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Parking Demand Forecast Model for Institutional Campus

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Abstract: *Parking of the vehicles has become the major issue in the present rapid urbanization. Adequate parking spaces at proper location are the biggest challenge for the civic administration. University campuses although generally has more spaces, is no exception to the problem of parking. Major concerns at most of the university campuses are overcrowding of vehicles at most preferred parking spaces. Students and staff hardly find proper spaces to park their vehicle near to the designated departments. Moreover, a habit of parking their vehicle in haphazard manner is making the situation within the campus make worst causing more inconvenience to the user. Many attributes contribute to this problem. Studies to determine adequate parking spaces at proper location within the campuses are undertaken elsewhere but no systematic study is reported for any Indian institutional campus. The present study attempts to identify the major attributes concern to the parking and develop a parking demand forecast model based on the data of field survey done on Indian institutional campus. The model developed would help to determine accurate parking demand so that adequate parking spaces can be planned at proper location.*

.***Keywords:*** *Parking, Parking demand Forecasting model, Institutional campus*

1. Introduction

Parking is an important part of urban traffic. Parking causes more and more problems which require a goal oriented and efficient parking policy. The parking problems threaten the quality of life. Big Universities/institutional campuses resemble small cities. The specific problem is the lack of convenient parking spots available in the campuses (Matthew Harang, 2009). The propensity to own private vehicles and the necessity for their use generated huge parking demand in cities and especially among the students and the effects can be visualized at any college campus. (Priyanka Kolhar, 2012) The vehicles of the students are almost park for most of the time in a day which implies that the peak demand is in the day time. Since the insufficient understanding about the importance of parking facilities and lack of corrective policy, the construction of campus parking facilities is slow and the proportion in total parking space is small.

Parking Demand at suitable locations within a college campus is one of the major influencing factors needed for proper and accurate management. The issue of campus parking is a nationwide problem. The real problem is not inadequate supply but inefficient management leading to overcrowding of the most desired parking space. Current parking planning practices are ineffective at solving parking problems. If the University is to construct more parking structures at the most convenient locations within a campus, it would be extremely costly. Hence, demand forecasting plays a very important role in such situation to the various demand points within a campus which will help in proper management. Parking demand varies with by the locations, time of the day, days of the week and on a quarterly or seasonal basis. Altering class times would alleviate the parking problems experienced at peak times. Thus, by knowing the parking demand at most sound and feasible locations in a campus would be very much helpful in proper management and services. Various parking demand forecast model developed for

the urban area considered it as an integrated system engineering issue and multi-index and multi-restriction problem and. (Zhengwu Wang et al. 2008; Xizhou Zhang et al. 2009; Cheng Tiexin et al. 2011). However no parking demand forecasting models is found especially for Indian university / institutional campus. The present study envisaged to develop model that will help to determine accurate parking demand in university / Institute campus which would help to plan adequate parking spaces to accommodate the parking demand.

2. Development of Model

2.1 Approach

The conceptual base for parking demand forecasting is to determine the peak time demand that fulfill design supply at various alternative locations. The key attributes influencing parking demand and formulating are identified. A well-designed questionnaire is prepared considering all these attributes to take respondent's opinion from the field about the significant parameters responsible for the parking issue. This questionnaire is divided in 5 parts. In the survey conducted, each individual's general information is taken in part A. In part B, travel pattern of the individuals is known. Information like distance of institute from their residence, trips to the institute, mode of travel, normal time of arrival and departure, average number of hours of parking and convenience of parking are obtained. In part C, parking characteristics are obtained by knowing the preferred parking place and lot occupancy time. In part D, options are given for enhancing the services offered near a parking lot in a campus, from which they are supposed to tick those they find important. Choices like cafeteria, paved surface with all basic amenities, landscaping, vehicle repairing centre and any other facility according to their opinion are asked. A Delphi technique is adopted to finally short list the most significant parameters. Data is also analyzed to determine the inter-relationship among the various factors. Based on the data, a model is developed for determining the parking demand considering the significant parameters identified. This is verified on the data obtained from the students of two institutions for the various probable parking locations in their campuses. This model is tested and the necessary alterations are made to suit finding the parking demand at various locations.

2.2 Parking Demand Forecasting Model

The parking demand is equal to the total parking quantities generated by these individual areas. The formula is,

$$y = \sum_{i=1}^{n} \alpha_i R_i \quad (i=1,2,\ldots n) \tag{1}$$

α_i refers to parking generation rates, which are the quantities of parking demand in per unit area;

R_i refers to the individual area m^2

The parking demand is affected by the number of students within the campus, the ownership of vehicles level, the campus teaching, utilization, condition of land affect the different vehicle attraction rate and bicycle parking facilities and utilization ratio, trip distance of departure from the destination, the distance between the destination and the vehicle parking facilities, the level of parking service (including parking safety, parking comfort, etc.) and many other factors. Considering these factors the Parking Generation Rate Model is thus improved by including constants for attraction rate, the number of trips during peak hours to attract, the bicycle parking facility cycling rate during the peak hours, the influence rate of travel distance, the utilization rate, the average turnover rate, parking place occupancy and service level to make it useful to get the demand number of the parking facilities in the campus teaching and office.

