

Studies on On-Street Parking Using License Plate Method In Basavangudi Bangalore

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ABSTRACT

The transport infrastructure contributes substantially to the state economy. Parking is an essential component of the transportation system. This essential component causes some major problems that are created by the increasing vehicle traffic. Some of the issues related to parking are congestion, delay, accident, pollution etc. It has an impact on transport development. The availability of less space in urban areas has increased demand for parking space especially in central business area. In Bangalore it has been documented that, two wheeler sales were observed to be at 1.5 million with an annual growth rate of 7-10%, while car sales were observed to be close to 5 lakhs units a year in the year 2012 as per siamindia.com. In order to accommodate the large volume of vehicle, cities must develop the affect their infrastructures—roads, flyovers, car parks. The Aim of the study was to analyze the existing condition of parking & Level of Service (LOS), delay in signalized intersection & also collect the behavior response from the commuters. In urban areas parking causes more and more problems which re-quire a goal-oriented and efficient parking policy. In order to implement a policy a study about the parking problem is important. Simple methodology was adopted to study the on street parking; some of the primary survey was carried out like volume count, parking duration, accumulation, demand survey and Willingness to Pay survey (WTP). In WTP survey, questions were asked to the road users, among them only 39% agreed to the implement the new parking policy. Regression model were employed to measure the relationship between parking demand and parking space capacity per activity roads.

Keywords: On street parking, Signalized intersection, Level of service, Delay, Parking survey, Duration, Willingness to Pay survey (WTP), Regression analysis

1. INTRODUCTION

On-street parking plays an important role in the efficiency of the overall transportation system. First of all, the start and end point of every car trip is a parking lot. Secondly, it is roughly estimated that out of 8760 hours in a year, the car runs on an average for only 400 hours, leaving 8360 hours when it is parked (1). Rapid population growth because of IT and other associated industries in Bangalore led to an increase in the vehicular population to about 1.5 million, with an annual growth rate of 7-10%. With the increase in population and the expansion of the city, the problem of connectivity of the populace has arisen. Quite obviously personalized modes of transport have grown at a tremendous rate and two wheelers along with the cars almost comprise 90% of the total registered vehicular population in the city. Two wheelers constitute more than 70% of the total volume, while cars comprise 15%, autos 4% and the remaining 8% includes other vehicles such as buses, vans and tempos

1.2. OBJECTIVES

- 1 Analyze the main street traffic flow condition.
- 2 Study of existing parking condition in an area.
- 3 Investigate the behavioral response of commuters to a range of parking price.
- 4 Identification of parking policies for possible implementation in the area.

1.3. NEED FOR STUDY

Parking is one of the serious problems that confront the urban planner and the traffic engineer. Before any measures for the betterment of the conditions can be formulated basic data pertaining to the availability of parking space, extent of its usage and parking demand are essential. If it is proposed to implement a system of parking charges it will also be

necessary to know how much to charge and what will be effect of the pricing policy on parking. Parking surveys are intended to supply all kind of information

2. LITERATURE REVIEW

Kardi Teknomo et.al [2] suggests that parkers’ behavior in choosing a parking location was mainly influenced by the availability of parking spaces, trip purpose, search and queue time, walking time, parking fee, security, and comfortability. Dr. Deo Chimba, et.al [3] suggests, in urban and suburban areas is characterized by parking space problems, especially during peak hours and special events. To overcome these problems, some local governments initiate on-street short term paying programs to limit length of stay and generate revenue. Paul C., et.al [4] attempted to study the impact of curb parking on traffic flow. Studies have consistently shown that on-street parking can result in more traffic accidents. Study reveals that, Curb parking represents a potentially hazardous and congestion causing use of public road space. Hongwei Guo et.al [5]. proposed Hazard-Based Duration Model to analyze the influential factors related to on-street parking, including effective lane width, the number of parking maneuvers, and occupancy. Study revealed that on-street parking has a significant impact on the travel time of vehicles

