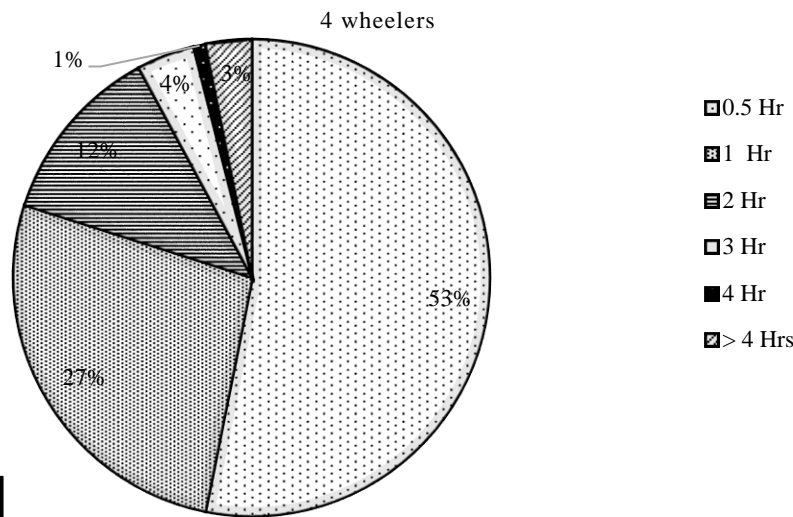


Figure 2. (a) and (b) Parking accumulation.





(b) Figure 3. (a) and (b) Parking duration.

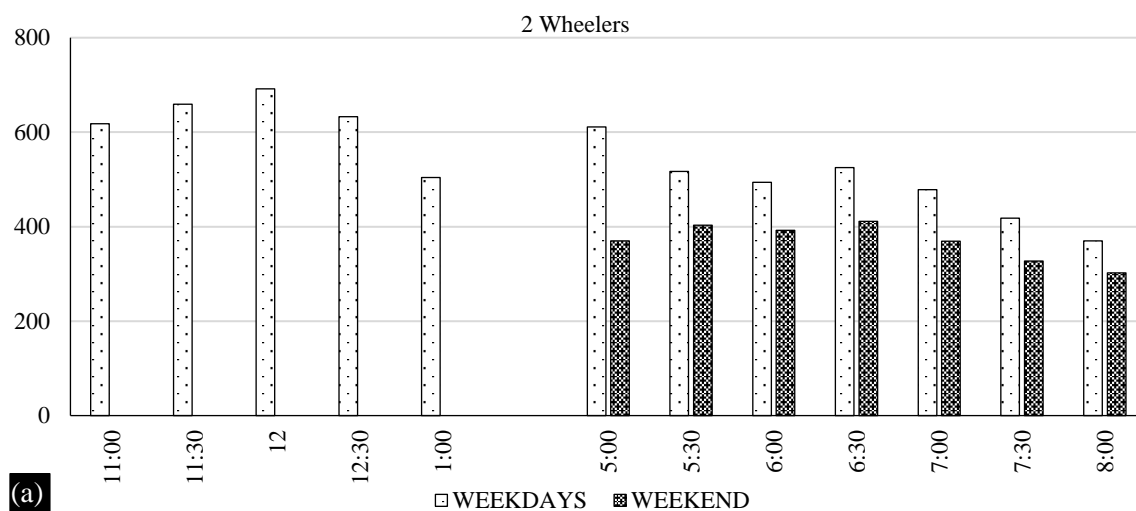
Peak parking volume observed during 8.30–9:00 pm in the evening for both weekdays and weekends. As the food stalls, restaurants open in the evening, parking accumulation remains high in the evening and the scenario gets even tough during the weekend evenings (Figure 2). In the total vehicle accumulation, 70% are 2-wheelers and 30% are 4-wheelers [12].

About 66% of the vehicles stayed for half an hour which indicates predominance of short-term parkers. 16% vehicles occupied the bay for 1 h. And only 4% vehicles remain for more than 4 h which are mainly of the shopkeepers.

