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Modelling parking for public health and education institutions in Srinagar City

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ABSTRACT

Parking is mostly seen in a strategic point of view in terms of demand and supply and not much effort has been made in the developing world to forge the relationship between parking demand with the factors affecting the demand for educational institutions. The focus of this work is on modeling off-street parking at educational institutes based on user's behavior. This work is an effort to determine the distinguishing factors affecting parking. In this study two types of multiple linear regression models using SPSS software were developed. Disaggregate model and aggregate model. The demand for this model is expressed in terms of parking usage per person per day in hours at educational institutions in Srinagar city. The disaggregate model analysis revealed that the most influencing independent variables for this model are travel distance and income per month for employees and visitors with the coefficient of variation (R) = 0.96 and coefficient of determination (R^2) = 0.92 and family income and travel distance for students with the coefficient of variation (R)= 0.98 and coefficient of determination (R^2)=0.96. Aggregate model study determines the most suitable independent variable for estimating the parking demand (vehicle hours) or parking supply (space hours) at educational institutions. The formula emulated can be used to establish the number of parking bays to be provided to accommodate the parking needs at educational institutions. The aggregate model analysis predicts that most fitting independent variable for determining the parking demand formula is the number of employees working at the institution with the coefficient of variation(R)=0.997 and coefficient of determination (R^2) = 0.993. The most suitable model is that for which the coefficient of variation(R) and coefficient of determination (R^2) is nearly equal to one. Goodness of fit test or significance test and validation test has been conducted on the developed equations and can be used with a high level of confidence.

Keywords: *Parking, city, institutes, disaggregate, aggregate model.*

1. INTRODUCTION

The unsustainable increase of private vehicles as a means of transport in urban areas has led to severe congestion and pollution. Valuable time and resources are wasted by urbanities in trying to cope with this stressful situation. A shift from private vehicles to public transport may be one of the solutions to this problem. Parking is one of the major problems that is created by the increasing role of individual modes in road traffic. Not only do vehicles require street space for movement but also require space to park where occupants can be loaded and unloaded. It is roughly estimated that out of 8760 hours in a year the car runs only for 400 hours, leaving 8360 hours when it is parked (j.barerly). The availability of less space in urban areas has increased the demand for parking space especially in areas like Central business district, near educational institutes, hospitals and other public places. Every car owner wishes to park his car as closely as possible to his destination so as to minimize his walking. This results in greater demand for parking space in CBD and other areas where the activities are concentrated. With the growing population of motor vehicles, the problem of parking has assumed serious proportions. 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 this information. Srinagar city is on the threshold of being declared a metropolitan area with an estimated population of 1.8 million in 2015. As a sequel to National Urban Transport Policy, Srinagar should have its own Urban Transport Policy in the form of a set of coherent and comprehensive set of guidelines. A paradigm shift is needed in transport operations from accommodating the ever-increasing number of private vehicles through additional road infrastructure to placing more emphasis on urban transport, low-cost public transport, and in addressing safety and environment issues. In dense urban context, cars are the most inefficient system of transport, creating traffic jams and needing more parking spaces. On conducting a detailed check at the local authority, it was found that there is no specific parking demand model that has been developed for estimating the number of parking space to be provided for different parking generating activities in the Srinagar city. No specific studies have been carried out to project the parking demand of educational institutions. Most of the parking spaces allocated are based on free land available at these institutions. Hence, it is necessary to obtain a balance of parking supply and demand. Therefore, it is important to develop a parking demand model so that the parking demand is calculated based on various independent variables.

1.1 Parking Supply and Parking Demand

Parking supply is the number of parking spaces provided. Small city can provide predominantly off-street parking meanwhile large city and central business district can be predominated by parking lots or parking garage. Parking demand is depending on trip generation, trip purpose and land use and socio-economic characteristics of users (John, 1992). Parking demands are not generated by the building space itself but it is generating by the number of residents in the area and its mode of transportation. Thus, there may be instances where an educational institution, because of its location (either at urban area, suburban area, or rural area etc.), would have higher or lower parking requirements than indicated by the recommended standard, where such conditions are not likely to change with time, modification of the standard is in order. In such circumstances a specialized study needs to be undertaken to establish these parking requirements.

