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Modelling The Response To Chargeable Off-street Parking Policy For Two-wheelers & Four Wheeler On Selected Urban Street Of Busy CBD Area

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Abstract — *The aim of the project is to assess the parking performance at the area surrounding the central business districts where the parking spills over should also be included in the survey of city of Vadodara. In this context, we carried out a questionnaire-based survey with three days in a walled city area of Vadodara. We extracted the information and their importance and vision towards parking from the data & know how much vehicle park in weekend & weekdays and how much hour they stayed on that location? From this survey we analyzed that, parking safety is very essential than parking charges for four wheeler owner, but the two wheeler owner having conservative approach towards parking charges. This survey is very helpful for making different policies of parking. Lastly, I have attempt to create a model using SPSS SOFTWARE .The BINARY LOGIT MODEL assessment showed that parking cost has, as expected, the most important impact on the choice of parking alternatives. In my paper, I had developed the analysis of parking turnover, parking accumulation and the various attractors for parking like number of bays, etc.*

Keywords- *Parking Facility, Parking Charges, behavior of respondent, CBD area, off-street parking*

I. INTRODUCTION

Parking especially 'Off-street Parking' is the most concerning problem in urban cities, which is created by the increasing traffic and growth of motorized vehicles. Every vehicle trips requires parking at its Destination, so parking facilities are an integrated component of the roadway system.

Road side parking: Unregulated road side parking is being resorted to by vehicle users as the owners and visitors prefer to park the vehicle close to the work place for easy access and safety of the vehicle. Parking of this type must be prohibited. To overcome, parking policy is one of the most powerful means for urban planners and policy makers who use it to manage travel demand and traffic in city centers. In many countries, governments are increasingly using parking policies as a means of reducing urban road traffic. Many researchers believe that parking measures are effective means of reducing congestion. Since urban access is considered crucial to the economic success of a downtown area, certain constituencies, such as business and retail, have historically been opposing to any parking restriction policies. In order to address these concerns and create appropriate parking policies, it is important to understand how visitors to the city center are likely to respond to new policies.

A) TYPES OF OFF-STREET PARKING

The types of off-street facilities commonly considered are:

1. Surface car parks.
2. Multi-storey car parks.
3. Roof parks.
4. Mechanical car parks.
5. Underground car parks.

1. Surface car parks:

Surface car parks, properly located and developed on a piece of vacant land or surrounding an office complex or super market, are very popular with the motorists. Great care is needed in their design and operation. The overall aesthetics of the area should receive due attention. A stall size of 2.5 m x 5 m is probably adequate for Indian conditions predominated by Small-size cars. If the surface park is to be operated with a fee-charging system, there should be arrangement for collecting the money. This can be done either manually by stationing an attendant in a kiosk at the entrance who sells the parking tickets or by installing an automatic vending machine which can be designed to raise a barrier rail upon insertion of a coin.

2. Multi-storey car parks:

Surface parks consume too much of the precious land in the heart of the city and are not, therefore, always feasible. One of the alternatives when land is costly is to provide multi-storey car parks.

Multi-storey car parks are designed for a capacity of about 400 to 500 cars. Larger capacity tends to increase the time for unparking a car. About five floors is also the upper limit for the same reason. The car parking floors, the ramps, the entrance and the exits should be well lighted. If the garage is without external walls, as is often the case, there is no need for artificial means for ventilation.

3. Roof parks:

A very popular method of solving the parking problems adopted in many cities is to park the vehicles on roof tops. Access ramps or mechanical lifts provide the necessary access to the roofs. To economize, many roofs may be linked together served by a single access ramp. In addition to the ramps, extra cost is involved in designing the roof tops and the structural elements for the parking load.

4. Mechanical car parks:

Mechanical car parks provide for lifting of the cars from floor to floor by means of a lift and transfer of cars to and from the parking stall by means of wheeling or mechanically operated transfer dollies or cradles. Since the ramps and aisles are eliminated in this system, it is more economical in space as compared to the ramped system, multi-storey garages. The disadvantages are the higher maintenance costs and the possibility of breakdown due to mechanical or power failure.

