

Analysis of Different Parking Spaces and Its Comparison: A Case Study at PMEC, Brahmapur, Odisha

Nitesh Kumar Garg ¹

U.G. Student, Department of Civil Engineering, Parala Maharaja Engineering College, Brahmapur, Odisha, India¹

ABSTRACT: The number of vehicles is increasing at an alarming rate in the urban areas. The commercialization of the area is also happening at a fast rate. The investment on roads and for parking facilities have not kept in pace with these growing traffic leading to congestion and accidents. The propensity to own private vehicles and the necessity for their use has generated huge parking demand in metropolitan cities. Almost all the metropolitan cities are experiencing increased problems related to parking.

Initially data has been collected from various parking spaces available in the Parala Maharaja Engineering College, Brahmapur, Odisha campus area by using License Plate Method. Then the variation of PCU with a certain time has been figured out and then all these data has been compared with the help of “t- test” to find out whether these parking pattern and demand are same or different.

KEYWORDS: License Plate Method, PCU (Passenger Car Unit), t – test.

I. INTRODUCTION

Transportation is the key infrastructure of a country. A country's economy status depends upon how well the country is served by its roads, railways, airports, ports, pipelines and shipping. The rate at which a country's economy grows is very closely linked to the rate at which the transport sector grows. As road transport gives personal mobility to persons, the vehicle ownership rate has been increasing at a fast rate round the world. There is significant and tremendous increase in the demand of parking spaces due to increase of road traffic during the last one decade in small cities, leading to congestion of on-street spaces in official neighbourhoods may give rise to inappropriate parking area in office and shopping mall complex during the peak time of official transactions. The demand also leads to economic, social and environmental losses and with increase in population the problem becomes more critical. As such parking spaces optimization and control has become a real challenge for city transport planners and traffic authority. It's a major issue for proper parking facilities in order to maintain the traffic conditions and adequate traffic flow. So, to overcome with the traffic and parking problems, it is needed to understand the parking demands so that the parking facilities can be improved. So, in order to know the parking demand, the parking patterns have to be first analysed. So, to study the parking pattern, different parking facilities have been surveyed at “Parala Maharaja Engineering College” where the parking demand is at the peak. Most of the people have their own vehicles, which leads to huge demand of proper parking space. Proper design of parking space is very important for good transporting system. If there will be lack of parking space and facility then it will be a chaotic condition for everyone. But designing of any parking space is not an easy job. It seeks a lot of parameters which should be known which could be found out with the help of simple data by applying some technique.

Generally, there are two types of parking patterns.

- a) **On Street Parking:** It means that the vehicles are parked on the sides of the street itself. This will be usually controlled by government agencies itself. Common types of on-street parking are as listed below. This classification is based on the angle in which the vehicles are parked with respect to the road alignment. As per

International Journal of Innovative Research in Science, Engineering and Technology

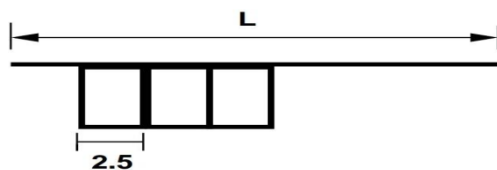
(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

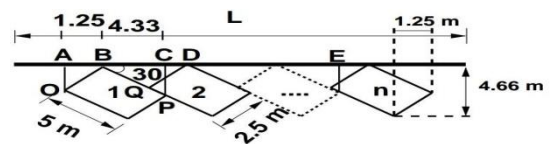
Vol. 9, Issue 3, March 2020

IRC the standard dimensions of a car is taken as 5×2.5 meters and that for a truck is 3.75×7.5 meters.