Thus the parking demand forecasting model institutional campus is

$$Q = \frac{\alpha X R}{\rho X \gamma} X \eta X \delta \tag{2}$$

Where,

Q is the vehicle parking demand in the rush hour

α is the attraction rate to a specific lot

R is the number of trips during peak hours to attract

ρ is the parking facility cycling rate during the peak hours

δ is the service facility factor

η is the influence rate of travel distance

Υ is the utilization rate

3. Case Study

The model developed is applied to study the parking demand at various locations within the 214 arces area campus of Visvesvaraya National Institute of Technology, Nagpur, India having around 3000 students. Five different alternatives for parking location are identified. 1) Main gate 2) Bajaj Nagar gate 3) Auditorium 4) Own Department 5) Other Department. A data is collected through a survey. On analyzing the data, the attraction rate is found that 31 percent of the students prefer to park in front of their own department, 19 percent of the students prefer to park near the main gate, 15 percent of the students prefer to park near the Bajaj Nagar gate, 10 percent of the students prefer to park near the Auditorium and 6 percent of the students prefer to park in front of other's departments. The different distribution of peak time of arrival and departure is observed from the survey to know the lot occupancy. The peak time of arrival is observed from 9:00 am to 11: 00 am. The percentage of arrival decreases up to 11:00 am in the morning. Similarly, the peak time of departure is observed from 5:00 pm to 6:00 pm. The user's departure time starts from 1:00 pm to 9:00 pm in the evening. Maximum numbers of students have two trips. The average number of trips of the students at the three different locations is shown below. Near main gate the average of daily number of trips is 2.31, at Bajaj Nagar gate the average of daily number of trips is 2.06 and near the auditorium the average of daily number of trips is found to be 2.3. The values of different constants estimated based on the data collected from survey is given in Table 1. The utilization rate Υ refers occupancy, which is parking time of each lot divided by the total time in a certain period of time which is inversely proportional to the demand. Table 2 provides the values utilization rate Υ determined analyzing survey data and using the following formula:

$$\Upsilon = \frac{\sum t_{ij}}{D_i T} \text{ (j = 1, 2…D)} \quad (3)$$

Other factors influencing are i) the service facility factor δ which is directly proportional to the demand at the specific parking lots and its value is 1.3. ii) η is the influence rate of travel distance, it is taken as 1.5.

The parking demand at each location is calculated using on the equation (2)Table 3 summaries the parking demand at each locations in VNIT Campus.

TABLE I: Constants For Attraction Rate, Number Of Trips And Turnover Rate Of Different Parking Locations At VNIT Campus

Parking locations	α **(parking/ 100 people)**	R	ρ
1. Main gate	0.19	240.50	0.350
2. Bajaj Nagar gate	0.15	214.93	0.357
3. Auditorium	0.10	239.20	0.149
4. Own Department	0.31	266.24	0.490
5. Other Department	0.06	224.64	0.192

TABLE II: Values of Utilization Rate at Different Parking Locations At VNIT Campus

Parking locations	t_{ij}	D_i	T	Υ
1. Main gate	342	5	480	0.1425
2. Bajaj Nagar gate	335	5	480	0.1397
3. Auditorium	402	5	480	0.1675
4. Own Department	366	5	480	0.1527
5. Other Department	360	5	480	0.1500

TABLE III: Parking Demand at Different Parking Locations At VNIT Campus

Parking locations	Parking Demand
1. Main gate	1394
2. Bajaj Nagar gate	966
3. Auditorium	1430
4. Own Department	1646
5. Other Department	701

4. Conclusion

The parking demand forecast is key for planning parking facilities within the campus. The classical parking rate generation model has its own limitation. Estimating parking demand is value exercise rather than technical exercise. The proposed parking demand forecasting model incorporates more influencing factors viz. attraction rate, travel characteristics, service facilities, turnover rate and utilization rate that changes demand. Thus, the proposed model can be useful for accurate measurement of parking demand and would help all the planners and administration to take appropriate decision on providing proper parking facilities in Institutional campus.

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6. References

[1] Matthew Harang, " Georgia Institute of Technology Campus Parking Policies" 2009, pp 1-5.

[2] Priyanka Kolhar, "Off street parking management plan for Dharwad city Karnataka India", *Journal of Engineering Research & Studies*, vol 3, pp 67-71, 2012.

[3] Cheng Tiexin , Tai Miaomiao ,Ma Ze " The model of parking demand forecast for the urban CCD" *in Proc. International conference on Furture Energy and Materials, 2011.*

[4] Zheng wu Wang, Zhenxia Tan, and Hui XU, "Location model and algorithm for public parking facilities" *in Proc International Conference on Computation Technology and Automation, 2008, pp 598-602*

[5] Xizhou Zhang, Ying Wen, Jun Liu, Dan Wan ." Layout planning study for off road park facilities based on complex system theory", *in Proc International conference of Information Management and Industrial Engineering, 2009, pp 271-275*
http://dx.doi.org/10.1109/ICIII.2009.374