5. Underground car parks:

The great advantage of underground car parks is the least intrusion they cause to the aesthetics of a place. These parks can be built in the basement of any multi storeyed building or below open spaces. Since the work involves large quantities of excavation, construction of retaining walls, ventilation and lighting, such car parks tend to be very costly.

II NEED OF STUDY

Parking is one of the major problems that is created by the increasing road traffic. It is an impact of transport development. The availability of less space in urban areas has increased the demand for parking space especially in areas like Central business district. This affects the mode choice also. This has a great economical impact. Hence there is a need to work out the effective parking policy measures to meet demand of existing parking facilities. Use of private vehicles on CBD areas, parking a problem which needs to be focus for managing the parking demand. Preference in choosing a parking location in the Central Business District area, especially for commuting, business and shopping trips, create a high demand for on street & off street parking which needs to attend by framing parking policy measures.

III OBJECTIVES

1. To calculate the parking load, accumulation, turnover, Average parking duration to understand parking trend of the study area.
2. To study the parking volume on the busy street in CBD area.
3. The formulation of the scenario of chargeable off- street parking policies.
4. To develop a model of 2 wheeler & 4 wheeler vehicles users for various formulated parking Polices in CBD area.
5. To estimate the revenue generated on account of chargeable parking policy.

IV LITERATURE STUDY

1."**Off-Street Parking Choice Sensitivity**" (BY John Golias, GeorgeYannis & MichelHarvatis, Transportation Planning and Technology , Volume 25, Issue 4, January 2002) deals with the determinants of choice between on- and off-street parking. In this context, a questionnaire-based survey was conducted and the stated preference method was used to develop an explanatory model. The model assessment showed that parking cost has, as expected, the most important impact on the choice of parking alternatives. The model assessment showed that parking cost has, as expected, the most important impact on the choice of parking alternatives. Furthermore, all other variables with a significant impact on parking choice are time related.

2. "**A Framework and Model for Parking Decisions"(by** Ofir Hilvert, Tomer Toledo, Shlomo Bekhor, Technion – Israel Institute of Technology) presents an overall parking choice and search behavior framework, composed of three time-space phases: pre-trip static decision, en-route passive search, and in-area search strategy adaptation. The empirical part of 6 the paper focuses on the first phase, and develops a parking choice model based on pooled stated and revealed preference data sources. Analysis of the survey results regarding parking decisions timing suggests that the majority of drivers make the final parking decision dynamically in proximity to the destination, thus supporting the proposed approach. The model estimation uses both RP and SP data. The joint RP-SP estimation process and the integration of heterogeneity component improved the results.

3. "**Off-street Parking Management Plan For Dharwad City, Karnataka, India"(by** Mrs Priyanka Kolhar , Journal of Engineering Research and Studies,2012) purposes that, 1) To assess the parking characteristics including parking duration and accumulation. 2) To assess the willingness of the commuters' to pay the off-street fee based on willingness to pay survey. 3)To evaluate the parking fee and the revenue generated per day for off street. Author obtained by the survey that to reduce parking turn-over is high causing congestion on the streets, heavy parking fee is to be levied on the short duration parking vehicles. Parking adequacy analysis suggests that majority of parking lots has already crossed their capacity and some are about to cross the capacity. To solve the parking problems immediately short-term solution can be

adopted with congestion pricing as, operation and maintenance cost is very much less for on-street parking management rather than off-street parking.

