Estimation of Shopping Trip Attraction Rate – A Case Study of Jagnath Area of Rajkot City

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Abstract— This study represents the trip attraction rates of the shopping centers in Jagnath area in Rajkot city. A total of ten shopping centers were surveyed, for which the number of people and vehicles entering and leaving the shopping center in every fifteen minutes interval is measured. Based on the surveyed data and photographs, the model relates the trip attraction of the shopping center as a function of physical features of shopping center, e.g. total parking space, total floor area and the number of stores in the shopping center. These models are useful for estimating the traffic volume to/from a new shopping center which, is being planned and to assess the traffic impact of the shopping center on the geometric design of roadways in the surrounding area. This model can serve as an alternative to the ITE trip generation manual (1997).

Key words: Sopping Trips, Trip Attraction Rate, Parking Spaces, Number of Stores, Floor Area, Traffic Volume

I. INTRODUCTION

Travel demand forecasting is essential for the design of transportation facilities & services, & also for planning, investment, & policy development. The trip generation the first step, consist of the process of estimating trip production and trip attraction (TA) of the traffic analysis zone (TAZ). TA identifies the number of trips attracted by the various activity centers in the TAZ and the trip production identifies the number of trips produced by the households in the TAZ. The main contributing factor for TA are shopping trips. This study deals with the trip attraction rate (TAR) of the shopping centers (SC), the number of people coming to the shopping center per unit time. The purpose of this study is to collect data about the number of people coming to SCs in the Jagnath plot area of the Rajkot city, and develop models for estimating the TAR of the SCs. The models will be used for planning and design of SCs, also for the geometric design and traffic control schemes on the roadways near the SCs.

II. LITERATURE REVIEW

A. Parikh M.S and Dr H.R.Varia, "A Review on Developing Shopping Trip Generation Model In Residential Area of Ahmedabad City - A Case Study of Gurukul Area" (2016):

Their study was aimed to study about the shopping trip generation in the urban residential area. They selected highly dense populated residential area of Gurukul of Ahmedabad city. For the selected area, they estimated average daily trips of shopping based on total population of the area, total shopping area, average distance from the wholesaler and average daily consumption of the commodities. The results indicate that it is possible to estimate daily shopping trips for the similar type of residential area.

B. George. P & Kattor. G. J, "forecasting trip attraction based on commercial land use characteristics" (2013):

Their paper focused on the formulation of a trip attraction model using multiple regression technique for the commercial land use in medium sized towns of Kerala. The correlation and regression analysis were performed based on these surveyed data. The study showed that the multiple regression model with the three independent variables namely the number of commercial establishments, percentage of shops in the commercial node and percentage of banks in the commercial node with the R2 and Adjusted R2 value of 0.991 and 0.9844 respectively gives the better estimate of trip attraction.

C. Navya S .V, Kumar. S.S & Kattoor. G. J, "Trip generation model for the core area of the Thiruvananthapuram city" (2013):

They observed that the travel demand in Thiruvananthapuram city is continuously growing dur to commercial activities. With intense developments in residential use and work centres spread over the city of Thiruvananthapuram there had been steep rise in mobility pattern of the people. They attempted to develop a home-based trip generation model to examine the factors influencing the trip generation rate in the study area. A mathematical model was developed and the results showed that trip generation rate was highly depended on the employment status of the people.

D. Kikuchi. S, Felsen. M, Mangalpally. S & Gupta. A, "trip attraction rates of shopping centers in Northern New Castel County, Delaware"(July 2004):

The report presents the trip attraction rates of the shopping centers in Northern New Castle County in Delaware. The study aims to provide an alternative to ITE Trip Generation Manual (1997) for computing the trip attraction of shopping centers in Delaware. As part of this study, a total of eighteen shopping centers were surveyed. The model developed is useful for estimating the traffic volume to/from a new shopping center which, is being planned and to assess the traffic impact of the shopping center on the geometric design of roadways in the surrounding area.