1.2 Parking Demand Studies

Parking studies include feasibility, functional design, financial structural design and demand studies. There are three types of parking demand studies

1.2.1 Comprehensive studies: it covers an entire area such as central business district (CBD). Usually these surveys are employed to assess the demand for parking, also the need and preferred locations for parking. Careful sampling design and analysis are necessary to compensate for the natural bias towards oversampling short-term parkers. In comprehensive studies the future parking demand is estimated with the use of forecasting models, which include population growth, demographic, social and economic trends, as well as trends of the local economy and use of transportation models. Analytical and comprehensive details of on and off-street parking are gathered along with detailed information on utilization patterns. From these, current deficiencies of the parking supply are identified (I.e. lack of supply, interference with traffic circulation). Then proposed scenarios for alleviating current deficiencies and fulfilling anticipated demands are developed and evaluated for judgment by officials and/or private interests. The development and evaluation of scenarios or alternatives analysis is conducted with a number of criteria, such as:

- Encouragement or discouragement of private auto mobile use.
- Identification of primary recipients of service and ways to screen out non primary parkers.
- Derivation of pricing schedule
- Issues regarding access distance (convenience and safety for walking)
- Satisfaction of municipal and private perspectives
- Zoning requirements
- Budget and future costs/in come flows.

1.2.2 Limited studies: it is similar to comprehensive studies but with reduced geographic scope and fewer requirements. Typically, in limited studies only one type of parking may be investigated (i.e. kerb side parking) while the estimation of future may not be required.

1.2.3 Site specific studies: They are geographically narrow but analytically extensive. Focus sites may include; existing, planned or expanding hospitals, campuses, shopping malls, residential, offices and industrial developments. Detailed inventories of existing supply and utilization are taken and future demands are forecast. In addition, attention is paid in regard to various types of users of parking supply: people who do business or work at the site (primary recipients of parking service) and people who park at the site and go elsewhere. Information on user's access mode, the mixo fuses in regard to their parking occupancy (i.e. in hospitals), visitors stay for few hours, doctors and nurses may stay in excess of 16hours and other staff stays 8 to 9 hours) are often measured. Change of shifts and the overlapping parking utilization patterns of land uses such as industrial parks are of critical importance due to concerns in parking availability and turnover, internal circulation, and potential congestion at access points.

1.3 Research Questions

Why modeling parking demand?

IRC has given parking space standards based on land use but as predicted by researchers parking demand is dependent on trip generation, trip purpose and land use and socio- economic characteristics of users. Therefore, Parking demands are not generated by the building space itself but it is generating by the number of residents in the area and their mode of transportation and their behavior. There may be instances where an educational institution, because of its location (either at urban area, suburban area, or rural area etc.), would have higher or lower parking requirements than indicated by the recommended standard.

1.4 Research Objectives

- To study the parking characteristics at higher educational institutions and to assess whether the demand is met with;
- To identify the problems of traffic and parking;
- To analyze the present parking scenario in Srinagar city;
- To determine the most suitable independent variables affecting parking demand and to develop a parking demand model.

1.5 Research Scope

The parking demand model developed can be used to estimates parking needs at educational institutions for planning of parking spaces, and to give ideas for developing parking demand models for other parking generating activities.

2. RELATED WORK

2.1 General Studies

2.1.1 Definitions of parking terms

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 as shown below.

$$\text{parking index} = \frac{\text{parking load}}{\text{parking capacity}} \times 100$$

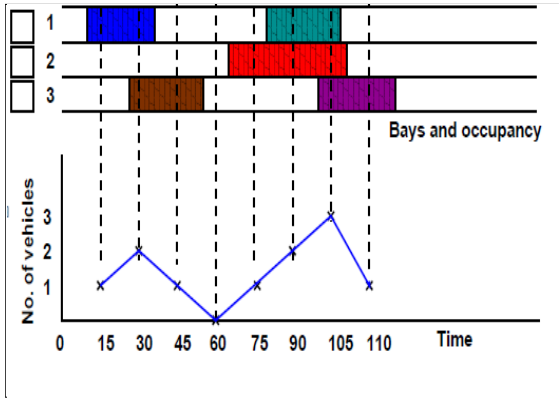

Fig. 1: Accumulation curve

Parking volume: Parking volume is the total number of vehicles parked at a given duration of time. This does not account for repetition of vehicles. The actual volume of vehicles entered in the area is recorded.

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.

Average parking duration: It is the ratio of total vehicle hours to the number of vehicles parked.

Parking duration =parking load/parking volume

Parking turnover: It is the ratio of number of vehicles parked in duration to the number of parking bays available.

Parking turnover = parking volume/ No. of bays available

This can be expressed as number of vehicles per bay per time duration.

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. Parking index can be found out as follows

$$\text{parking index} = \frac{\text{parking load}}{\text{parking capacity}} \times 100$$

2.1.2 Parking Survey

General, Parking surveys are prerequisite for developing new or expand parking programs. The studies should be designed to asses:

- Inventory of existing parking space supply and measure current levels of space usage (accumulation and space turnover).
- Identify salient parking characteristics (duration, purpose, trip destination and walking distances to destination).
- Quantify demands and needs.
- Estimate capital investment and operating costs, usage and revenues.