4. " **Comparison of On-Street Parking Management in Ermita-Malate Manila and Makati Central Business District '' (by De La Salle,** Eastern Asia Society of Transportation ,2013) stated that the on-street parking facilities in Ermita-Malate area needs improvement since most of the on-street parkers stay for a very long period and they park in areas where parking is not allowed. The laws and ordinances are not implemented properly, thus, the motorists tend to ignore these.To overcome problems More parking facilities should also be constructed so that the demand will be met by the supply of parking spaces. Off-street parking facilities are harder to increase since some areas are residential areas so off-street parking facilities should be increased instead. The open lot parking facilities should be constructed into a building parking facility so that the number of slots will be increased.

5. "**Modeling the Response to Parking Policy"(by Yoram Shiftan and Rachel Burd-Eden,** Transportation Research Record ,2007) presents a model to estimate the likely response to two parking policy: an increase in parking cost and a decrease in parking availability that will increase the driver search time for parking. The model is based on the responses of center visitors to a stated preference survey. From these survey author concluded that Use of stated-preference data may include some bias, this approach enabled the modeling of different types of responses, not merely mode shift, and to differentiate between workers and non-workers. These two features of this approach provide a very important advantage in analyzing the implications of such policies to the vitality of city centers.

6. "**Short-Stay Car Parking Choice Behaviour- A Case Study of Cardiff City Centre"(by** Chao Qi, International Journal Of Transportation,2008) deals with the individuals' parking choice behaviour can significantly contribute to the parking policy making for urban areas. Based on a parking-user survey conducted in the main short-stay parking places around the Cardiff city centre, this thesis provides a thorough analysis of individuals' parking behaviours. By this survey he concluded that Through the application of chi-square tests, underlying relations across parking users' profiles have been revealed. discrete choice models have been developed to acquire parking users' sensitivities to parking charge and parking availability. The above finding will provide useful references to the parking policy improvement within the Cardiff context.

V STUDY AREA

The study was conducted in Mangalbazar of Vadodara city in state of Gujarat. Mangalbazar is the shopping hub for Vadodara.Of the total number of vehicles parked in the lots considered, 93% were two wheelers, 7% were four wheelers in mangalbazar.. CBD areas are greatly affected by parking hence, areas under the influence of CBD activities are considered for the study. The methodology adopted, to achieve the objectives of the above-mentioned study, is discussed in the following paragraphs.

Fig. 1: Location of Study area profile

VI METHODOLOGY

(1) **Review of available plans and survey data**: Study of available plans, survey data and statistics related to mangalbazar were identified, compiled and reviewed. The parking codes and practices were studied. In addition, the relevant agencies and government departments were contacted for collection of secondary sources of information.
(2) **Selection of off – street parking lots**: The central business district is usually the area where parking survey is needed.
(3) **Methods of survey conducted:** License Plate Method of Survey, Questionnaire Type Parking Usage Survey were the parking surveys conducted.

A) Data Collection and Analysis Using License Plate Survey Method:

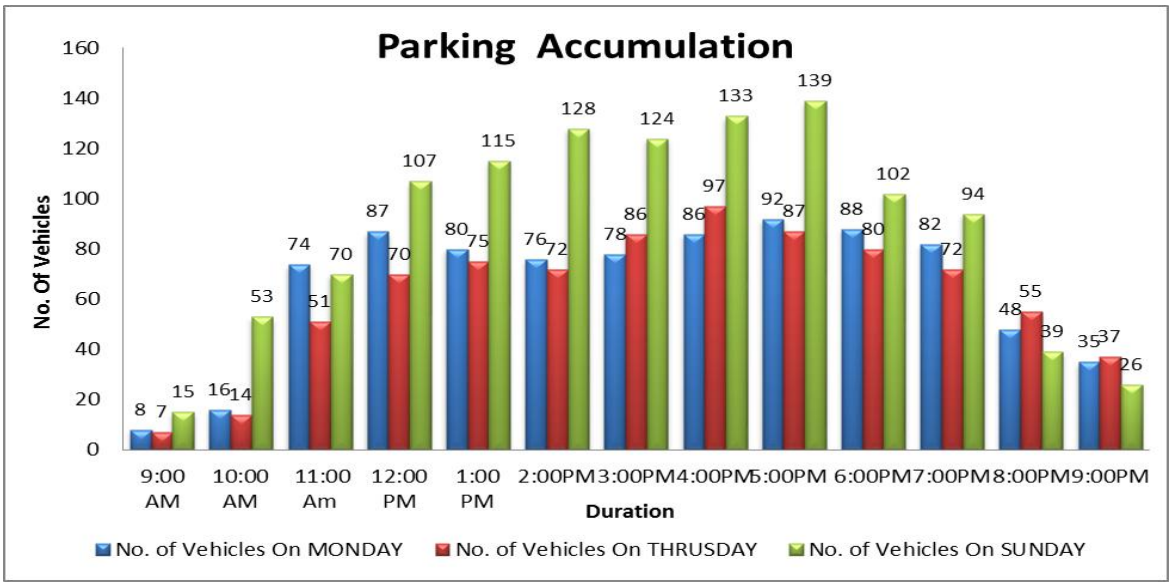

Fig. 2: Graph Of Parking Accumulation

From this survey other data also calculated 1) parking duration 2) parking load (veh/hr) 3) parking index (veh/hr)

4) parking turnover (%).

	Monday (day 1)	Thursday(day 2)	Sunday (day 3)
Parking Duration	2hour 40 min	2hour	3 hour 30 min
Parking load (veh/hr)	52.21	42.46	27.86
Parking index (veh/hr)	52.21	42.46	27.86
parking turnover (%)	3.85	3.84	5.47

Table 1. data result

B) Data Collection And Analysis Using Questionnaire Type Parking Usage Survey Method:

1) Age Distribution of Respondents:

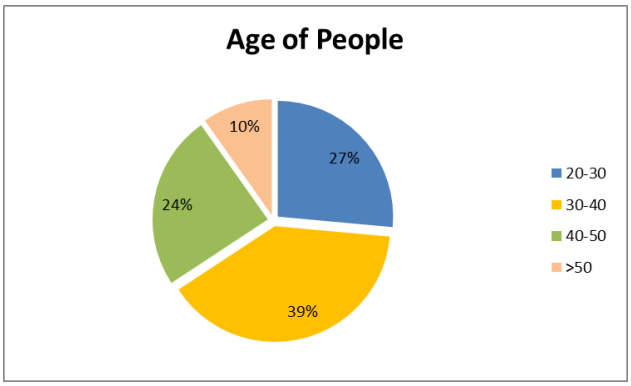

Fig 3.Graph Of Age of people

The result of age distribution of respondent shows that on study area max. 39% of people are in age 30-40 Year , 27% of people are in age 20-30 year ,24% of people are in age 40-50 year & 10% of people are in age of >50 years.

2) Gender Distribution of Respondents:

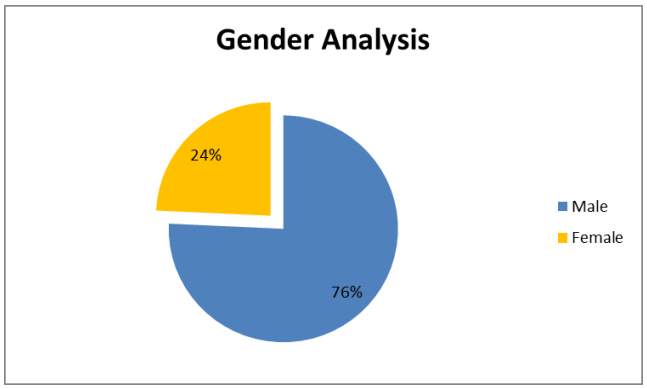

Fig 4.Graph Of Gender analysis

The result evaluated that 76% of male & 24% of female are parking vehicles on CBD area.