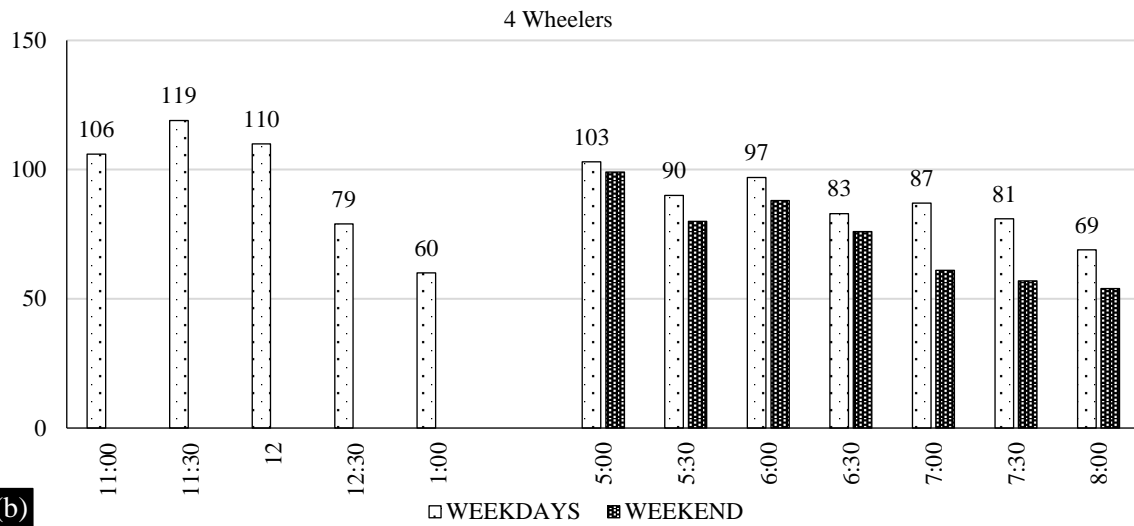
Parking demand in the evening is observed 1.8 times higher than the morning during weekdays. During weekends, the demand was 1.5 times higher than the weekdays. This shows that the weekends are more crucial for parking management in this area [13].

Khanderao Market Road

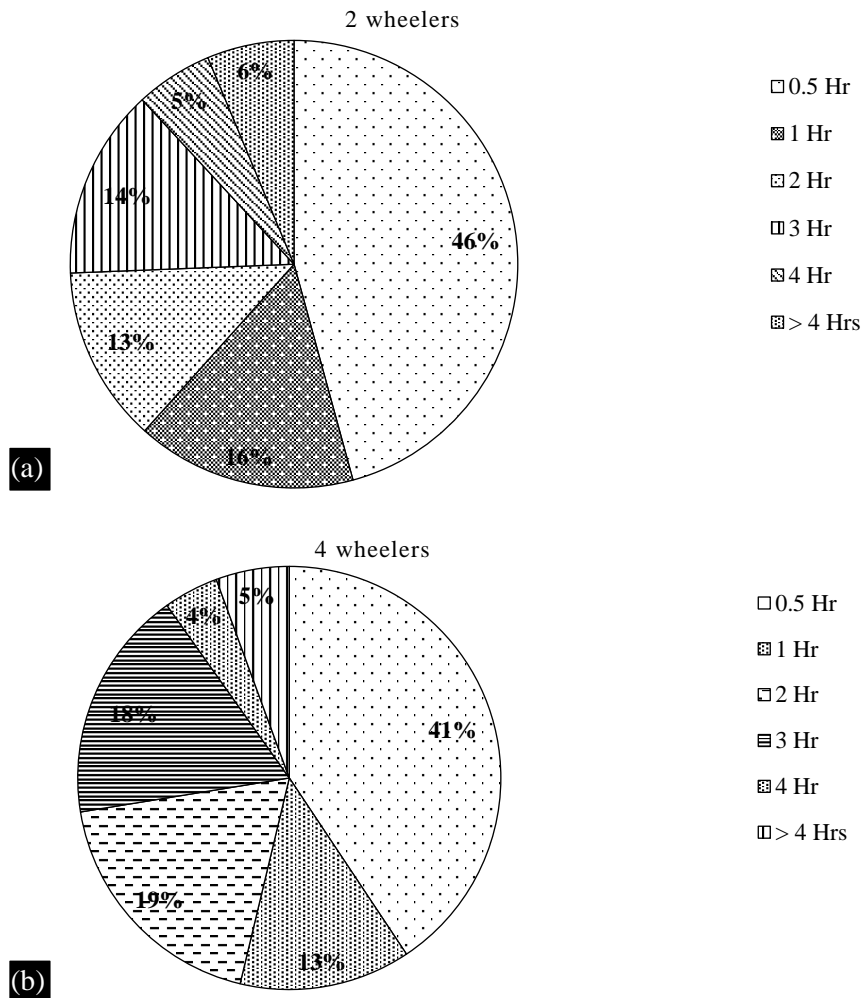
Parking accumulation during morning is seen higher between 11 and 1 due to VMC office and Khanderao market during weekdays (Figure 3). And the peak is observed during 12–12.30 in the morning. In the evening, after 5 pm, the accumulation is seen reducing. And it remained lowest at 8 pm in the evening. In the weekend, many of the shops, VMC office remains close and so parking accumulation is seen lower than the weekdays (Figure 4). In the total vehicle accumulation, 86% are 2-wheelers and 14% are 4-wheelers.



