

# Review of Parking Demand Models

<sup>1</sup>Hemangi P. Vanol, <sup>2</sup>Vijay J. Chitaria

<sup>1</sup>P.G. Student, <sup>2</sup>Associate Professor

<sup>1</sup>Civil Engineering Department,

<sup>1</sup>L.D. College of Engineering, Ahmedabad, India.

**Abstract:** Urbanization has its advantages as well as drawbacks and the effect of the late can result in diverse losses if not attempted in time. One of the most important aspects of Transportation is lack of Parking policy now a days. The parking issue is trending all around the world especially in central business district (CBD). Parking is an issue at forefront of transportation planning in the core of any urban area. Ahmedabad is one of the largest cities in India which is also affected by the parking problems. Insufficient Off-street parking facilities and tendency to park the vehicle near destination lead to high parking demand. These factors result in reduction of the main carriageway width, decrease in flow speed, increase in vehicular delay and creates unnecessary congestion to traffic flow which creates cruising of parking. Proper Parking management policy should be implemented to control the parking demand. The vehicle ownership and poor quality of transit system are also reasons for increase in demand. This is a literature review-based paper that aims at studying various researches already done in the field and drawing conclusions thereon.

**Index Terms-** Parking, Parking Demand, Parking Supply, Demand Model, Off/On street Parking.

## I. INTRODUCTION

Each medium of transportation involves three necessary elements, without which it cannot operate effectively: the vehicle, the right of way, and the terminal. For water transportation, these essential consists of the vessels, waterways, and port facilities; for railroad transportation, trains, tracks, and stations; for air transport, planes, airways and airports. Similarly, the elements of motor transportation are vehicle, the road, and a place to park at the end of trip. Increased urbanization gives rise to problem of congestion. As cities are growing, it will be important to plan and build new facilities for both public and private transport.

Terminal facilities are an integral part of any transportation system, and road transportation system. Traffic is not usually generated for the sake of the movement. It travels towards a destination and having arrived there, the vehicle must be parked while some business, whether private, public, recreational, or servicing, is transacted. Failure to supply suitable terminal facilities for the expected and allowable demand results in congestion and frustration. This eventually leads to most desirable for the day to day business of a city and inhabitants, unless alternatives and adequate travel facilities are provided. Generally, increases in vehicle ownership result in increased parking demand. In the India and other country developing & developed countries the increase in demand are posing a major problem, for which ready solution are not available. Without knowledge of the demand, solution cannot be proposed.

There is strong relationship between parking facilities and traffic flow characteristics in the city. Unplanned urbanization and transport facilities cause inadequate parking facilities. Inadequate parking facilities result in decrease of road capacity and many negative side effects such as air, and noise pollution. Beside these, it may also cause economic consequences by the losing time and fuel, loss of the productivity, high energy consumption, and increase in accidental death rates. Thus, all parking facilities as well as other should be designed and planned properly in order to provide a better life for the people and for the prosperity of the city. Due to rapid growth in population, increase in mobility of households, supermarket, new shopping and commercial centers have been built up as a result of the traffic flow rate has begun. With families getting smaller and the total number of motor vehicles exceeding the total number of heads per family, the parking scenario is woefully falling short of the current requirements in the country.

The situation is such that on any given working day approximately 40% of the roads in urban India are taken up for just parking the cars. The problem has been further exacerbated by the fact that nowadays even people from low income group are able to own cars. The number of families with cars has become much more than what the country is able to manage. Although shopping centers have their own parking facility, people tend to park on the street and go to underground parking only when no space is available on the street.

It is interesting to know that the number of hours a private vehicle remains parked. The vehicle moves for 5% of the times and 95% time it is parked. In many cases, due to inadequate parking we see cars parked outside offices blocking the access to the building itself. A survey was carried out in India and it is roughly estimated, that in a year in which 8760 hours the car runs for an average for only 400 hours leaving 8360 hours when it is parked. The concentration of human activities is increased on limited land, both in terms of commercial activity and residential activity causes the parking problem. Every vehicle owner would wish to park the vehicle as closely as possible to his destination so as to reduce his/her walking distance. The result is great demand for parking space in central business district and activities concentrated areas.