3)Vehicle ownership of Respondent:

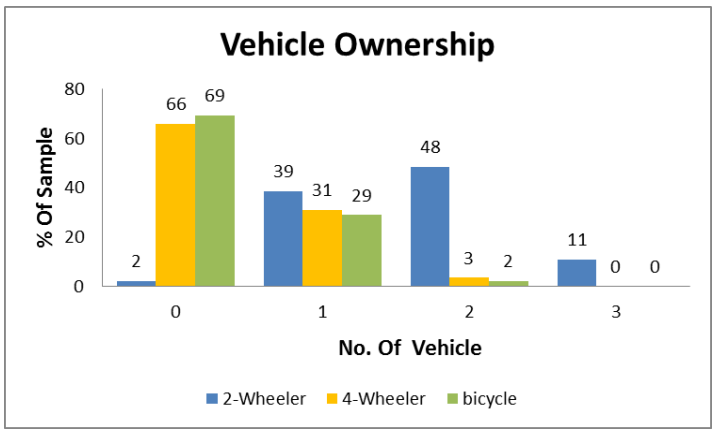

Fig 5.Graph Of vehicle ownership

This graph evaluated that 2% of people having 0 nos. -2 wheeler, 66% of people having 0 nos. -4 Wheeler, 69% of people having 0 nos. -bicycle.
39% of people having 1 nos. -2 wheeler, 31% of people having 1 nos. -4 Wheeler, 29% of people having 1 nos. –bicycle.

4)Total Monthly Fuel Expenditure Of Respondent:

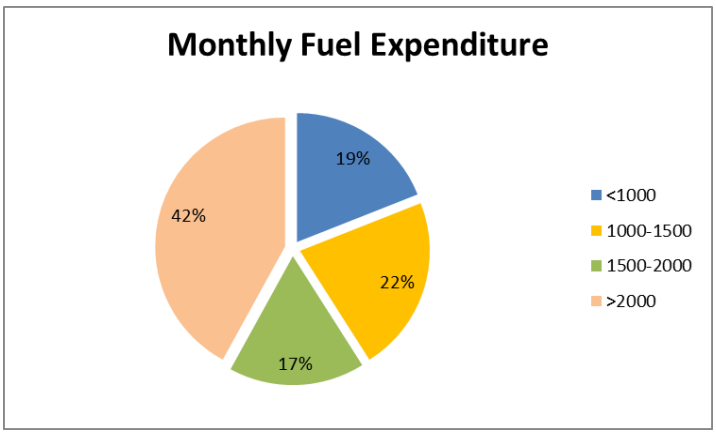

Fig 6.Graph Of monthly fuel Expenditure

The result of monthly fuel expenditure of respondent evaluated that 42% of people monthly fuel expenditure is > 2000, 19% of people monthly fuel expenditure is <1000, 22% of people monthly fuel expenditure is 1000-1500, 17% of people monthly fuel expenditure is 1500-2000.

5)Distribution Of Total monthly income of household Of Respondent:

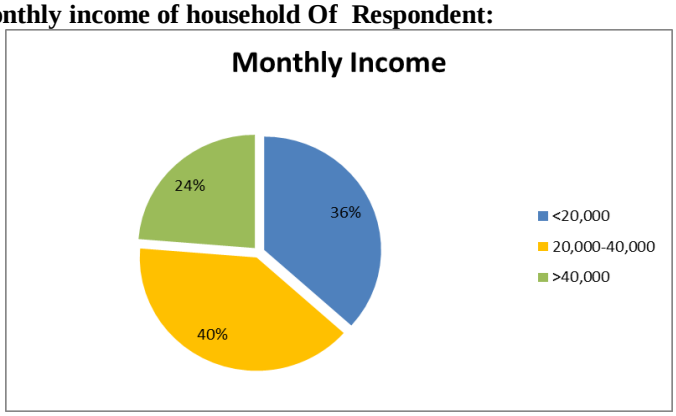

Fig 7.Graph Of monthly fuel Expenditure

The result of monthly income of respondent evaluated that 36% of people have monthly income is <20,000 , 40% of people have monthly income is 20,000-40,000 & 24% of people have monthly income is >40,000.