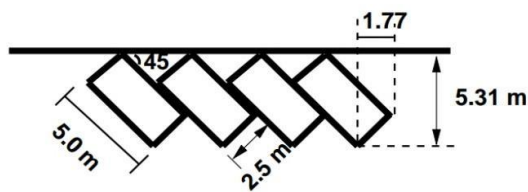
- i. **Parallel Parking:** The vehicles are parked along the length of the road. Here there is no backward movement involved while parking or unparking the vehicle. Hence, it is the safest parking from the accident perspective. However, it consumes the maximum kerb length and therefore only a minimum number of vehicles can be parked for a given kerb length. This method of parking produces least obstruction to the on-going traffic on the road since least road width is used. Parallel parking of cars is shown in fig. 1(a). The length available to park N number of vehicles, $L = N/5.9$.
- ii. **30° Parking:** In this parking, the vehicles are parked at 30° with respect to the road alignment. In this case, more vehicles can be parked compared to parallel parking. Also there is better manoeuvrability. Delay caused to the traffic is also minimum in this type of parking. An example is shown in fig. 1(b).
- iii. **45° Parking:** As the angle of parking increases, more number of vehicles can be parked. Hence compared to parallel parking and 30° parking, more number of vehicles can be accommodated in this type of parking. From fig. 1(c), length of parking space available for parking N number of vehicles in a given kerb is $L = 3.54 N + 1.77$.
- iv. **60° Parking:** The vehicles are parked at 60° to the direction of road. More number of vehicles can be accommodated in this parking type. From the fig. 1(d), length available for parking N vehicles $= 2.89N + 2.16$.
- v. **Right Angle Parking:** In right angle parking or 90° parking, the vehicles are parked perpendicular to the direction of the road. Although it consumes maximum width, kerb length required is very little. In this type of parking, the vehicles need complex manoeuvring and this may cause severe accidents. This arrangement causes obstruction to the road traffic particularly if the road width is less. However, it can accommodate maximum number of vehicles for a given kerb length. An example is shown in fig. 1(e). Length available for parking N number of vehicles is $L = 2.5N$.



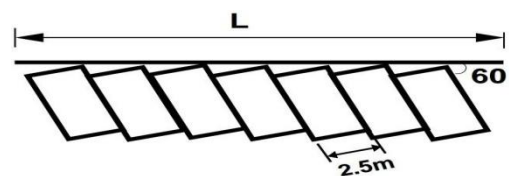
(a)



(b)



(c)



(d)

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 3, March 2020

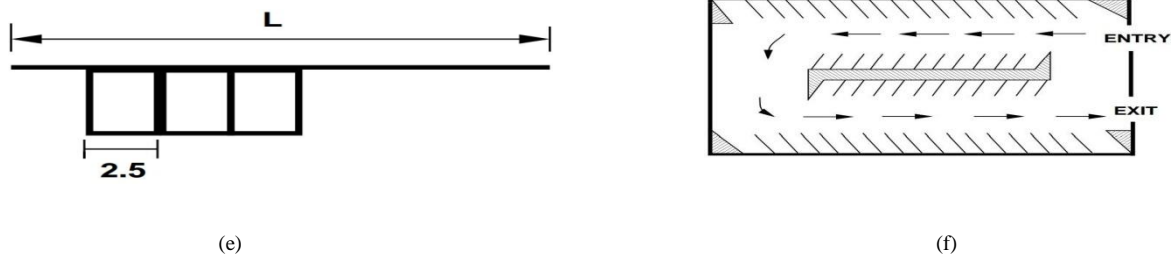


Fig. 1: Illustration of Different Types of Parking (a) Parallel Parking (b) 30° Parking (c) 45° Parking (d) 60° Parking (e) Right Angle Parking (f) Off Street Parking

- b) **Off Street Parking:** In many urban centres, some areas are exclusively allotted for parking which will be at some distance away from the main stream of traffic. Such a parking is referred to as off-street parking. They may be operated by either public agencies or private firms. A typical layout of an off-street parking is shown above in fig. 1(f).

There are some minimum parking requirements for different types of building. For residential plot area less than 300 sq. m require only community parking space. For residential plot area from 500 to 1000 sq. m, minimum one-fourth of the open area should be reserved for parking. Offices may require at least one space for every 70 sq. m as parking area. One parking space is enough for 10 seats in a restaurant where as theatres and cinema halls need to keep only 1 parking space for 20 seats. Thus, the parking requirements are different for different land use zones.