3. METHODOLOGY

Simple method was adopted to study the existing condition of on street parking. This simple method includes three important parts like preparation, survey and output. In the preparation part, papers related to the parking, Karnataka parking policy were collected and examined the general character of the area. In survey part some of the primary surveys were conducted, primary surveys like, volume count, parking demand, accumulation, duration, and willingness to pay survey. Behavior response from the commuters was very important part in the survey. In the third part, the outcome of the survey was analyzed to see the requirement implement the new parking policy

4. TRAFFIC AND PARKING DATA ANALYSIS

4.1 Traffic Volume of Commercial Roads

Traffic Volume count was carried out in the important roads of Basavanagudi. Important roads like Bull Temple road, Vanivilas road, Gandhi Bazaar road, DVG road, NR Colony road. These major roads are two-way divided carriage way with four lanes, except DVG road its two-way lanes. Data was collected using field data sheets and carried out by the trained persons.

Table 1 Main Traffic Flow Table.

Time	Bull Temple Road		Vanivilas Road		Gandhi Bazaar Road		DVG Road		N R Colony Road	
	↑↑	↓↓	↑↑	↓↓	↑↑	↓↓	↑↑	↓↓	↑↑	↓↓
8-9	935	1289	1299	930	1394	1438	384	265	1038	858
9-10	1012	1202	1605	821	1527	1394	375	329	986	827
10-11	812	1132	1281	788	1076	1313	382	252	714	716
11-12	659	1113	808	623	1002	909	316	272	584	582
12-1	690	1302	864	706	872	1078	357	334	642	557
1-2	707	964	763	625	829	1047	347	248	746	656

2-3	679	773	737	621	1007	1123	363	312	753	721
3-4	1006	994	747	617	1158	1212	419	228	723	719
4-5	1229	1210	921	714	1393	1361	506	403	959	958
5-6	1233	1328	1244	1147	1691	1637	513	473	1342	1197
6-7	1440	1480	1459	1413	1807	1664	587	550	1483	1579
7-8	1630	1740	1577	1566	1754	1573	652	542	1487	1563

4.2 Parking Studies

4.2.1 Parking Volume

Total number of the vehicles used the parking space is called parking volume. The purpose of this study was to know the total number of vehicles utilized the parking space. This survey was carried out in all the roads along with the main traffic flow survey. Commercial roads parking volume data is mentioned in the below Table 2

In residential areas, location was divided into A, B and C to make the study easier. Here only parking volume was noted. The residential areas data's are as tabulated in the Table 3.

Table 2 Parking Volume (Commercial).

SI No	Roads	Vehicle In Numbers
1	Vanivilas Road	679
2	N R Colony	1099
3	DVG Road	3207
4	Bull Temple Road	1703
5	Gandhi Bazaar Road	6407

Table 3 Parking Volume (Residential).

SI No	Location	Parking Volume in Numbers
1	A	820
2	B	1685
3	C	1750

4.2.2 Parking Turnover (Commercial and Residential):

Parking turnover is equal to the total number of different vehicles parked during the count period divided by the number of available parking spaces. The purpose of this study was to find the average use of the parking lot. Field data of both commercial and residential areas is tabulated in both the Table 4 and 5

Table 4 Parking Turnover (Commercial).

Sl No	Roads	Total Volume Of Parked Vehicles	Capacity	Turnover Rate
1	Vanivilas Road	679	72	9
2	N R Colony	1099	108	10
3	DVG Road	3207	349	9
4	Bull Temple Road	1703	180	9
5	Gandhi Bazaar Road	6407	567	11

Table 5 Parking Turnover (Residential).

Sl No	Location	Parking Volume	Parking Capacity	Turnover Rate
1	A	820	131	6
2	B	1685	213	8
3	C	1750	273	6

4.2.3 Parking Duration (Commercial and Residential):

It is one of the important studies of parking. This study helped to analyze the length of time spent in the parking space. The field data is tabulated in the Table 6 to 13. The values are expressed in numbers. The nature of served land use plays a major role in determining parking durations.