6) Frequency of Visit Of Respondent:

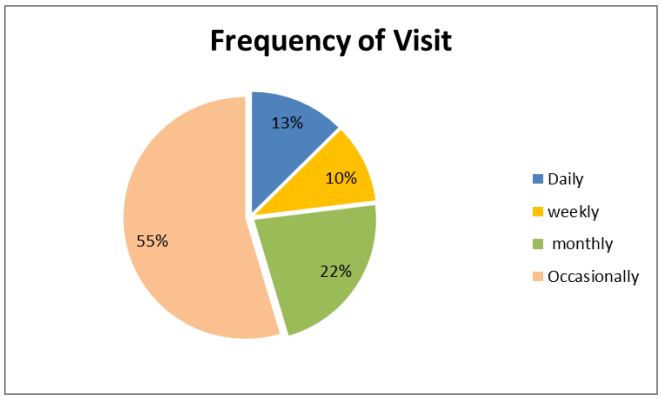

Fig 8.Graph Of Frequency of visit

The result evaluated that13% of people visiting daily,10% of people visiting weekly,22% of people visiting monthly & 55% of people are visiting occasionally on study area.

7) Shopping Priority Of Respondent:

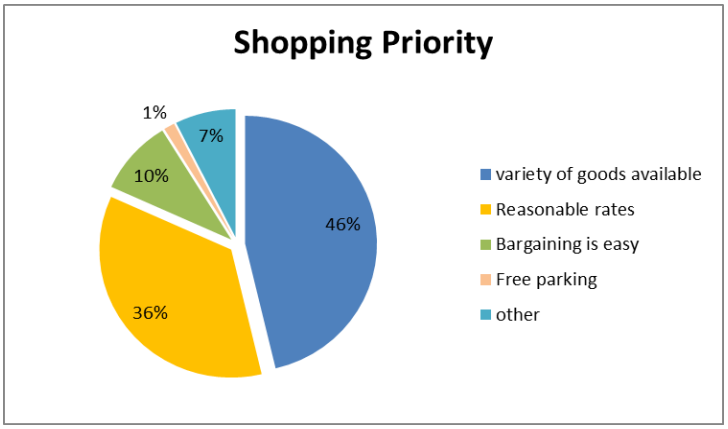

Fig 9.Graph Of Shopping Priority

The result of shopping priority of respondent evaluated that 46% of people have choosing option 1.variety of goods available, 36% of people have choosing option 2.Reasonable rates, 10% of people have choosing option 3.Bargaining is easy, 1% of people have choosing option 4. Free parking,7% of people have choosing option 5.other

8) Parking Charge Response:

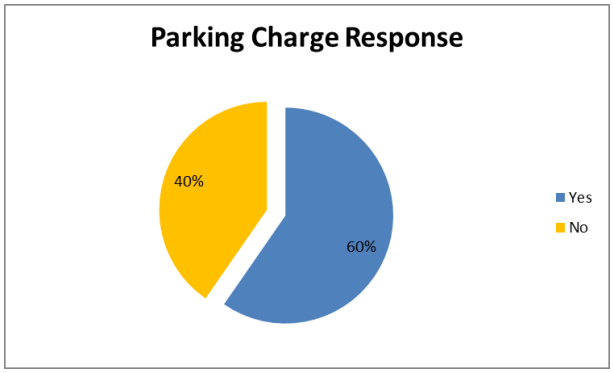

Fig 10.Graph of Parking Charge Response (%)

The result of parking charge response evaluated that 60% of people are ready to park on off street parking study area, if parking charge are introduced. & 40 % of people are not ready to park on off street parking study area, if parking charge are introduced.