The aim of this study is to estimate the number of trips attracted in TAZ.

III. RESEARCH METHODOLOGY

The macroscopic model computes the TAR of the SC, by considering the SC on the whole as one "store" or the unit of analysis. The ITE Trip Generation Manual

(1997) expresses the relationship between the Gross Leasable Area (GLA) and TAR of the SC in the form of a regression model. The factors are total floor area of the SC, total number of parking spaces and total number of stores. The total floor area influences the number of customers visiting the SC and the total number of attractions for various individual stores. The TA to a SC also depends on the total number of parking spaces, which, in turn depends on the total floor area, and the concentration of the customer at a particular time. The number of parking spaces is controlled by the minimum parking standards for the SC based on its floor area. Another factor that the number of people coming to the SC depends on is the number of stores in the SC. The data of number of persons and vehicles incoming and leaving a shopping center in three hours each at an interval of 15 minutes was conducted for six days per shopping center. The data of floor area of a shopping center and the no. of parking spaces was also obtained.

IV. DATA COLLECTION

A. Data Required For Analysis:

Based on the model proposed, the data required for analysis is divided into three general categories:

– The trip attraction rate (TAR) of the whole Shopping Center (SC) in terms of number of vehicles entering the SC in 15 minutes interval
– TAR of individual store in SC in 15 minutes interval
– The physical features of SC e.g.. Floor space (sq. ft) , number of parking spaces, number of stores.

B. Survey: Time and Place:

The data was collected on different days of week and different times of the day for routine days and the days during festival. All the data was collected for every 15 minutes time interval. This interval was chosen because highway capacity manual uses this interval as the base unit for capacity calculation. The typical duration of a survey was 3 hours. The shopping centers were observed between 4 p.m. and 7 p.m. during the week days, Saturdays (10 a.m.- 1 p.m.) and Sundays (11 a.m.- 2 p.m.). The dates and time of the survey for each SC are as shown in table-1

Name of SC	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Time
Landmark						•		AM
							•	MID
	•							PM
King's Plaza						•		AM
							•	MID
			•					PM
Shivam Complex						•		AM
							•	MID
		•						PM
Sapphire Complex						•		AM
							•	MID
				•				PM
Hira Panna Complex						•		AM
							•	MID
				•				PM
City plaza						•		AM
							•	MID
					•			PM
Golden Space						•		AM
							•	MID
			•					PM
City shops						•		AM
							•	MID
				•				PM
Gayatri Complex						•		AM
							•	MID
		•						PM
Center Point						•		AM
							•	MID
	•							PM

Table 1:

C. Data Collected:

The detailed observation regarding the number of people visiting each store in the SC were performed for all 10 SCs. There is large variation in the number of people coming to the SC depending on the time of the day, day of the week and the season. The trip attraction rate of SC is obtained by the

number of vehicles entering and leaving the SC in every 15 minutes iinterval this number is converted to the number of person, using the observed vehicle occupancy rate of 1.1 persons per vehicle. The data for the heera panna complex is shown in table 2. the incoming number of people to the various stores in the SC for different 15 minutes interval is shown. The last row of the table shows the number of vehicles incoming vehicles to the SC.