As it is, the cities in India are highly congested and on top of that the parked cars allege a lot of space that could otherwise be used in a better way. The abomination of the crisis like issue of pollution to this mix can be understand by increase in fuel consumption. In the Indian cities, with the possible exception of Chandigarh, were never planned in such a way so as to accommodate an overrun of cars as is the situation now. The enthusiasm of present-day urban planners has only made the situation worse. It took India 60 years to have 100 million vehicles, then just another 10 years to add 100 million more. There is no end to this vehicular demand, driven by rising incomes and aspirations of owning a vehicle as a status symbol. Vehicular population is growing at double the rate as of human population in cities such as Bengaluru, Ahmedabad and Pune, with Hyderabad, Chennai, Jaipur not too far behind.

A number of researches have been done in this field. The study of Parking demand has been carried out by various researchers covering number of parking problems across the world. Some of the works have been discussed in the following section.

## II. LITERATURE REVIEW

**Yong Xue, Changqiao Shao, Yilin Chen (2017)**<sup>[1]</sup> proposed a parking demand forecasting method based on scenario analysis. By analyzing the situation of parking demand that may arise in the future, three scenarios were set up to analyze the influence factors of the parking demand. The data were processed and analyzed by SPSS software, the prediction model of parking demand, and the parameters in the model were determined. Finally, the developed models were used to predict the parking demand of Beijing City in 2020.

**Hyeonsup Lim, Grant T. Williams, Dua Abdelqader (2016)**<sup>[5]</sup> studied an alternative method by utilizing an assignment model with a generalized cost approach. This enables more detailed information of forecasting parking volumes and assessing parking accessibility with consideration of shared parking and time-of-day distribution of parking demand. A case study was conducted in downtown Knoxville, Tennessee providing a sensitivity analysis for investigating the effects of parameters in the model. The sensitivity analysis includes parking generation rates, walking speed, and cruising time. Additionally, the results of three alternative scenarios are provided to show the advantages of this model to examine the impact of parking facility development on adjacent facilities. Manual adjustments and surveys may be required to apply this model for other cities, but it would provide more useful information for their (policymakers, developers, and planners) decision making.

**Shejun Denga, Xiaofei Ye (2016)**<sup>[6]</sup> he took the parking vehicle out of the off-street parking access in the city as the research object, analyzes the main influence factors of the vehicle in the process of entering in the parking lot, and the crossing time is defined as the cross through the waiting time and travel time. By the way of theoretical analysis and field investigation, he presents one calculation model through the waiting time while another through the travel time, and verify the analysis. Based on the measured data about parking entering rate, and conducted a sensitivity analysis the combination conditions of different non-motorized vehicle lane width and flow. According to analysis and practical data, this paper set up a model of outside parking crossing time influenced by non-motor vehicles traffic flow. They also have done sensitivity analysis on this model based on the practical parameter data of project.

**Nafiseh Hosseini, Ali Khoshgard (2016)**<sup>[2]</sup> proposed an innovative method to predict the spatial distribution of parking demand and then it is applied to the central area of Tehran. Based on the proposed method of present research, for estimating the spatial distribution of parking demand it is required to estimate the number of vehicles with the destination of each area, which will not necessarily stop in that area. Therefore, the estimation of parking demand for each area is firstly initiated with the assumption that all the vehicles getting into a destination area are parked in the same area and sufficient parking space is also provided there. In this study, the number of vehicles getting into a traffic area at different hours and depending on the trip purpose is obtained from the results of the modeling of Tehran transport system utilizing emme2 software. Emme2 is a complete travel demand modelling system for urban, regional and national transportation forecasting. Emme2 offers a transport modeling application framework for leading computational performance and unmatched technical rigor, and makes assembling model workflows efficient. In present study, a method was proposed in which the study area is divided into some areas known as parking area. The formation of these areas was made in such a way that the parking location in each area is in the first priority for the vehicles with the final destination of that area, and parking in the surrounding areas, except in certain cases, is not desirable. Therefore, the proposed method can be promisingly utilized in the field of parking planning. Other advantages of the proposed method include the possibility of considering the effects of transportation policies such as developing the public transportation system, imposing restrictions on personal vehicles such as the extending the traffic limitation zones, the movement of land uses, etc. Therefore, the parking areas benefit from a dynamic nature and it is possible to form different parking areas based on the transportation policies.