Cost and revenue estimates can then be compared to assess the financial feasibility of an overall parking improvement program. The feasibility study should determine:

- How many spaces are needed under present conditions?
- How many spaces will be needed under future conditions?
- Where should the additional spaces be located?
- What type of patrons will they serve (short or long term) and what are their characteristics?
- What parking rates are realistic?

Steps of parking studies

a) *Inventory of existing parking facilities*

- Detailed listing of the location and all other relevant characteristics of each legal parking facility, private and public.
- The study area includes both on- and off-street facilities.
- Type and number of parking spaces at each parking facility.
- Times of operation and limit on duration of parking, if any.
- Type of ownership (private or public)
- Parking fees, method of collection
- Restrictions
- Other restrictions, loading and unloading zones, bus stops, tax i ranks.
- Permanency
- The inventory should be updated at regular intervals of about four to five years

a) Collection of data on parking accumulation, parking turnover, and parking duration

❖ *Accumulation:*

- By checking the amount of parking during regular intervals on different days of the week.
- Carried out on an hourly or 2-hourbasis.
- used to determine hourly variations of parking and peak periods of parking demand

❖ *Turnover and Duration:*

- Collecting data on a sample of parking spaces in a given block.
- Recording the license plate of the vehicle parked on each parking space in the sample at the ends of fixed intervals during the study period.
- The length of the fixed intervals depends on the maximum permissible duration
- For example, if the maximum permissible duration of parking at a kerb face is 1 hour, a suitable interval is every 20minutes.
- If the permissible duration is 2 hours, checking every 30 minutes would be appropriate. Turnover is then obtained from the equation.
- Manual collection of parking data is still commonly used,
- Possible for all parking data to be collected electronically.
- Wirelesss sensors

$$T = \frac{\text{number of different vehicles parked}}{\text{number of parking spaces}}$$

2.2 Paper Review

THE DEVELOPMENT OF MODEL ESTIMATION TO DETERMINE PARKING NEEDS AT

LRT STATIONS IN SUBURBAN AREA Choy Peng NG and Dadang Mohamad MA'SOME (University Putra Malaysia 43400 Serdang Selangor 43400 Serdang Selangor Malaysia Malaysia) determined the most suitable independent variable for estimating the parking demand formula for suburban LRT station. The parking study involved existing site surveys, which provided the actual on-site demand apart from highlighting the highest existing parking volumes on selected LRT stations. In this research, the daily average passengers have high degree of association with parking supply. The developed models whereas:

$$y = 0.04x_1$$

or

$$y = 0.034x_1 + 125x_3$$

Where y = Parking supply/demand, X_1= Average daily passenger, X_3= Parking charges. The first model is much prefer, as it is well to define the parking needs at suburban LRT station. The second model could also be used but it is not so economical compare to the first model. If a new LRT station will be located at suburban area and parking facilities will be provided, the above formula could be one of the guides to estimate number of parking space to be provided. The number of daily passengers is affected by number of population or density in 5 km distance around the LRT station.

An analysis of the spatial distribution of parkingsupply

Policy and demand: Young, Beaton, Satgunarajah (department of civil engineering, Monash university, Victoria, Australia,2010) studied the spatial distribution of parking of Melbourne City. Parking facility is one of the important transport facilities in urban area specially the central districts having high retail activity and employment opportunities. Parking policies and pricing impacts the entire city

transportation and land use. Transport planner and Land use planner look for parking places differently. Spatial integration of parking, land use and transport facility are ignored. Parking influences the spatial distribution of transport use and viability of development. Parking should be considered as at metropolitan level than to consider for a particular region.

Analysis On Parking Demand Of The Commercial Buildings Considering The Public Transport Accessibility: Qin, Xiao, Gan, Pan (nature and science. 2010; 8(3): 63-68), [ISSN: 1545-0740] analyzed the parking demand of shopping centre and markets from the data obtained by conducting parking demand survey at various locations of Bejing. Relationship between parking demand and transport accessibility was analyzed. Parking demand decreases with good and efficient transport facility. Parking demand rate with different public transport accessibility was determined and a parking demand model with different accessibility was provided.

ATTITUDES AND BEHAVIORAL RESPONSES TO PARKING MEASURES: Warden, Borgers, TImmermans (Urban planning group, Eindhoven university of technology, March 2006) studied attitude and behavioral responses of car drivers to planned parking measures at campus of the Eindhoven University of Technology, the Netherlands. In an on-street questionnaire, car drivers were asked their opinion about restricting access to the campus area for cars of non-university car drivers through (i) a barrier, (ii) proper identification when entering the campus area, and (iii) payment. The response of more than 700 car drivers was used in multinomial logit analysis. Most drivers wanted to continue into the University campus by car. Half of the car driver responded they would change their mode of transport or park car outside the campus if they have to pay parking fee.