9) Parking Charge Response VS Priority :

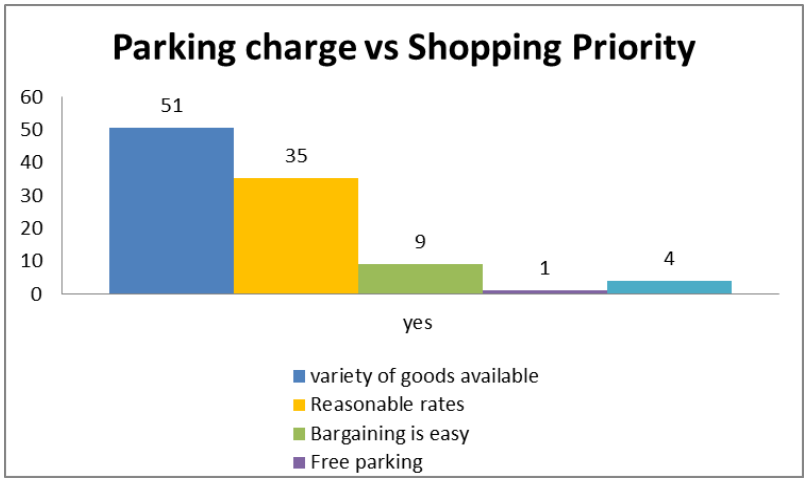

Fig 11. Graph of Parking Charge Response VS Priority (%)

10) Parking Charges per hour:

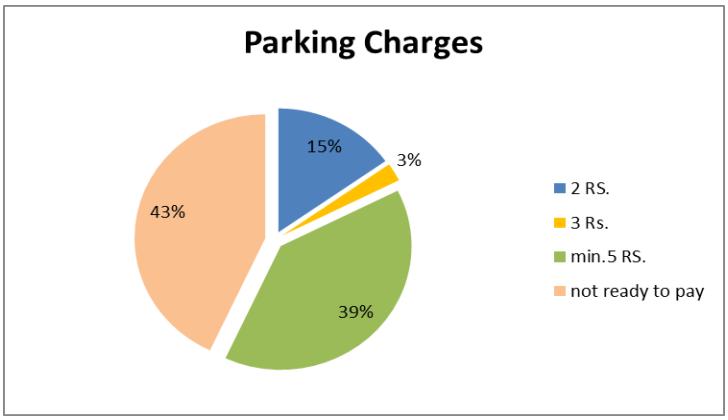

Fig 12. Graph of Parking Charges (%)

The result evaluated that 15% of people are ready to pay 2 RS. For parking, 3% of people are ready to pay 3 RS. For parking, 39% of people are ready to pay min 5 RS. For parking & 43% of people are not ready to pay.

VII USE OF SPSS SOFTWARE FOR LOGISTIC REGRESSION

In a nutshell, logistic regression is multiple regression but with an outcome variable that is a categorical variable and predictor variables that are continuous or categorical. In its simplest form, this means that we can predict which of two categories a person is likely to belong to given certain other information. When we are trying to predict membership of only two categorical outcomes the analysis is known as **binary logistic regression**, but when we want to predict membership of more than two categories we use **multinomial (or polychotomous) logistic regression**.
Binary logistic regression, but most of the principles extend easily to when there are more than two outcome categories. Now would be a good time for the equation-phobes to look away. In simple linear regression, we saw that the outcome variable *Y* is predicted from the equation of a straight line:

$$Yi = b0 + b1X1i + \varepsilon i$$

in which *b*0 is the *Y* intercept, *b*1 is the gradient of the straight line, *X*1 is the value of the predictor variable and ε is a residual term. Given the values of *Y* and *X*1, the unknown parameters in the equation can be estimated by finding a solution for which the squared distance between the observed and predicted values of the dependent variable is minimized (the method of least squares).