**Mr. Debasish Das, Prof. Mokaddes Ali Ahmed, Mr. Saptarshi Sen (2016)**<sup>[3]</sup> found out important parameters on on-street parking, generated a parking demand estimation model and to carry out sensitivity analysis to obtain most sensitive parameter(s) for demand estimation. The data are collected from field survey. Four CBDs of Kolkata, viz. Camac Street, Dalhousie, Gariahat and Park Street have been selected as case study areas in this study. The estimated demand is found to be much higher than the present supply. The forecasted demand is also estimated. Statistical software like SPSS is used for analysis. Sensitivity analysis is carried out to determine the significance of the parameters and its impact on parking demand. Three parameters viz, and are considered as the controlling parameters and then sensitivity analysis is carried out to find out most significant parameter or

controlling parameter for a particular study area. The values of these three parameters are changed at the rate of 10 percent and maximum up to 50 percent. The value of one parameter is changed at a time, keeping other two constant and the demand is estimated. One parking demand estimation model is generated by incorporating all most all-important parameters. It is observed that the demand is much higher than the existing supply. So, sensitivity analysis is carried out among three selective parameters to rank them based on their significance. It is observed that is the most sensitive parameter for all four locations. The existing parking fee is increased to reduce the parking FI. According to the graphs, the parking demand is higher in office area than shopping. As Camac Street comprises of office and shopping complexes, the demand obtained is maximum. The present and the future gap between the demand and the supply obtained from this study, can be effectively used by the policy maker for solving the parking problems.

**Saptarshi Sen (2016)** <sup>[8]</sup> developed a parking demand model is to estimate the parking demand. Parameters like age, vehicle ownership, parking duration, annual family income, distance between origin and destination are incorporated to generate the demand model. Further the estimated demand is compared with the existing supply. The parking demand model is obtained by analyzing the data collected from various types of surveys. Parameters like average number of 4-wheelers owned, average duration of parking (in hours) and probability of preferring car over transit as the mode of transport were incorporated in this study. A general form of the regression equation (by incorporating the above-mentioned parameters) is shown below:

$$Y = a_0 \times a_1 x_1 \times a_2 x_2 \times a_3 x_3$$

Where,

Y = Parking demand

x1 = Average number of 4-wheelers owned

x2 = Average duration of parking (in hours)

x3 = Mode choice

The in-out survey was conducted at Gariahat from 12 noon to 9pm on a weekend and at Dalhousie it was conducted in a weekday from 9am to 7pm to determine the peak parking accumulation. The counting was done manually to complete the survey. Questionnaire survey was also conducted at both the survey locations. A minimum number of questions were set to get maximum information. The survey was done over 100 respondents for each location. The extracted data is used to develop the parking demand equation of the two locations using linear regression analysis in SPSS. A parking demand model is generated by the use of SPSS in this study for the two locations, viz. Gariahat and Dalhousie. Using this demand model, the parking demand is estimated and is compared with the existing parking supply. The methodology used in this study can also be used for assessing parking demand for other similar type of CBDs.

**Sylvain Belloche (2015)** <sup>[7]</sup> The focus of this paper is on modelling on-street parking search time. The modelling starts from Axhausen's proposal for off-street parking, but specificities of on-street parking allow for taking into account several models to estimate on-street parking search time. These models are then confronted to a survey done in several districts of Lyon. The results of this confrontation give interesting conclusions about on-street parking search time modelling, validation and further research needs in order to improve the model robustness. On-street parking in different districts may follow different laws, the analysis has then been done on different samples of average measures. A multiple correspondence analysis and a hierarchical ascendant classification have first been used to determine samples, but with poor results. Hence, samples have been elaborated depending on the district parking characteristics and of the time of the measure.

