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*Parking Demand Modelling for Educational Institutions in
Jammu & Kashmir: A Case Study*



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Summary

- 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.
- In this study two types multiple linear regression models using SPSS software were developed.
- Disaggregate model study determines the most suitable independent variables affecting the parking demand based on user's socio economic behavior.
- Aggregate model study determines the most suitable independent variable for estimating the parking demand (vehicle hours) or parking supply (space hours) at educational institutions.

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Introduction

- The unsustainable increase of private vehicles as a means of transport in urban areas has led to severe congestion and pollution.
- Srinagar city is on the threshold of being declared a metropolitan area with an estimated population of 1.615 million in 2018 (Population of Srinagar, 2016) .
- 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.
- 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 at educational based on users behavior in Srinagar city.
- Most of the parking spaces allocated are based on free land available at these institutions

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 generate by the number of residents in the area and their mode of transportation and their behavior.

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.

Research scope

- The parking demand model developed can be used to estimate parking needs at educational institutions for better planning
- This study can give ideas for developing parking demand models for other parking generating areas.

Literature Review

- Peng NG and Ma'some (2005) determined the most suitable independent variable for estimating the parking demand formula for suburban LRT station. In this research, the daily average passengers have high degree of association with parking demand.
- Young, Beaton and Satgunarajah (2010) studied the spatial distribution of parking of Melbourne City and concluded that Parking policies and pricing impacts the entire city transportation and land use.
- Chakrabarty and Mazumdar (2010) took into consideration various behavioral characteristics factors influencing the parking demand and also their influence on each other was tried to find out.
- Warden, Borgers and Timmermans (2006) studied attitude and behavioral responses of car drivers to planned parking measures at campus of the Eindhoven University of Technology, the Netherlands and concluded that Half of 77 the car drivers responded they would change their mode of transport or park car outside the campus if they have to pay parking fee.

METHODOLOGY

- 1
 - Understanding the problem
 - Research Goal and Questions
 - Study's Operational Definitions

- 2
 - Literature Review

- 3
 - Site selection
 - Identifying factors affecting parking
 - Design of tools for collecting data

- 4
 - Field work and Data collection

- 5
 - Analysis of the data collected**

- 5
 - Regression models using the variables and data obtained from the field survey

- 6
 - Results and discussion
 - Conclusion
 - Recommendations

Study Methodology

The multiple linear regression will be considered and solved using the software SPSS. Steps followed in the Multiple Regression Analysis using SPSS Software Package are:

- Inclusion of the dependent variable;
- Inclusion of the entire set of independent variables (parameters) or predictors;
- Variables having least partial correlation with the dependent variable removed sequentially (step-wise) so that all the variables that contribute least to the model (statistically insignificant) are eliminated; and
- Determining the final functional form containing only those parameters or predictors which have significant impact on the dependent variable (here parking demand).

Significance Level (Sig.) determines whether the particular parameter is a significant predictor of the dependent variable.

Site Selection

- The study location must be an educational institute located.
- There must have a provision of adequate parking space, which cater the parking demand.
- The parking area is not linked to other land use categories.

Site Survey and Data Collection

- Employees survey
- Student survey
- Visitor survey
- Parking survey

Parking surveys

- **In-out survey:** The number of vehicles that enter and leaving the parking lot for a particular time interval is counted. Parking duration and turnover is not obtained. Only one person is required
- **Fixed period patrolling:** All vehicles are counted at the beginning of the survey and after a fixed time interval that may vary between 15 minutes to 1 hour. Here is chance of missing short term parkers.
- **License plate method of survey:** In this case of survey, every parking stall is monitored at a continuous interval of 15 to 30 minutes and the license plate number is noted down. There are less chances of missing short-term parkers. But this method is very labour intensive.