Table 6 Parking Duration (Commercial) Vanivilas Road

Number of Times Seen	1	2	3-4	5-8	9-12	13-20	21-22	Total
Average Duration in Hours	½	1	1½-2	2½-4	4½-6	6½-10	Over 10	
Total Parked	428	169	70	12	0	-	-	679
%	63	24.9	10.3	1.8	0	-	-	100

Table 7 Parking Duration (Commercial) Bull Temple

Number of Times Seen	1	2	3-4	5-8	9-12	13-20	21-22	Total
Average Duration in Hours	½	1	1½-2	2½-4	4½-6	6½-10	Over 10	
Total Parked	664	720	270	40	9	0	-	1703
%	39	42.3	15.9	2.3	0.5			100

Table 8 Parking Duration (Commercial) N R Colony

Number of Times Seen	1	2	3-4	5-8	9-12	13-20	21-22	Total
Average Duration in Hours	½	1	1½-2	2½-4	4½-6	6½-10	Over 10	
Total Parked	680	309	86	5	5	7	7	1099
%	61.9	28.1	7.8	0.5	0.5	0.6	0.6	100

Table 9 Parking Duration (Commercial) DVG Road.

Number of Times Seen	1	2	3-4	5-8	9-12	13-20	21-22	Total
Average Duration in Hours	½	1	1½-2	2½-4	4½-6	6½-10	Over 10	
Total Parked	1459	1131	514	90	11	2	0	3207
%	45.5	35.3	16	2.8	0.34	0.06		100

Table 10 Parking Duration (Commercial) Gandhi Bazaar.

Number of Times Seen	1	2	3-4	5-8	9-12	13-20	21-22	Total
Average Duration in Hours	½	1	1½-2	2½-4	4½-6	6½-10	Over 10	
Total Parked	3643	1662	851	199	35	8	9	6407
%	56.9	25.9	13.3	3.1	0.54	0.12	0.14	100

Table 11 Parking Duration of Location A (Residential).

Number of Times Seen	1	2	3-4	5-8	9-12	13-20	21-22	Total
Average Duration in Hours	½	1	1½-2	2½-4	4½-6	6½-10	Over 10	
Total Parked	361	253	158	20	10	4	14	820
%	44	31	19.2	2.4	1.2	0.5	1.7	100

Table 12 Parking Duration of Location B (Residential).

Number Of Times Seen	1	2	3-4	5-8	9-12	13-20	21-22	Total
Average Duration In Hours	½	1	1½-2	2½-4	4½-6	6½-10	Over 10	
Total Parked	853	557	220	21	5	4	25	1685
%	50.6	33.1	13.1	1.2	0.3	0.2	1.5	100

Table 13 Parking Duration of Location C (Residential)

Number of Times Seen	1	2	3-4	5-8	9-12	13-20	21-22	Total
Average Duration In Hours	½	1	1½-2	2½-4	4½-6	6½-10	Over 10	
Total Parked	741	660	240	59	16	4	30	1750
%	42.34	37.71	13.71	3.4	0.91	0.23	1.7	100

4.2.4 Parking Occupancy (Commercial and Residential):

Parking occupancy is also one of the important studies of parking. The purpose of the study was to understand the utilization of parking space on the street. Data was collected at every 30 minutes i.e. from 8.00 AM -8.00 PM. Both Residential and Commercial demand Graph (fig 1 to 3) is plotted against time and percentage.

