A Comprehensive Study on Trip Attraction Rates of Shopping Centers in Dhanmondi Area

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Abstract—Studies of people trips and vehicular attraction to activity centers have been conducted in western countries but few have been done in Asian countries. In Bangladesh, this kind of study has been newly introduced. In this study, trip rate analysis method is used to estimate the trip attraction rates of the shopping centers at Mirpur Road, Dhanmondi area of Dhaka. As part of this study, a total of six shopping centers were surveyed, for which the number of vehicles (car) and persons entering the shopping center during peak hour for every 15 minutes time interval were counted. The approach deals with the relationship the trip attraction rates of the shopping center as a whole. It relates the trip attraction of the shopping center as a function of the physical features of the shopping center, e.g. total parking spaces, gross floor area, and the number of stores in the shopping center. It would be useful in the regional transportation network or the channelization of traffic control around a shopping center. The data would be useful in assessing the traffic impacts surrounding a new shopping center, and also the region wide traffic volume impacts.

Index Term—Trip Attraction Rate, Transportation planning, Shopping Center, Mirpur road

I. INTRODUCTION
TRAVEL demand forecasting is essential for the design of transportation facilities and services, and also for planning, investment, and policy development. Trip generation is the first step of the traditional four-step travel demand forecasting process. It is critical that this step produces an accurate value as these values form the basis for the subsequent steps and the errors in this step can propagate in the entire estimation process. [1-3]

The trip generation step consists of the processes to estimate trip production and trip attraction (TA) of a traffic analysis zone (TAZ). Trip Attraction identifies the number of trips attracted by the various activity centers in the TAZ and trip production identifies the number of trips produced by the households in the TAZ.[4-5] Trip Attraction is obviously most pertinent relative to traffic at specific land use activity. It also plays a role in many phases of transportation planning and traffic engineering related activities.[6-7] The main contributing factor for Trip Attraction is work trips. Trips for shopping are the next main category of Trip Attraction.

This study deals with the trip attraction rate of the shopping centers, the number of people coming to the shopping center per unit time.

Transportation planning issues faced by most Asian cities include rapid urbanization and motorization which is leading to sharp increase in travel demand and the supply has largely remained unmatched with demand. So, trip attraction is important to the traffic engineer and planner in considering the impact of new development such as office complex, shopping center and residential development.[8-10] New development leads a various impact to the people’s daily activities. For example the impact of surrounding roadway network tends to make people moving far from one place to another place. Road length is increasing and road network patterns change according to the accessibility needs of people and desire to reach their destinations. Hence, new development will increase the travel demand with their also increase the vehicles. [11-13]

Several studies in western countries have already been done regarding the vehicles generated by a proposed commercial development site and then are able to predict the traffic impact of commercial establishments. Henry Fan, et.al. (1996) recommended the provision adequate parking facilities to minimize the traffic congestion on the vicinity of commercial establishments. Gross floor area, leasable floor area, occupancy rate, car park spaces and peak parking demands were the variables considered in the study. The methodology of the study conducted was the number of vehicles parked in the building was counted then followed by hourly parking accumulation counts, and then the counts were summarized every 15 minutes. Vehicles parked on the vicinity or the adjacent street whether designated or prohibited areas were also counted.
It is difficult to consider all the factors influencing the Trip Attraction Rate of shopping center especially factors like land use characteristics of the surrounding area. However, other factors like the physical features of the shopping center that are easy to measure and analyze should be incorporated in the estimation of the Trip Attraction Rate. In addition to this, the general procedures for estimating Trip Attraction Rate of the shopping center do not consider the effect of the type and features of the constituent stores of a shopping center. The TA of the constituent stores in a shopping center affects the level of trip chaining in the shopping center. It is very vital to involve the trip-chaining phenomenon in the estimation of Trip Attraction Rate of the shopping center.

This study involves the estimation of Trip Attraction Rates of shopping centers at Dhanmondi Area in Dhaka City. This study also provides the foundation for subsequent research to be conducted, local agencies, and/or private organizations to further build a comprehensive urban trip attraction database of shopping centers. The most applicable outcome of this study is the production of quantitative information on travel characteristics of urban land uses like shopping centers that can be used in traffic impact studies.

II. METHODOLOGY

A. Data Collection

Trip rate analysis method was used in the study. To attain the purpose, six shopping centers around Dhanmondi area were surveyed. The shopping centers were Orchard Point, ARA Center, Metro Shopping Mall, Rapa Plaza, Plaza AR and Adel Plaza. The location of six shopping centers is marked by red dots in Figure 1. The number of people and vehicles attracted to the shopping centers with mixed uses such as for shopping, fitness centers, and other services were counted as they visit the particular building. The surveyors positioned themselves near the entrance(s) and exit(s) while also move around the vicinity of the building especially along on-street parking lots. This is to know whether occupants of vehicles parked on the road are going to the building or not.

![Fig. 1. A map showing the shopping centers location](image)

The Trip Attraction of the shopping centers was obtained from the number of people and vehicles entering the shopping center in every 15 minutes interval. Number of incoming shoppers and car trips were counted by survey for every 15 minute intervals during the peak period. The peak period time range was (4:00pm-7:00pm). Incoming shopping trip counts were collected by visual observation. One surveyor was appointed in each gate of the shopping center. Data were collected for typical week day and weekend day (Friday, Saturday). For each shopping center data were collected for two days to get the shopper trip variation during week day and weekend. There was a large variation in the number of people coming to the shopping center depending on the number of the time of the day, day of the week and the season. The fluctuations in the Trip Attraction Rate of the stores and the shopping center on the whole show the complexity involved in studying the trip attraction of shopping centers. The number of vehicles and people entering the shopping center during a three-hour survey period for two different days were collected. These data about the specific characteristics of shopping centers surveyed were processed and statistical analysis was done to determine trip attraction rate. The study tends to get the recent trip attraction pattern of the Dhaka City with the new development of their surrounding area. The whole study plan is shown in Figure 2.