Parking has some ill-effects like:

- Congestion:** Parking takes considerable street space leading to the lowering of the road capacity. Hence, speed will be reduced; journey time and delay will also subsequently increase. The operational cost of the vehicle increases leading to great economical loss to the community.
- Accidents:** Careless manoeuvring of parking and unparking leads to accidents which are referred to as parking accidents. Common type of parking accidents occur while driving out a car from the parking area, careless opening of the doors of parked cars, and while bringing in the vehicle to the parking lot for parking.
- Environmental Pollution:** They also cause pollution to the environment because stop - ping and starting of vehicles while parking and unparking results in noise and fumes. They also affect the aesthetic beauty of the buildings because cars parked at every available space create a feeling that building rises from a plinth of cars.
- Obstruction to Fire Fighting Operations:** Parked vehicles may obstruct the movement of fire fighting vehicles. Sometimes they block access to hydrants and access to buildings.

Before taking any measures for the betterment of conditions, data regarding availability of parking space, extent of its usage and parking demand is essential. It is also required to estimate the parking fares also. Parking surveys are intended to provide all these information. Since the duration of parking varies with different vehicles, several statistics are used to access the parking need. The following parking statistics are normally important.

- Parking Accumulation:** It is defined as the number of vehicles parked at a given instant of time. Normally this is expressed by accumulation curve. Accumulation curve is the graph obtained by plotting the number of bays occupied with respect to time.
- Parking Volume:** Parking volume is the total number of vehicles parked at a given duration of time.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 3, March 2020

This does not account for repetition of vehicles. The actual volume of vehicles entered in the area is recorded.

- c) **Parking Load:** Parking load gives the area under the accumulation curve. It can also be obtained by simply multiplying the number of vehicles occupying the parking area at each time interval with the time interval. It is expressed as vehicle hours.
- d) **Average Parking Duration:** It is the ratio of total vehicle hours to the number of vehicles parked. Parking turnover: It is the ratio of number of vehicles parked in duration to the number of parking bays available. This can be expressed as number of vehicles per bay per time duration.
- e) **Parking Index:** Parking index is also called occupancy or efficiency. It is defined as the ratio of number of bays occupied in time duration to the total space available. It gives an aggregate measure of how effectively the parking space is utilized.
- f) **Parking Efficiency:** Parking efficiency is defined as the ratio of parking load to total number of bays in the considered interval of time.

Parking surveys are conducted to collect the above said parking statistics. Some common parking surveys conducted are passenger car unit, in-out survey and license plate method of survey.

- a) **PCU (Passenger Car Unit):** PCU is an interference value which is being used to change a vehicle into its equivalent passenger car unit. The equivalent PCUs of different vehicle categories does not remain same under different circumstances.
- b) **In-Out Survey:** In this survey, the occupancy count in the selected parking lot is taken at the beginning. Then the number of vehicles that enter the parking lot for a particular time interval is counted. The number of vehicles that leave the parking lot is also taken. The final occupancy in the parking lot is also taken. Here the labour required is very less. Only one person may be enough. But we won't get any data regarding the time duration for which a particular vehicle used that parking lot. Parking duration and turnover is not obtained. Hence we cannot estimate the parking fare from this survey. For quick survey purposes, a fixed period sampling can also be done. This is almost similar to in-out survey. All vehicles are counted at the beginning of the survey. Then after a fixed time interval that may vary between 15 minutes to "i" hour, the count is again taken. Here there are chances of missing the number of vehicles that were parked for a short duration.
- c) **License Plate Method:** This results is the most accurate and realistic data. In this case of survey, every parking stall is monitored at a continuous interval of 15 minutes or so and the license plate number is noted down. This will give the data regarding the duration for which a particular vehicle was using the parking bay. This will help in calculating the fare because fare is estimated based on the duration for which the vehicle was parked. If the time interval is shorter, then there are less chances of missing short-term parkers. But this method is very labour intensive.