Parking Occupancy

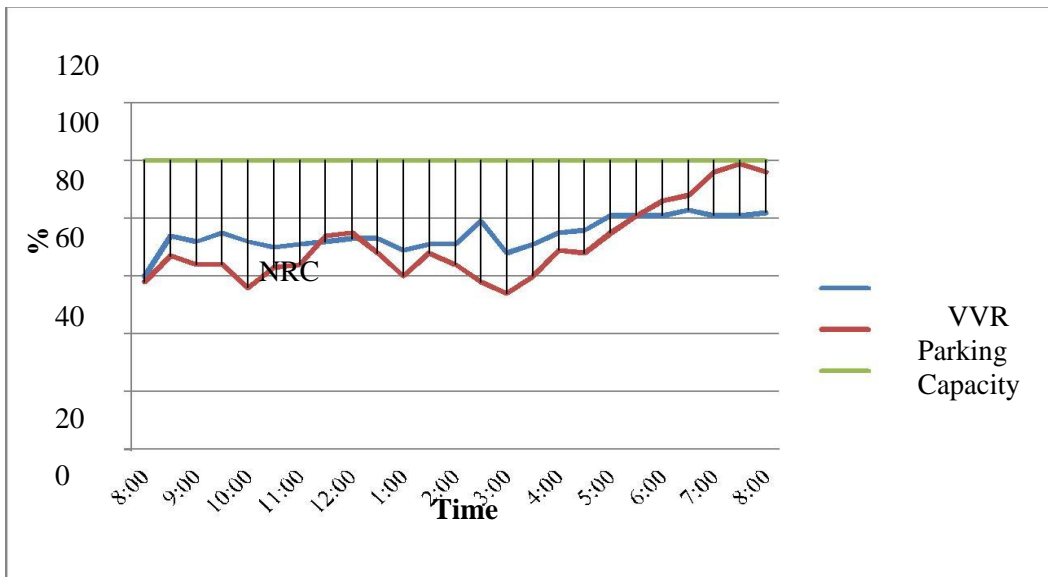


Fig 1 Parking Occupancy of NR colony and Vanivilas Road

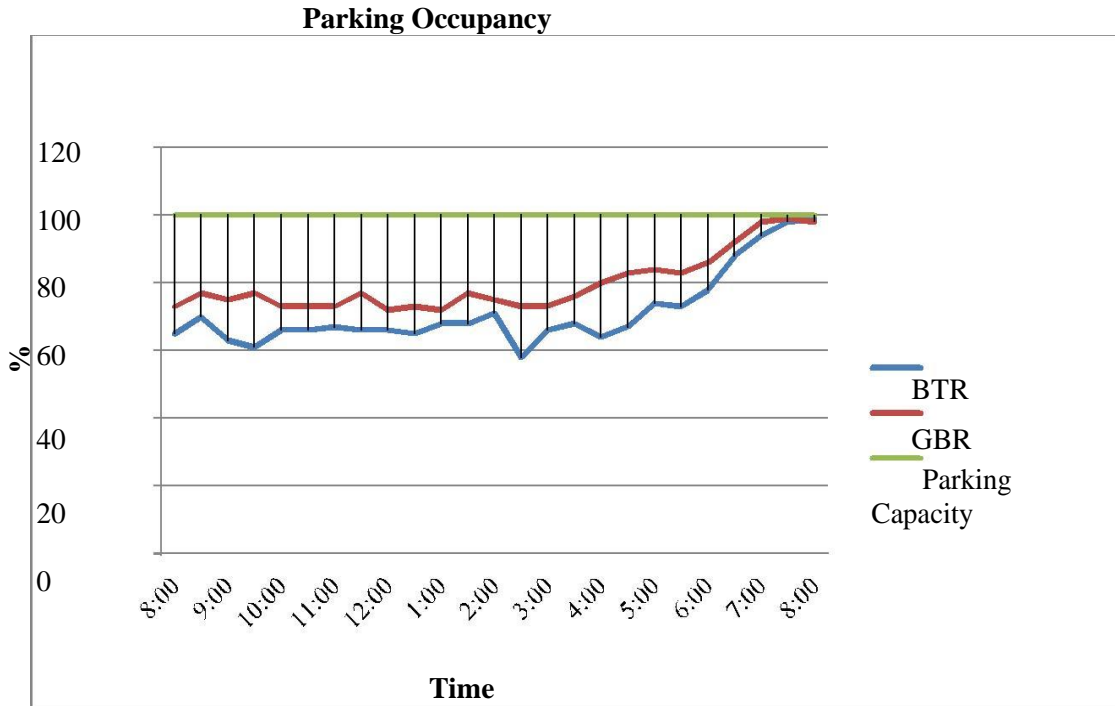


Fig 2 Parking Occupancy of Bull Temple Road and Gandhi Bazaar Road.