Store	time interval											
	1	2	3	4	5	6	7	8	9	10	11	12
JB Sarees	1	2	4	5	0	0	8	7	6	1	2	0
lady zeal	2	5	0	4	1	3	2	4	2	0	3	5
Mansha	0	6	2	3	2	2	1	2	1	1	2	1
Kajree	1	3	1	2	4	3	1	1	1	2	1	1
shree fashion	4	2	4	1	6	1	6	4	0	7	3	3
cute camp	5	1	5	0	1	1	2	6	7	1	6	7
dam fashion	6	2	0	5	2	5	6	0	4	0	4	2
new matching	4	0	6	3	5	7	0	0	2	1	5	1
RB fashion	0	0	3	4	6	1	2	1	3	1	8	3
heera fashion	0	1	2	5	0	0	9	2	6	2	1	5
Shantidoot	8	3	1	7	0	0	3	5	1	7	8	8
Girliee	2	5	1	9	1	2	4	4	2	5	9	1
LD tailor	1	6	0	1	1	4	6	6	1	2	1	0
diya fashion	2	7	0	3	2	6	1	2	7	1	1	1
vaishali traders	3	2	2	6	3	8	1	1	8	4	1	6
Gender	4	1	4	0	6	1	5	5	0	1	2	3
RGS	5	3	2	1	4	1	3	7	1	5	6	5
Benzer	6	4	1	1	7	7	2	1	1	3	2	1
meena bazaar	7	5	0	6	2	1	5	5	2	6	8	2
hey baby	1	7	2	3	1	2	9	3	3	2	1	7
fabric art	1	0	3	5	1	7	0	2	7	6	0	8
sri traders	2	1	0	2	7	9	0	1	4	2	0	1
siddhi cement	2	2	4	1	8	9	1	1	2	0	1	0
sanghi cement	0	2	6	4	9	1	1	6	1	1	2	1
no of incoming vehicle	33	36	26	49	29	38	47	40	46	29	48	36

Table 2: Number of incoming persons to different stores & incoming vehicles to the heera panna SC in 15 minutes intervals.

D. Data Analysis:

The model estimates the trip attraction rate (TAR) of the shopping center (SC) based on the physical features like floor area, number of stores and available parking space of a shopping center (SC). A sample TAR data used in calculation of heera panna SC is shown in table 3. The vehicle trip measured in the survey were converted into person trips using vehicle occupancy rate of 1.1 person per vehicle. This value is used as the observed TAR of SC.

Time interval	Observed TAR of SC
13:00-13:15	36.3
13:15-13:30	39.6
13:30-13:45	28.6
13:45-14:00	53.9
14:00-14:15	31.9
14:15-14:30	41.8
14:30-14:45	51.7
14:45-15:00	44
15:00-15:15	50.6
15:15-15:30	31.9
15:30-15:45	52.8
15:45-16:00	39.6
Total	502.7

Table 3: Trip attraction rate of Heera Panna SC for 15 minutes interval of all the shops

As discussed earlier, the independent variables in the model are the number of stores, floor area and the number of parking spaces available in the SC. The dependent variable in the model is the 15 minute TAR of the SC. Table 7.2 shows the values of the variables considered in regression analysis for the 10 SCs that are surveyed. TAR in the first column of table 4 is the average value of all the 15 minute observations of the TAR of the SC in table 4. The floor area is estimated by measurements on the site and also the number of stores were observed by site visit

The general equation of the model is as follows:

$TAR = AX1 + BX2 + CX3 + \beta$

Where X1 , X2 , X3 are the physical features of SC & β is a constant.

Sr. No	Name of Shopping Center	TAR (15 min)	Floor area (Sq. Ft)	No. of stores	Parking space
1	Heera panna complex	41.89	16,382	23	200
2	Kings plaza	38.68	15,396	15	390
3	Shivam complex	52.98	10,200	22	280
4	Sapphire complex	19.70	5782	17	120
5	Landmark	52.5	18,139	25	420
6	City plaza	46.84	4420	16	45
7	Golden space	34.37	6840	14	170
8	City shops	29.24	4610	20	210
9	Gayatri complex	26.49	5548	11	200
10	Center point	28.78	10,396	12	350

Table 4: Parameters describing the SCs

V. CONCLUSION

This study was conducted to evaluate the trip attraction rate of the traffic analysis zone (TAZ). With the help of the data collected number of trips attracted to a shopping center is calculated. These calculated trip attraction rates can be further used in developing the regression model. These models can be used used to estimate the TA for the new shopping center being planned. They are also used to estimate the impact of the traffic volume of new shopping center on the geometric design of roadways in the surrounding area.

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