All the data collected from various PCU data tables would be compared with each other to find out that whether the parking patterns are different to each other or not. Here "t-test" would be applied; the reason behind this is that samples are less in number so it cannot be undergone for any other test. First the value of degree of freedom (i.e. df) would be found. For finding out this 'df', number of sample ('n') would be observed so as to get the value of 'df'. After that the 't'-value (t-critical value) would be found and from t-table a certain confidence interval would be fixed and with the help of t-table the value of t-critical would be determined. If t-stat would be greater than t-critical then the parking pattern is different otherwise it would not be different.

$$t = \frac{(\sum D)/N}{\sqrt{\frac{\sum D^2 - \frac{(\sum D)^2}{N}}{(N-1)(N)}}$$

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 3, March 2020

Where, D: Differences, N: Number of observations

The objectives of this study are to observe the followings:

- a) To collect the data regarding the duration for which a particular vehicle will use a parking bay by using License Plate Survey methodology.
- b) Calculation of PCU values for different parking spaces in P.M.E.C. campus.
- c) Drawing of line plan of various available as well as parking space required in near future by using AutoCAD.
- d) Comparison of various parking areas by using t-test.

Paper is organized in the manner that section I describes general idea about present scenario and problems related to parking spaces, different types of parking and various terminologies associated with the calculation of different data. Section II deals with a review of previous work done in the field of parking by different scholars and research person from all over the world. Section III deals with empirical study, analysis of results and comparison and discussion on the results found. Finally, Conclusion and scope for future work in this field is summarised in section IV.

II. LITERATURE SURVEY

Young et al. (2010) in their study observed the spatial distribution of parking of Melbourne City. Parking policies and pricing impacts the entire city transportation and land use. Parking influences the spatial distribution of transport use in viability developments. Parking should be considered as at metro Politian level than to consider for a particular region.

Chakrabarty and Mazumdar (2010) in their research on behavioural characteristics of car parking demand observed the various behavioural characteristics of parking demand for various trips, location and with various urban areas.

Qin et al. (2010) in their research on parking demand of commercial buildings analysed the parking demand of shopping centre and markets from the data obtained by conducting parking demand survey at various locations of Beijing.

Warden et al. (2006) studied attitudes and behavioural responses of car drivers to plan parking measures at campus of the Eindhoven University of Technology which is placed at Netherland. This paper is based on the car drivers' opinion about restricting access to the campus area for cars of non-university car drivers through a barrier, proper identification and payment.

Morency and Trepainer (2008) studied the characterizing parking spaces using survey data and proposed empirical measures and methods regarding the use of parking spaces in a strategic urban area. According to their thesis parking spaces were classified on the basis of jurisdiction, location and rates. Using this data, statistics describe the use of the spaces and developed area. By taking advantages of above descriptions, parking accumulation, profiles are developed and summarised by key indicators.

Farzanmanesh et al. (2008) in their research described an ideal method for parking site selection by the use of GIS, fuzzy logic and weighting criteria to determine proper parking sites. Suitable place for parking is selected for one of the high traffic regions of Esfahan city in Iran. Population growth, sprawling of cities and increasing of vehicles result in heavy traffic and prolonged city trips. Utilizing public parking regarded as an effective approach to abate traffic load in city centres, in that spaces designated for vehicles parking along the roads would be freed, and consequently the usable space of the roads would increase, which in turn would contribute to the smooth flow of traffic.

In his research on transportation systems engineering, Mathew (2014) studied the parking spaces availability in urban areas like central business districts, major metro cities, etc.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 3, March 2020

In his research of t – test method, Singh (2014) compared the values of PCU for different parking areas to find out whether two different parking areas are similar in pattern or not.

III. EMPIRICAL STUDY

The data had been collected from different site within the campus area of Parala Maharaja Engineering College, Brahmapur, Odisha such as academic building – 1, canteen, boy’s hostel – 2, utility block and workshop – 1. These data had been collected from different sites at the time from 8:30 am to 3:00 pm for academic building – 1, canteen and workshop – 1 and from 8:30 am to 6:00 pm for boy’s hostel - 2 and utility block. From this survey, the information related to how many two wheeler vehicle has been parked at a specified parking place was recorded.