(a) Figure 3. (a) and (b) Parking duration.



(b) Figure 4. (a) and (b) Parking accumulation.



(a) (b) Figure 5. (a) and (b) Parking duration.

46% of the vehicles stayed for half an hour. 16% vehicles occupied the bay for 1 h. And only 6% vehicles remained for more than 4 h. Here, the short-term parking is observed less than 50%. The parking demand ratio, the demand in the evening is observed 1.2 times lower than the morning during

weekdays (Figure 5). During weekends, the demand is 1.3 times lower than the weekdays. This shows that the weekdays are more crucial for parking management in this area [14].

Waghodia Road

Parking volume during morning is seen moderate. And the peak is observed between 12 and 12.30 in the morning during weekdays. In the evening after 6 pm parking volume is seen increasing. And it remained at peak between 8 and 8.30 due to roadside vendors, food eateries, etc. Parking volume is seen remaining moderate during weekends. There is no great fluctuation in volume during weekend. In the total vehicle accumulation, 89% are 2-wheelers and 11% are 4-wheelers. 71% of the vehicles stayed for half an hour which is highest amongst all three study areas. 12% vehicles occupied the bay for 1 h. And only 3% vehicles remain for more than 4 h. Parking demand in the evening is observed 1.4 times higher than morning during weekdays. Parking demand ratio during weekdays and weekends remained almost moderate (Figure 6).