Steps of Parking Surveys

Identification of parking generators



Inventory of existing parking facilities



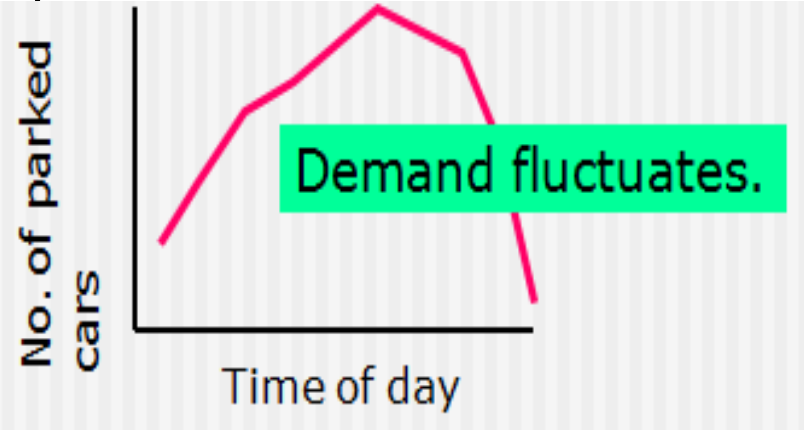
Collection of data on parking accumulation, parking turnover, and parking duration



Collection of information on parking demand

Collection of parking data

- Accumulation – checked about every 15 to 30 minute basis



- Turnover and (max permissible) d

T = NO. OF DIFFERENT VEHICLES PARKED

NO. OF PARKING SPACES

Collection of information on parking demand

- Interview parkers on a typical weekday between 8:00 am and 10:00 pm.
- Or, give drivers a survey form

If you get 30% back, you are really fortunate.

Trip origin

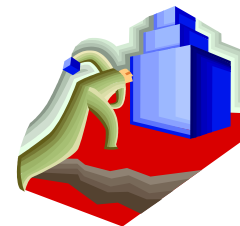
Trip purpose

Destination after parking

Socio-economic characteristics

Arrival and departure

Vehicle type



Parking Demands and Models

- Aggregate model has been developed based on the characteristics of the institutes. The demand is expressed in terms of peak parking demand based on accumulation curve. In aggregate model peak demand is expressed as a function of floor area, number of students, number of employees, availability of college bus facility and parking charges at these institutes.
- Disaggregate model was developed at KU based on socio-economic characteristics of users. Parking demand has been expressed in terms of parking usage in hours per day. The model has been developed for two groups. One group include only students and the other group includes employees and visitors. The structure of the disaggregate model is:

$$Y(1,2)=a+b_1 \times x_1 + b_2 \times x_2 + b_3 \times x_3 \dots\dots\dots$$

Parking demand at various educational institutes

Name of Institution	Vehicle	Peak parking demand (Veh. hours)	Conversion factor*	Total car parking demand (Veh. hours)
University of Kashmir, Srinagar	Car	682	1	682
	Bus	14	1.96	28
	Bicycle	383	0.16	62
NIT Srinagar	Car	202	1	202
	Bus	4	1.96	8
	Bicycle	83	0.16	14
IUST Awantipora	Car	150	1	150
	Bus	31	1.96	61
	Bicycle	69	0.16	11
Women's College M.A road	Car	91	1	91
	Bus	2	1.96	4
	Bicycle	187	0.16	30
GMC Srinagar	Car	115	1	115
	Bus	6	1.96	12
	Bicycle	65	0.16	10
*based on parking space requirement and converting all demand in terms of car parking space				

Characteristics of various educational institutes

Name of the Institution	Total area (hectare)	Floor area (m2)	Total number of employees	Total number of students on roll	College bus services	Parking charges	Peak parking demand
University of Kashmir	74.56	94675	1974	7993	available	none	772
NIT Srinagar	28.61	27050	500	3200	not available	none	224
IUST Awantipora	14.67	26320	489	3464	available	none	222
Women's College M.A Road	4.5	12000	260	3554	not available	none	124
GMC Srinagar	10.46	22450	352	750	1	none	137

Case processing summary of employee and visitors, and students

		Case processing summary of	
		Employee and visitors	Students
Mode of travel	Public transport	24.0%	54.3%
	Bicycle	16.0%	19.2%
	Private car	60.0%	26.5%
Liking efficient public transport	No	28.0%	25.0%
	Yes	72.0%	75.0%
Willing to choose public mode of travel, if parking fee is introduced	No	63.2%	44.8%
	Yes	36.8%	55.2%

Difficulties during data collection

- All the respondents did not return the questionnaire
- The questionnaire was distributed till filled questionnaires were obtained from 500 respondents

Parking demand modeling

- Using SPSS, parking modeling with simple linear regression analysis is done with two methods, which is the “Enter” and “Stepwise” method.
- Four types of equations are formulated and checked for goodness of fit test.