Table 1: Different Data for all sites

Observation Factors	Academic Building – 1	Canteen	Utility Block	Boy’s Hostel – 2	Workshop – 1
No. Of Bays	214	15	20	44	48
Parking Index (%)	8.86	51.13	95.25	35.06	39.98
Average Turnover	1.69	2.93	6.70	2.81	2.23
Parking Volume (No. of Vehicle)	362	44	134	124	107
Average Duration (minutes/vehicles)	150.79	39.21	41.98	164.76	129.11
Parking Capacity (vehicles hours)	1391.00	97.50	190.00	440.00	312.00
Parking Load	152.00	4.42	9.87	34.05	35.42
Efficiency (%)	71.00	29.40	49.35	77.30	73.79

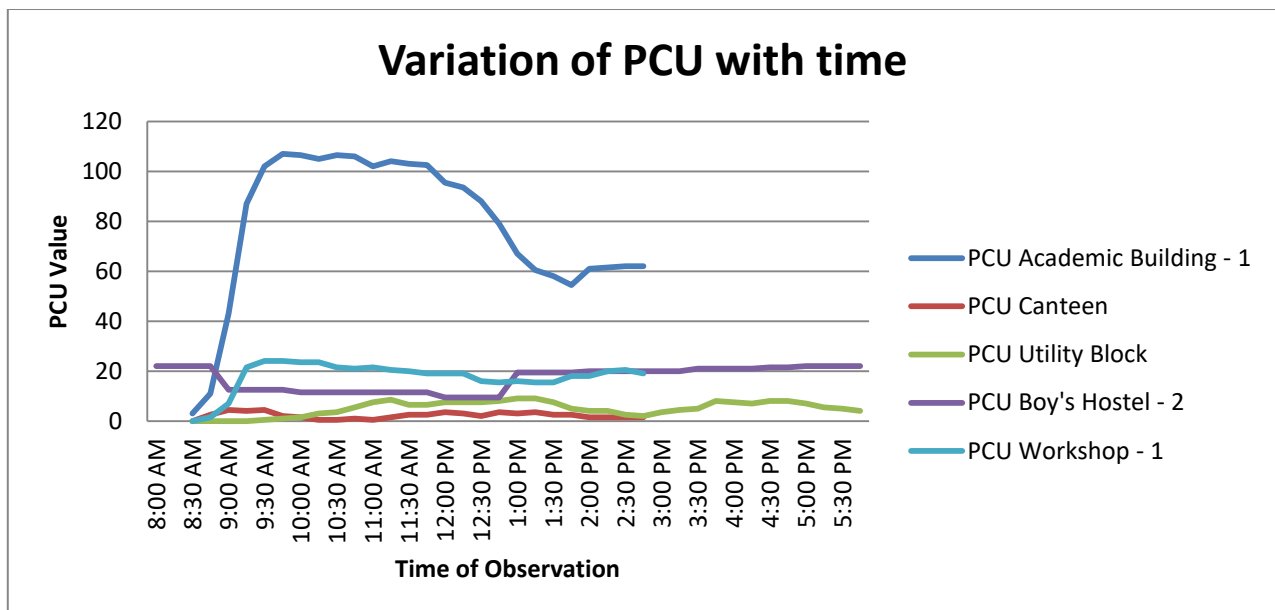


Fig. 2: Illustration of Variation of PCU with time for Different Sites

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 3, March 2020

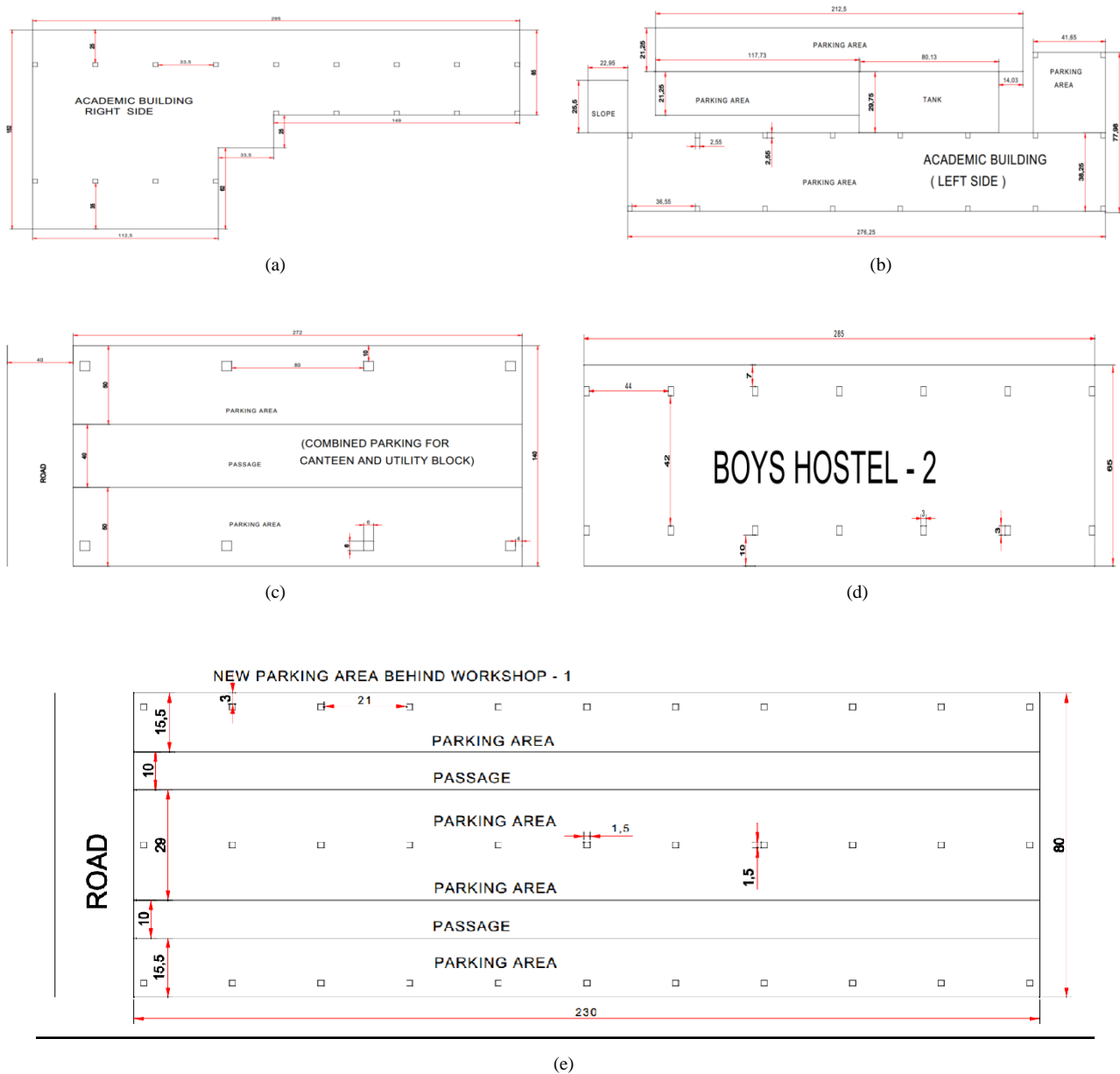


Fig. 3: Line Plan of Parking Area (a) Academic Building – 1 (right side)(scale – 1:10) (b) Academic Building - 1 (left Side)(scale – 1:8.5) (c) Combined for Canteen and Utility Block (scale – 1:20) (d) Boy’s Hostel – 2 (scale – 1:10) (e) Workshop – 1 (scale – 1:5)

All dimensions are in metres and all pillar size is 0.3m x 0.3m

All the above data collected from various PCU data tables have been compared with each other to find out that whether these parking patterns are different or not. Here “t-test” has been applied; the reason behind this is that samples are less in number so it cannot be undergone for any other test. First the value of degree of freedom (i.e. df) has been found. For

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 3, March 2020

finding out this ‘df’, number of sample (‘n’) has been observed so as to get the value of ‘df’. After that the ‘t’-value (t-critical value) has been found and from t-table a certain confidence interval has been fixed and with the help of t –table the value of t-critical has been determined. If t-stat would be greater than t-critical then the parking pattern is different otherwise it would not be different. Since there is no specified alpha value (probability of making the wrong decision when the null hypothesis is true) but generally, the alpha value ranges from 1 % to 10 %, so, let the alpha level for the observations be 5 % i.e. 0.05.