**Xiaolong Ma, Xiaoduan Sun, Yulong He, Yixin Chen (2013)** <sup>[4]</sup> Using six parking facilities in Beijing Lama Temple as an example and this paper investigates the parking behavior at the tourist site. Based on the data collected at these six parking facilities through a stated-preference survey, a multinomial logit model was developed, which reveals the relationship between parking decision and influential factors. parking charge rate and capacity, and another is the parking duration and number of parking turnovers for individual parking space. The performance data were collected on a typical weekday (Thursday) during the peak tourist season. There are 604 spaces in all and all the parking spaces were observed from 8:00 a.m. to 20:00 p.m. parking space. The models reveal an important location effect, in such that the results of the analysis vary substantially across the three locations. Drivers are most sensitive to walk time and not very sensitive to the price. The results of this study suggest using parking charge as leverage to balance the parking facilities utilization. For instance, lowering the price at remote parking facility to such a level that its parking utilization will be the same as one close all destinations.

### III. CONCLUSION

Different aspects of Parking demand in various land use have been studied. Some have calculated the parking demand forecast for the future aspect and some have found out current parking demand-supply ratio and applied relatable parking fees in the study. Some focus on the effect of on street parking in traffic congestion whereas some focus on choice of parking facilities based on destination place.

The questionnaire survey, In-out survey are found to be most effective for the data collection. The other method used for the data collection is license plate method. The various factors considered for the data collection are origin and destination of trip, travel length, vehicle ownership, age of vehicle owner, family income, off-street parking facilities available at destination, parking fees, For the analysis purpose, various software like SPSS for data attraction, Manual Count Made Easy (MCME), VISSIM, etc. are used.

A multinomial logit (MNL) model, regression analysis, sensitivity analysis is used which helps to achieve objective of the study. Any of these models can be effectively used to study the parking demand models.

These models can be used to predict future demand and pricing substitutes based on changes in land use and additions or subtractions of parking supply. It is also possible to add or subtract or change any land use in the input data to show changes throughout the city in demand. This could be crucial in planning the layout of the city, urban renewal, and estimating the flow of parking demand in and around the city. The model also prepares transportation planners and decision-makers to fully utilize future technological deployments and its relation to data availability. Necessary action needs to be taken in introducing and improving public transit sectors and the users also needed to shift to transit from private cars. The present and the future gap between the demand and the supply obtained using the various models, can be effectively used by the policy maker for solving the parking problem.

#### IV. REFERENCES

- [1] Yong Xue, Changqiao Shao, Yilin Chen (2017). Study on Application for Parking Demand Prediction with Scenario Analysis”.
- [2] Nafiseh Hosseini, Ali Khoshgard (2016). An Innovative Method for Estimating the Spatial Distribution of Parking Demand in Different Areas. Civil Engineering Journal.
- [3] Mr. Debasish Das, Prof. Mokaddes Ali Ahmed, Mr. Saptarshi Sen (2016). Controlling on-street parking demand using sensitivity analysis: A case study at Kolkata. Journal of Transportation Systems. 17th COTA International Conference of Transportation Professionals. American Society of Civil Engineers.
- [4] Xiaolong Ma, Xiaoduan Sun, Yulong He, Yixin Chen (2013). Parking choice behaviour investigation: A case study at Beijing Lama Temple. 13<sup>th</sup> COTA International Conference of Transportation Professionals. Published by Elsevier.
- [5] Hyeonsup Lim, Grant T. Williams, Dua Abdelqader (2016). Alternative Approach for Forecasting Parking Volumes. Transport Research - WCTR 2016. Elsevier.
- [6] Shejun Denga, Xiaofei Ye (2016). A Model to Research Off-street Parking Across the Travel Time Based on the Impact of Non-motorized Traffic and Other Factors. 6<sup>th</sup> International Conference on Green Intelligent Transportation System and Safety (GITSS 2015), Elsevier.
- [7] Sylvain Belloche (2015). On-street parking search time modelling and validation with survey-based data. 4th International Symposium of Transport Simulation-ISTS'14. Published by Elsevier.
- [8] Saptarshi Sen (2016). A Case Study on On-Street Parking Demand Estimation for 4-Wheelers in Urban CBD. Journal of Basic and Applied Engineering Research.