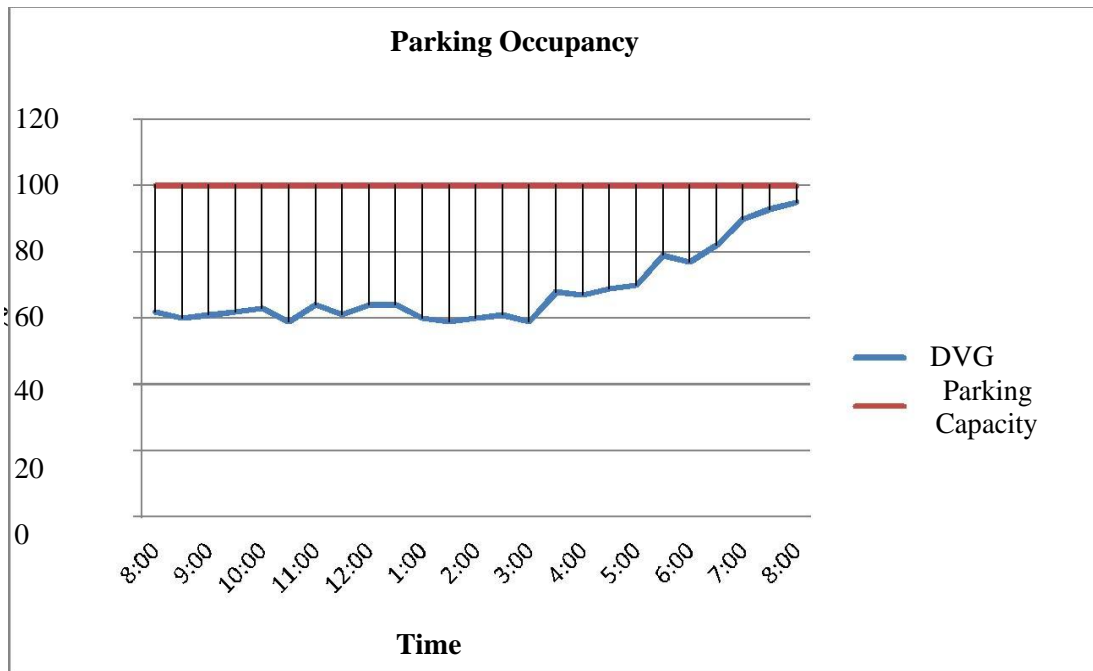


Fig 3 Parking Occupancy of DV Gundappa Road

4.2.4 Parking Accumulation

Total number of vehicle parked in an area at an each hour interval of time. It is expressed in numbers. The data collected were useful in quantifying variation in demand over the course of the day. It also helped in identifying the peak period. Graph was plotted against time and number of vehicles. The variation was because of the land use, purpose, etc.,