$$df = N - 1 \quad (N: \text{no. of observations})$$

$$df = 13 - 1 = 12$$

By using the alpha value and degree of freedom in the t-table for two tails, it is found that

$$t = 2.179 \text{ (critical value)}$$

Table 2: Comparison of Various PCU values by t - test

Sl. No.	Observation Sites	t - Critical	t - Stat	Type of Parking
1.	Academic Block – 1 & Boy’s Hostel – 2	2.179	6.408	Different
2.	Academic Block – 1 & Canteen	2.179	8.650	Different
3.	Academic Block – 1 & Utility Block	2.179	8.684	Different
4.	Academic Block – 1 & Workshop - 1	2.179	8.494	Different
5.	Boy’s Hostel – 2 & Canteen	2.179	8.631	Different
6.	Boy’s Hostel – 2 & Utility Block	2.179	5.741	Different
7.	Boy’s Hostel – 2 & Workshop – 1	2.179	0.892	Not Different
8.	Canteen & Utility Block	2.179	3.169	Different
9.	Canteen & Workshop – 1	2.179	7.923	Different
10.	Utility Block & Workshop – 1	2.179	7.330	Different

In case of comparison for mean, parking pattern of boy’s hostel - 2 and workshop - 1 has not been found different while others have been found to have different parking pattern.

IV. CONCLUSION

The main objective of this was to study whether the available parking spaces provided in PMEC campus is sufficient for the number of vehicles being parked inside the campus or not but after studying all the available parking spaces in the campus, it has been observed that the parking spaces are not sufficient for the number of vehicles being parked inside the campus. Also, the efficiency of each of existing parking space has been found above 70 %, so it is necessary to construct a new parking space behind workshop – 1. And, the individual efficiency of canteen and utility block is less than 50 %, so it has been concluded that a combined parking area would be sufficient for these areas.

The collected data had been converted into corresponding Passenger Car Unit (PCU) values and the graphs of variation of PCU value with time had been plotted. Considering the PCU values, the t – test for different parking spaces has been conducted to compare whether these parking areas pattern are similar to each other or not and it had been found that only the parking pattern of boy’s hostel – 2 and workshop – 1 are similar to each other while parking pattern of all other areas are different from each other.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 9, Issue 3, March 2020

REFERENCES

- [1] Chakrabarty and Mazumdar, "Behavioral Characteristics of Parking Demand", Institute of town planners, India journal 7-4, 2010.
- [2] Dr. S. K. Khanna and Dr. C. E. G. Justo, "Highway Engineering", Nem Chand & Bros, Roorkee, U. K., India, 1971.
- [3] Dr. Tom V. Mathew, "Transportation Systems Engineering", Chapter – 41 (Parking Studies), IIT, Bombay, February 19, 2014.
- [4] Farzanmanesh Naeeni and Abdullah, "Presentation on Ideal Method for Parking Site Selection", Department of environmental sciences, faculty of environmental studies, Malaysia, 2001.
- [5] <http://www.statisticshowto.com/probability-and-statistics/t-test/>
- [6] Indian Road Congress - 106, Guidelines for capacity of urban roads in plain areas.
- [7] Kumari Pratibha, "Different Parking Spaces and Its Comparison", Thesis for project, NIT, Rourkela, May, 2012.
- [8] L. R. Kadiyali, "Traffic Engineering and Transportation Planning", Khanna Publishers, New Delhi, 1987.
- [9] Morency and Trepainer, "Study of Empirical Measures & Methods", Interuniversity research centres on enterprise network logistics and transportation (CIRRELT), Canada, 1998.
- [10] National Programme on Technology Enhanced Learning (NPTEL), Chennai.
- [11] Peter Van Der Waerden, Aloys Borgers and Harry Timmermans, "Study on Attitude & Behavioural Responses of Car Drivers to Planned Parking Measures", Urban Planning Group, Eindhoven University of Technology Eindhoven The Netherlands, 2002.
- [12] Qin, Xiao and Gan Pan, "Study on Parking Demand of Shopping Centre & Markets", Beijing key laboratory of traffic engineering, Beijing University of technology, Beijing, China, 2001.
- [13] SP – 12 : 1973 (Tentative recommendations on the provision of parking spaces for urban areas)
- [14] Young, Beaton and Satgunarajah, "Spatial Distribution of Parking", Department of civil engineering, Monash University, Victoria, Australia, 2009.