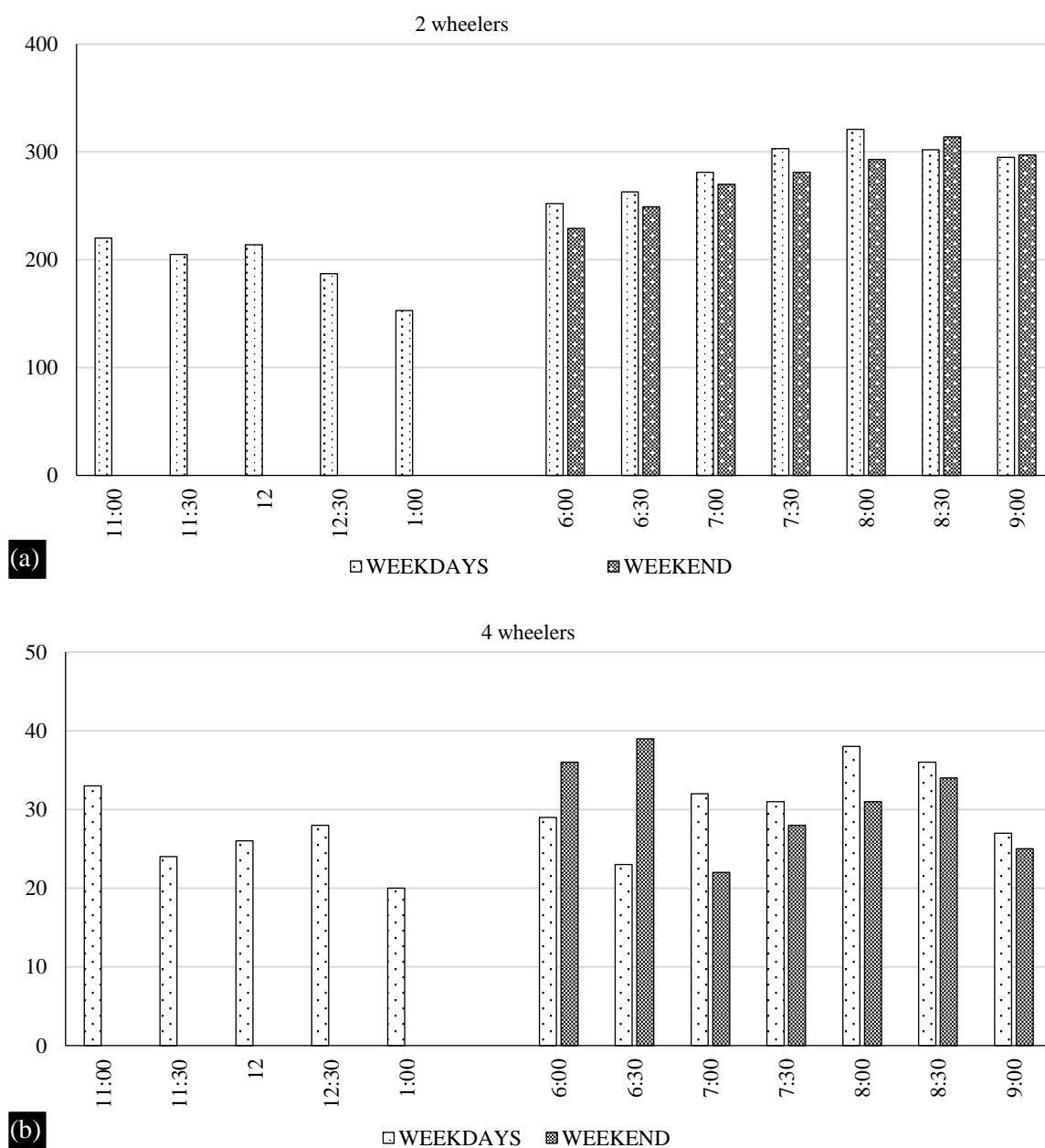


Figure 6. (a) and (b) Parking accumulation.

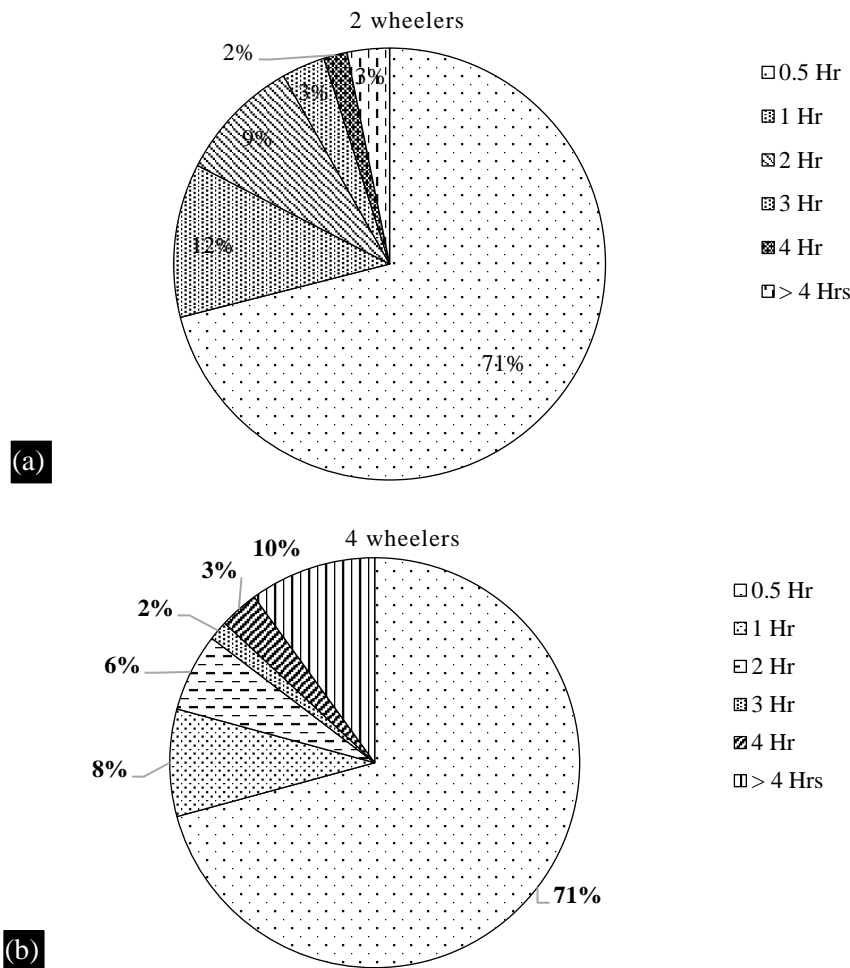


Figure 7. (a) and (b) Parking duration.