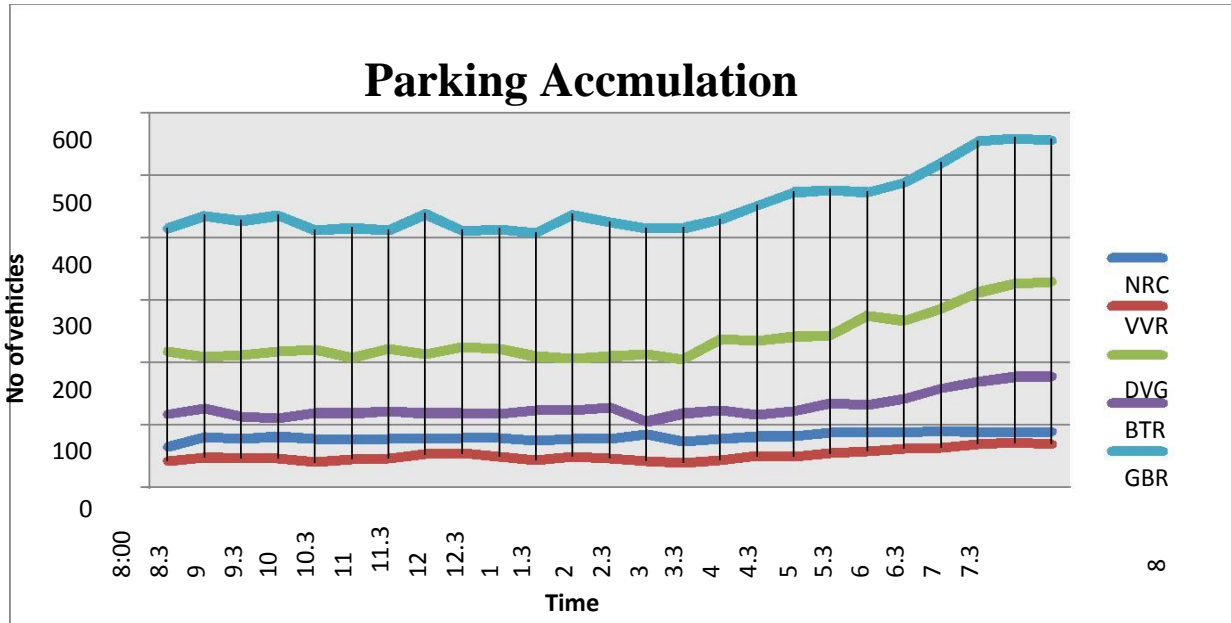


Fig 4 Parking Occupancy of Location A and B (Residential)

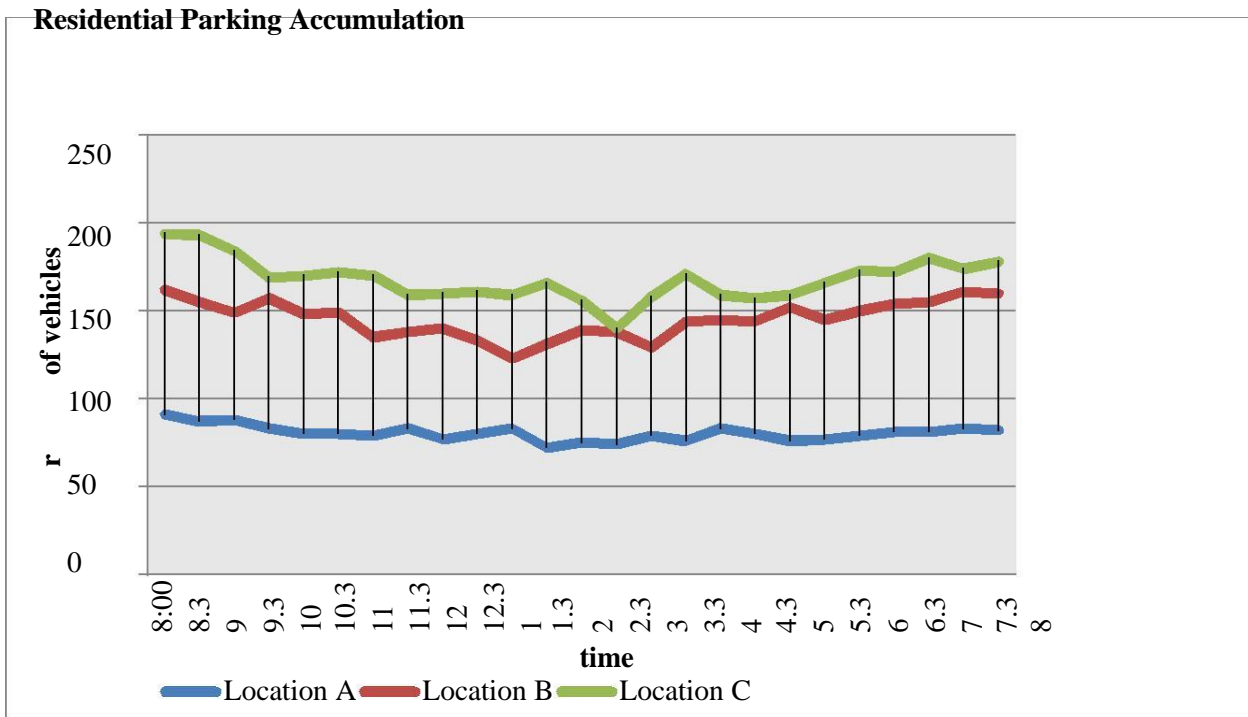


Fig 5 Parking Occupancy of Location C (Residential)