An Example to show data analysis for *linear regression by stepwise method with and without constant for students at University of Kashmir*

Model		Variables	Coefficient	t	Sig.	R	R ²
1		(Constant)	2.064	5.072	0.000	-	-
		Travelled distance	0.280	5.555	0.000	0.720	0.524
2	With constant	(Constant)	0.930	1.689	0.103	-	-
		Travelled distance	0.280	5.923	0.000	-	-
		Family income per month	0.329	2.808	0.009	0.790	0.632
		(Constant)	1.522	2.820	0.009	-	-
3		Travelled distance	0.430	6.061	0.000	-	-
		Family income per month	0.415	3.764	0.001	0.840	0.713
		Travel time	-0.497	-2.703	0.012	-	-
1	Without constant	Travelled distance	0.580	17.471	0.00	0.950	0.710
		Travelled distance	0.360	8.112	0.00	-	-
2		Family income per month in lacs	0.660	5.899	0.00	0.980	0.960

Results and discussion

The results given by the stepwise method were more accurate and were used to estimate parking supply.

For employees and visitors, the travel distance and income came out to be the influencing parameters affecting parking demand. The final models evaluated are:

- ***Parking usage = 0.38 (travelled distance) with $R = 0.914$ and $R^2 = 0.836$***
Or
- ***Parking usage = 0.23(travelled distance) + 0.43(income per month in lacs) with $R = 0.957$ and $R^2 = 0.916$***

For students, the travel distance and family income came out to be the influencing parameters affecting parking demand. The models developed are:

- ***Parking usage = 0.58(travelled distance) with $R = 0.950$ and $R^2 = 0.710$***
Or
- ***Parking usage = 0.36(traveled distance) + 0.66(family income per month in lacs) with $R = 0.980$ and $R^2 = 0.960$***

Results and discussion

The number of employees working in the institution has the highest degree of association with the parking demand. The model developed is:

- *Peak parking demand (vehicle hours) = 0.401(total number of employees) with $R = 0.997$ and $R^2 = 0.993$*

The above equation can be used as a guide to estimate the number of parking spaces to be provided if a new educational institution is to be established in Srinagar.

Conclusion

- 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 in this thesis.
- 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.
- 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.
- The aggregate model developed determines the independent variables influencing parking demand. It has been concluded that number of employees working in the institution has highest degree of association with the parking demand.
- For employees and visitors the travel distance and income are the influencing parameters affecting parking demand and for students the influencing parameters are traveled distance and family income .

Recommendation

- The negative impact of parking activities on the traffic and transportation scenario in most of the metropolitan cities of India is reaching an alarming stage. The diverse culture and vast geography of India demands that the separate study on parking demand and the factors influencing parking demand should be conducted at each major city. It would not be wise to blindly emulate the west and formulate plans based on their experiences.
- Complexities of the transportation scenario in the country should be studied indigenously as well as scrupulously in order to develop models and plans.
- Srinagar city is on the threshold of being declared a metropolitan city with an estimated population of 1.615 million in 2018. As a sequel to National Urban Transport Policy, Srinagar should have its own Urban Transport Policy in the form of coherent and comprehensive set of guidelines.
- This study is one of such efforts to study parking demand and the factors effecting parking demand at Srinagar city and finally formulate parking demand model. The parking demand models have been developed, but because of limited time and resource the study was carried out at small scale. For developing improved parking demand models in the Srinagar city, such studies should be conducted at comprehensive level.

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