RESULTS AND DISCUSSIONS

A detailed analysis of parking spaces of different areas and having different types of facilities has been carried out, which is shown in the foregoing section (Figure 7).

It was observed that at *L&T, Muktanand Road*, parking signs have been installed by VMC, but bays have not been demarcated. It was leading to the haphazard parking. Abusive use of parking space is observed during the study. The parking spaces are in other uses than its original purpose like as sitting spaces for the restaurants or vendors are hindering the parking space. Buildings which are provided with the parking facilities are underutilized due to some or the other reason. Basement remains empty while on street parking gets full and is difficult to find. All these resulted into reduction in the carriage way of road and congestion on the streets.

At *Khanderao market Road*, parking signage and bays are completely missing which is creating unorganized parking situations. Commercial complexes having basement parking spaces are very poorly maintained, waterlogged, dark and so they remained under-utilized or not in use. VMC office has not provided visitor's parking inside the campus and so it creates very chaotic conditions on street during working hours. Many shops were seen encroaching the parking spaces for the product's display.

At *Waghodia Road*, parking signage and bays are completely missing. As a result, there was no clarity about the parking zones. Change in land use is observed as one of the major challenges here. As the buildings are transforming from residential to commercial land use, they are putting an extra pressure on urban roads. Parking space is being encroached by the street vendors/hawkers and as a result vehicles

are being parked on road, reducing the carriage way of road. There are no enforcement actions are being taken currently, which is a major drawback here.

Summary of Questionnaire Survey

The questionnaire survey is carried out at the different locations of Vadodara like Sama, Harni, Karelibaug, Shubhanpura, Makarpura and Manjalpur, etc., apart from the selected three routes, to know the citizens' perception and opinion regarding parking problems and get them involved in the process of development. The survey was carried out by random sampling method using 350 samples.

Results show that 86% people are not happy with current parking situations. 92% people are not really able to find a parking space with ease. 78% people use free on-street or off-street parking facility. While choosing the parking, overall convenience is the prime factor seen by the users, followed by security, distance from destination and parking charges being the last deciding factor. 78% people agreed to pay for parking if secured and reliable service is provided. 60% people think that parking charges will impact its demand as 63% people might shift to other modes due to implication of parking charges.

CONCLUSION

Many government agencies are involved in the process of parking management which is creating overlapping roles and responsibilities amongst them. Moreover, the fund collected from parking fines, penalties and developed parking facilities are also very much scattered. So, it is difficult to manage and reuse them for improvement of parking spaces.

Only organizing and managing parking spaces will not work, but with this, all the hindering elements like vendors, hawkers, etc. need to be managed. Parking infrastructure like parking signs and demarcation of bays are completely missing in many parts. And so, there is no clarity about the available parking, which ultimately leads to congestion, violation and haphazard parking situations.

Change in land use like residential areas are now transforming into mixed use or commercial buildings which is putting an extra pressure on urban services like parking.

Buildings have not provided enough parking facilities as per the land use or GDCR. This is creating a spillover effect and adds to on-street parking. The parking spaces provided in the buildings are underutilized or not in use because of inconvenience like poor gradients of access for basement parking, hoardings, kiosks and hawkers. Parking spaces are poorly maintained that have water logging with bad smell, darkness and no air ventilation which discourage people to use such facilities.

Different areas of city will require a different parking management approach based on the character of the area and so same approach will not work.

RECOMMENDATIONS

Parking Management Cell

The cell shall be formed under the purview of VMC within Town planning department. It shall comprise members from all the concerned government bodies like urban local body (VMC), Traffic police department, which is responsible for enforcement of policy, contractors responsible for running the pay-and-park parking lots, experts like transportation planners, urban planners, and lastly, citizens which are the end users of the any plan or policy must be consulted. Their engagement is must for successful implementation of the policies.

The cell will mainly have three divisions namely administrative management, operations and financial management.