4.3 Willingness to Pay Survey (WTP Survey):

WTP survey is very important to understand the behavior response of the commuters. The interview was conducted for 2 weeks on working days, public views and opinions about the problems and solutions relating to parking

were gathered through questionnaire survey. Results of the questionnaire survey are mentioned in below **Table 14** Out of 663 (overall) interviews, only 39% of road users were agreed and rest 61% users not agreed to implement the new parking policy. Interview was conducted with pedestrian, vehicle owners, drivers, shop owners etc in different places and time of study area.

Table 14 Willingness to Pay.

	A	B	C
Number Questioned	225	266	172
People Who Answer Yes	89	102	68
Percentage of People Questioned	40	38	40
People Who Said No	136	164	104
Percentage of People Who Said No	60	62	60

4.4 Parking Demand Model

In a regression analysis we study the relationship, called the regression function, between one variable y , called the dependent variable, and several others x_i , called the independent variables. Regression function also involves a set of unknown parameters b_i . If a regression function is linear in the parameters (but not necessarily in the independent variables!) we term it a linear regression model. Otherwise, the model is called non-linear. Linear regression models with more than one independent variable are referred to as multiple linear models, as opposed to simple linear models with one independent variable

Table 15 Regression Input Table

Location	Demand (Y)	Capacity (x)
NRC	90	108
VVR	71	72
BTR	178	180
GBR	560	567
DVG	330	349

Table 16 Regression Output Table

Regression statistics	
Multiple R	0.999
R Square	0.998
Adjusted R square	0.997
Standard Error	9.85
F	1697.97
Significance F	0.00
Co efficient of Y (Beta)	-7.82
Co efficient of X (B)	0.994

The value of the multiple R is 0.999. It is well within the acceptable ranges (i.e. within - 1 to 1). The significance of the linear model is apparent because it has higher value of 99.8 percent of the variance observed. The magnitude and direction of influence is indicated by the B and Beta values. The B-value (0.994) implies with an increase by a unit change in parking space is expected to yield a change in parking demand by 0.994 units. The sign of the partial regression coefficient (Beta) is negative, implying that an increase in parking space will bring about a corresponding decrease in parking demand by - 7.72 units for every unit change in parking capacity

5. RESULTS AND CONCLUSIONS

Vanivilas Road:

The study has chosen for the survey the stretch from Ramakrishna Ashram circle to the signal intersection (close to Giriya's electronics). There are 72 lots in the stretch, out of which 25 percent is for 4 wheelers and remaining for 2 wheelers. Here in some part of the road, precautionary measures were taken to shift parking from main to residential roads and only one side parking was allowed. The study found that, the parking was mainly utilized by people for hotels and restaurants particularly during evening hours. About 99 percent demand for parking found during evening hours. Survey found that all the vehicles in VVR preferred short-term parking. The result shows that 87.9 (63+24.9) percent of the vehicles parked between 0-1 hours. There was no long term parking evidence in the study area. Parking accumulation curve has steeply increased from 2.00 pm to 8.00 pm. parking vehicle was found not exactly within the parking space; many of them were used to park behind other vehicle.

N R Colony: The study conducted parking survey at N R Colony road, which consist of 108 parking lots. Parking found on the either side of the road. Even though the stretch is allocated for four wheelers, 83 percent two wheelers utilized the parking space and vans are other means of transport which also utilized parking space. Turnover rate of vehicle has registered more, other than Gandhi Bazaar road in Basavangudi. The study found that, along with 90 percent of both short and medium parkers (i.e. from 0-2 hours), 2.5 percent long term parkers (i.e. more than 2 hours) were used parking space. A majority of parkers parked their vehicles while visiting the temples, hotels and banks, which are adjacent to the parking site. From 3.00 pm-8.00 pm, the demand for parking found almost constant. The parking accumulation was uniform between 8.00 am – 8.00 pm. Here demand was less compared to other roads