		B	S.E.	Wald	df	Sig.	Exp(B)	90% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	HouseholdIncome			8.172	2	.017			
	HouseholdIncome(1)	1.436	.579	6.157	1	.013	4.204	1.623	10.890
	HouseholdIncome(2)	.537	.474	1.285	1	.257	1.711	.785	3.732
	FrequencyofVisit			1.541	3	.673			
	FrequencyofVisit(1)	.584	.668	.764	1	.382	1.793	.598	5.381
	FrequencyofVisit(2)	.402	.437	.843	1	.359	1.494	.728	3.068
	FrequencyofVisit(3)	-.045	.334	.018	1	.893	.956	.552	1.656
	PurposeofTrip			3.519	3	.318			
	PurposeofTrip(1)	1.415	.864	2.681	1	.102	4.116	.994	17.048
	PurposeofTrip(2)	.679	.732	.861	1	.354	1.972	.592	6.574
	PurposeofTrip(3)	1.817	1.478	1.511	1	.219	6.151	.541	69.947
	@2Wheeler	-.202	.241	.701	1	.402	.817	.550	1.215
	@4Wheeler	-.388	.384	1.019	1	.313	.678	.361	1.277
	Modechoise(1)	-1.625	.568	8.172	1	.004	.197	.077	.502
	Constant	-.068	1.177	.003	1	.954	.935		

a. Variable(s) entered on step 1: HouseholdIncome, FrequencyofVisit, PurposeofTrip, @2Wheeler, @4Wheeler, Modechoise.

Table 2.Variables In The Equation

The regression equation in this case should be:
Y= α +β1 (Household Income 1) + β2 (Purpose Of Trip) + β3 (Mode Choice 1)

Compared with the equation to model, the general sensitivity , 3 variables are added into the new equation : household income 1, purpose of trip , mode choice.
If respondent gender is female, the variable "female" will equal 1. Otherwise it will be 0. (male as the reference).
If the resulted co-efficient β1, β2 and β3 are significant (sig < 0.05), then it can be argued that compared to the males, female parking users have different sensitivity to parking features.

The significances of Household Income(2) = .257 , Frequency of Visit = .673, Frequency of Visit(1) =.382 , Frequency of Visit(2)= .359, Frequency of Visit(3) = .893 , Purpose of Trip = .318 , Purpose of Trip(1)= .102 , Purpose of Trip(2) =.354 , Purpose of Trip(3) = .219 , @2 wheeler =.402, @4 wheeler = .313 separately. They are much larger than the threshold value 0.05. Thus, there is no sensitivity difference found between male and female parking users.

The resulted equation in this case should be:
Y= -0.68 +1.436 (Household Income 1) + 1.415 (Purpose Of Trip) – 1.625 (Mode Choice 1)

Results obtained by regression analysis are as follows:
After looking at all of the above data and measuring categorical variables of Household Income ,purpose of trip,frequency of visit ,mode choice , 2 wheeler , 4 wheeler in SPSS, a logistic regression analysis was performed. This statistical analysis can confirm the researchers' conclusion from Chi-Square tests that only gender and charge introduce were true predictors of CBD area. Table 6.2: Omnibus Tests of Model Coefficients is that the conglomerate significance (or the overall p-score) for the entire model is equal to .000, which is less than .05. This depicts that the overall model will predict usage.

VIII CONCLUSIONS

1. People have given positive response to charge introduced with regard Time Restriction and hence it can be stated that it can be an effective tool for management of parking demand.
2. This policy may be effective for the Vadodara city and it is also effective for the city having a same population growth rate.
3. Government can generate revenue from this policy.
4. Their capacity and some are about to cross the capacity.
5. Parking license plate method analysis suggests that majority of parking lots has already crossed.
6. Travel parameters like trip length, frequency of visiting, shopping priority ,shopping duration ,fuel expenditure, vehicle ownership and walking time from parking to destination have identical significant for response to chargeable for off-street parking policy at study area.
7. Prohibition of parking in peak hours is to be varied based on the variation in the peak accumulation in their respective parking lots.
8. The high demand for parking spaces in the horizon years could be effectively met by the development of automated parking system.

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