Study Influence Of Parking In The WaysOn Road Capacity Around School Based On Flocking Theory

Zhen Yu Wanga, Wei Li Zhanga, Lei Wanga, Jin Xin Caoa, (Institute of Transportation, Inner Mongolia University, Hohhot, 010070, China) studied the influence of on street parking on road capacity in front various schools in china. This paper has analyzed the data, studied the time distribution of parking and fitted it by Poisson distribution and tested the degree of fitting well, and then established a model of velocity-capacity. The developed model is:

$$C_B = \frac{3600v}{L(v)}$$

where $L(v) = -0.2632v^2 + 3.0944v + 3.5342$

The goodness of fit of the model has been tested and the effectiveness has been proved by relative data.

3. THE PROPOSED METHOD

3.1 Proposed Methodology

The methodology adopted is summarized in given figure 2.

4. CONCLUSION

This study of parking demand analysis in Srinagar city is first time carried out in Srinagar city based on scientific methods using modern sophisticated software SPSS. This study was carried out in limited time and utilizing limited resources. This study concludes that: -

- The disaggregate model developed determines the independent parameters influencing parking demand, where parking demand is expressed in terms of parking usage.
- For employees and visitors, the travel distance and income are the influencing parameters effecting parking demand. The final model evaluated areas;
- Parkingusage=0.38 (traveled distance) Or
- Parking usage=0.23(traveled distance) +0.43(income per month in lac)
- For students the travel distance and family income are the influencing parameters affecting parking demand. The model developed areas;
- Parking usage=0.58(traveled distance) or
- Parking usage=0.36(travelled distance) +0.66(family income per month in lac)
- The aggregate model developed determines the independent variables influencing parking demand. The parking demand is expressed in the units of vehicle hours. The number of employees working in the institution has highest degree of association with the parking demand. The model developed is as:
- Peak parking demand (vehicle hours) =0.401(total number of employees.
- The Srinagar city lacks in the efficient public transport system. The transportation system in the city faces frequent traffic jams and traffic congestions which is mainly due increased growth of private vehicles. The solution to the problem lies in introducing the best public transportation system.

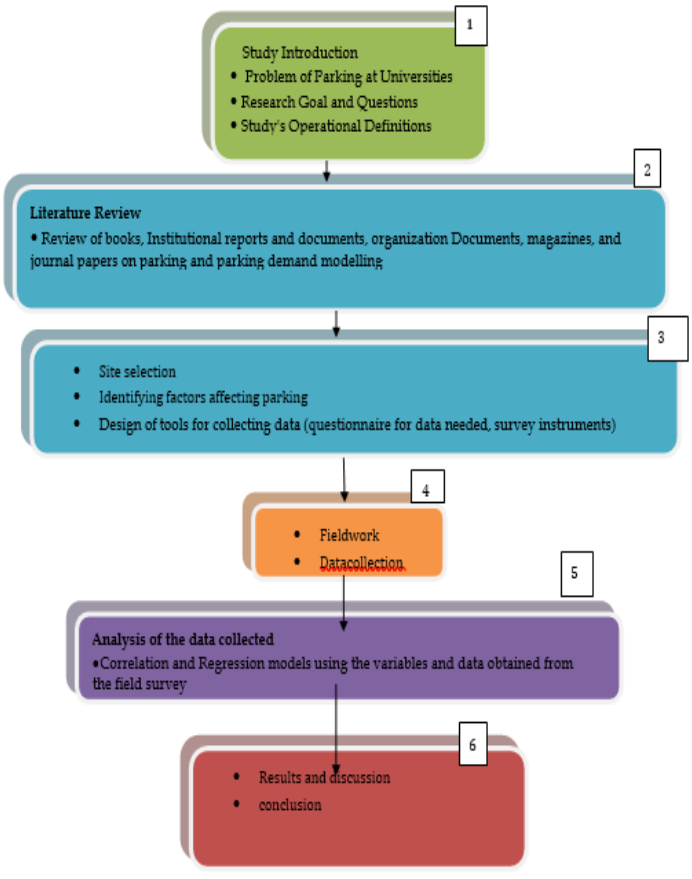

Fig. 2: Proposed Flowchart

- Free parking in the city, mostly in the educational institutes and other offices encourages the use of private mode of travel, causing traffic jams and congestions at morning and evening peak hours, if parking fee is introduced the people will shift to public mode of travel and subsequently decrease traffic jams on the roads during morning and evening offices hours.

- Almost all the study sites have inadequate parking area, the capacity of the parking lawn is less than demand, compelling the parkers to park their vehicles all-round the site at their own will. This vagueness may be removed by conducting detailed studies of parking demand and using scientific models as have been developed.

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