Formulating Parking Area Management Plan

The Parking Management Area Plan (PMAP) is an area level plan which includes the demarcation of all types of parking spaces for all modes as well as essential street amenities. This includes on-street, off-street and multi-level parking facilities, vending zones, multi-modal integration facilities, green open spaces along with the allied traffic and pedestrian/NMT circulation plans, signage plans and pricing strategy.

Use of Smart Parking Technology

As Vadodara has been nominated for smart city, integrating ITS into parking management would be beneficial. Sensors and cameras can be used as tools to get the information about the occupancy, availability of parking space, track the parking duration of particular vehicle and violation in the parking.

Mobile application can be developed to get the real time data of parking with accuracy. They can now acquire the information about availability of parking space before reaching to that space. Even the parking slots can be booked prior reaching to that area.

Apart from these:

- Rather than a common guideline for different buildings/land use, developer shall suggest the parking demand for the building based on the possible land use of the building. Some land uses can also be restricted. And in that case, if the violation happens, high penalty can be charged.
- It is observed that shop owners park their vehicles on street for maximum time of the day. And these occupy a huge amount of parking space. This is the dominant problem in the CBD area of any city. And so, shopkeepers shall be charged monthly or yearly, a certain amount of money for the parking spaces they are using. This fund can be used for improvement of parking facilities.
- Parking pricing structure must be varied with the length of stay, peak hours, importance of commercial areas, land prices etc. Strict no parking zones shall be created, and high penalties shall be charged in case of violation.

REFERENCES

1. Government of national capital territory of Delhi, T. department. Parking management area plan for national capital territory of Delhi: A guidance framework. Delhi: Subgroup, committee on parking policy; 2022 Nov.
2. Anumita Roy Chowdhury, Usman Nasim, Gaurav Dubey. Pampering Cities: How to manage urban India's parking needs. New Delhi: Centre for Science and Environment; 2018.
3. Anumita Roy Chowdhury. Parking policy: getting the principles right. New Delhi: Centre for science and environment (CSE-GIZ orientation workshop). 2012 Jul 26.
4. Dawda N, Joshi G, Arkatkar S, Vasudevan N. Multimodal of lateral transport system: a case study of successful cities worldwide. In: Deb D, Balas V, Dey R, Shah J. (editors). Innovative Research in Transportation Infrastructure. Lecture Notes in Intelligent Transportation and Infrastructure. Singapore: Springer; 2019. p. 101-10. doi: 10.1007/978-981-13-2032-3_10.
5. Reynolds KA, Russ WP, Socolich M, Ranganathan R. Evolution-based design of proteins. *Methods Enzymol.* 2013;523. doi: 10.1016/B978-0-12-394292-0.00010-2.
6. Litman T. Parking Management: Strategies, Evaluation and Planning. Victoria Transport Policy Institute; 2021 Nov 5.
7. Priyanka Kolhar. Offstreet Parking Management Plan for Dharwad City, Karnataka, India. *Journal of Engineering Research and Studies.* April-June 2012;3(2):67-71.
8. Litman T. Distance-based charges: A practical strategy for more optimal vehicle pricing. 78th Annual Meeting. Canada: Victoria Transport Policy Institute. Transportation Research Board; 1999. Session 458 Paper No. 99-0678. 1999.
9. Revthi Siva Kumara. (2018 Mar 12). Delhi divided: will new parking management plan reduce traffic congestion? [Online]. Citizen Matters.

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10. Institute for Transportation and Development Policy. (2013 Aug). Common Sense Parking Reforms for Indian Cities. [Online]. <https://www.itdp.in/tag/parking/>
 11. National Urban Transport Policy (2014), Ministry of Urban Development, Government of India. <http://itdp.in/wp-content/uploads/2014/11/NUTP-2014.pdf>.
 12. Shoup Donald C. The High Cost of Free Parking. London: Routledge. 2020. doi: 10.4324/9781351179539.
 13. Transport Department, Government of National Capital Territory of Delhi. Parking Management Area Plan for National Capital Territory of Delhi: A Guidance Framework. 2017 Nov.
 14. Dave S, Dawada N, Joshi GJ. Modeling on-Street Parking Scenario and Response to Paid Parking Policy Using Statistical Techniques for CBD Area of Vadodara City. In: Mathew T, Joshi G, Velaga N, Arkatkar S. (editors). Transportation Research. Lecture Notes in Civil Engineering, vol 45. Singapore: Springer; 2020. doi: 10.1007/978-981-32-9042-6_14.