DVG Road: Dvg road is famous for commercial activities and parking stretch consists of 349 lots. It is the second largest parking capacity road among other. Width of the road is less compared to other roads. There is no parking facility for four

wheel vehicles; the stretch is only allocated for 2 wheel vehicles. Even though capacity is high, turnover rate is less compared to N R Colony and Gandhi Bazaar road. The medium term parking duration was higher than short term duration. Short term parking found 45.5 percent (30 min) and 51.3 percent medium term parked between 30 min -2 hours. The study found that, the demand for parking was more than 90 percent in the survey hours i.e. between 7.00 pm-8.00 pm. parking accumulation (fig 4.10) reveals that, it gradually increased in the evening hours.

Bull Temple Road: The study conducted parking survey at Bull temple road, which consists of 180 parking lots. Even though, parking facility is created exclusively for the cars other vehicles also make use of the parking lots. However cars are the major users of to parking facilities. About 40 percent were cars and rests of them were 2 wheelers and autos utilized the parking facility. Between 6.00pm and 8.00pm the parking lots were utilized at a maximum level of available parking space. the graphical representation of parking accumulation reveals that the trend accumulation almost constant up to 3.00 pm and it increased steeper rate between 4.00pm-8.00pm. Rate of turnover was less compared to N R Colony and Gandhi Bazaar Road. The study found that short term duration of vehicle parking is predominant in the parking area with 82 percent.

Gandhi Bazaar Road: Gandhi Bazaar has evolved as a predominantly shopping centre and it attracts customers from all over the city. It is the first largest parking road among others in the study area. Parking was provided both the sides. There are 567 lots in the stretch. About 18 percent of the vehicles are cars and in actual terms out of 604 capacities 108 is reserved for car. Accumulation level of the vehicle up to 3.00 pm is almost constant; it means the demand for parking space was almost constant. The maximum demand was found is 99 percent i.e. around 7.00pm-8.00pm and minimum demand was 72 percent around 12.00 pm-1.00pm. Turnover rate of vehicle parking per space has registered 11, which is more compared to other roads. It was observed that 83 percent of vehicles parked for the duration between 0-1 hours. 57 percent of vehicle stayed for less than half-an-hour which was very short span of parking. The existing parking spaces are not enough in order to meet the growing demand for parking. Illegal parking was quite common across the road. The study found that the demand for vehicle parking was significantly high during evening and some of the car owners/drivers failed to find parking lots to park their vehicles. On the other hand, Gandhi Bazaar road is one of the busy commercial centers.

Residential Areas: Importance is given for commercial areas than residential areas. The study found that short term parkers were more in all three locations than the long term parkers. Turnover rate is less in location A and C compared to location B. Morning demand is quiet high in location A and C than in location B, in location B demand is high in morning as well as in evening than in the afternoon. Accumulation rate is almost same in all three locations. From analyzing the results, the following can be concluded:

1. The parking data collected on the day of survey showed high parking demand at all commercial roads except in N R Colony. Thus, it eventually leads parkers who did not find parking spaces to park their vehicles at undesignated locations (on the other words illegal parking).
2. The future parking demand was calculated using present parking accumulation rate; result showed that the facilities should be expanded to accommodate more parking users. However, due to less availability of land at this area to expand it horizontally, a multi-storey parking facility should be considered to increase the number of parking spaces. Thus, it allows parkers to shift from private vehicles to public transportation which obviously would help relieve the level of congestion and its associated problems at the study area.
3. The regression equation established to measure the relationship between parking demand and parking space capacity per activity roads. This study found to have a high degree of coefficient of variation, $R^2 = 0.998$ for this independent variable. The established equation of regression model is $Y = 1.0041x + 8.3819$. This shows that the equation established in this study have a high goodness of fit.
4. The occupancy rate was above 95 percent in all the roads (except N R Colony), the reason for high parking demand were not related to short of parking supply, but were generally related to poor parking managements. So, there should give importance to parking policies and management.

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