![Fig. 2. Flow chart of the study](image)

B. Data Analysis

The following equations were used for calculating different trip attraction rate:

1. Peak hour person trip attraction rate (Trips per 1000 sq.
ft. per hour) = (Peak hour person trip /Gross Floor Area (GFA))*1000
2. Peak hour person trip attraction rate (Trips per shop per hour) = (Peak hour person trip/total number of shop)
3. Peak hour person trip attraction rate (Trips per entry gate per hour) = (Peak hour person trip/number of entry gate)
4. Peak hour person trip attraction rate (Trips per 100 employees per hour) = (Peak hour person trip/total no of employee of shopping center)*100
5. Peak hour car trip attraction rate (Trips per 10 parking spaces per hour) = (Peak hour car trip/total number of parking spaces)*10
6. Peak hour car trip attraction rate (Trips per 10,000 sq. ft. per hour) = (Peak hour car trip/ Gross Floor Area)*10,000

Using the equations above Trip Attraction Rates was calculated for six shopping centers and also for week day and weekend. Then standard deviation of Average Trip Attraction Rate of the shopping centers from Grand Average was calculated using the equation below.

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (X_i - \mu)^2}, \text{ where } \mu = 1 \frac{1}{N} \sum_{i=1}^{N} X_i$$

III. RESULTS AND DISCUSSIONS

Data were collected for each shopping center from (4 pm – 7 pm) which was the peak period for shopping centers. The number of incoming people and number of car were counted for every 15 minutes interval. The sum of every 4 consecutive interval incoming trip was then analyzed for the calculation of peak hour incoming trip rate. The highest hourly data was considered as peak hour trip rate for each shopping center. This procedure was done for both week day data and weekend data.

From Figure 3, highest peak hour person Trip Attraction Rate was in Adel plaza with 11.7 person trip/1000 ft²/hour on weekend. Adel plaza attracted highest person trips per 1000 ft² area during peak hour because it is a popular shopping mall of branded clothing. A.R.A center made lowest peak hour Trip Attraction Rate 6.2 person trip/1000 ft²/hour on weekday and same as in a typical week day. From the graph, it is clearly noticeable that weekends are found with higher Trip Attraction Rate (person trip/1000 ft²/hour) than weekday (typical working day) for six shopping centers because on weekend the shopping centers attract more shoppers. Figure 4 illustrates the variation in peak hour Trip Attraction Rate (person/10 employee/hour) of six shopping centers. Again Adel Plaza was found with highest person trip/10 employees/hour with a value of 401 on weekend. Metro Shopping Mall made lowest Trip Attraction Rate with a value of 136 person/10 employee/hour. Nearly 238 person trips/100 employee/ hour are visible in both Plaza A.R. and Rapa Plaza. A weekend trip attraction rate for the shopping exceeds the weekday shopping centers in all cases. It is natural that at weekend shoppers have more free time to spend in the shopping centers than the week days. The variation in peak hour Car Trip Attraction Rate (trips/10,000 ft²/hour) of six shopping centers is showed in Figure 5. ARA Center had the highest Car Trip Attraction Rate 14.8 trips/10,000 ft²/hour. From survey it was found that majority of the shoppers coming to the shopping center generally use car as transportation mode. Again Metro Shopping Mall made lowest (trips/10,000 ft²/hour) with a value of 4.5. Car trip attraction is lowest here because it is situated in residential area and most of its regular customers can easily come here by walking. In majority, except Plaza AR and Rapa plaza, it is interesting to note that car trip attraction rate on weekday is greater than the weekends as people love shopping on holidays with their family. Figure 6 indicates variation of peak hour car trip attraction rate among different shopping malls. The highest trip attraction rate (car trip/10 parking spaces/hour) produced by Adel plaza both on weekend and weekday. The rate was 21 (car trip/10 parking spaces/hour) for weekday and 17(car trip/10 parking spaces/hour) for weekend. This was because shoppers prefer car trip to shopping center more in weekday than weekend to avoid traffic congestion near shopping centers. The similar condition happened for both ARA center and Orchard point.

In case of Plaza AR, the value of car trip per 10 parking spaces per hour for weekend exceeded the weekday value of weekday. The car trip attraction rate was lowest for Metro Shopping Mall. The value was 5.2 (car trips/10 parking spaces/hour) for weekend. Figure 7 indicates the peak hour Trip Attraction Rate (person/entry gate/hour) variation of six shopping centers. ARA Center has only one entry gate. Rest of the Shopping Centers has two entry gates. But ARA Center was found with least peak hour Trip Attraction Rate value 136 (person/entry gate/hour). Rapa plaza made highest Trip Attraction Rate 357 person/entry gate/hour both on week day. Figure 8 illustrates the peak hour Trip Attraction Rate (person trips/shop/hour) variation of six Shopping Centers. Adel plaza made highest Trip Attraction Rate 52.1 trips/ shop/hour on weekend whereas, 40.7 person trips/shop/hour on weekday. ARA Center produced least peak hour Trip Attraction Rate value 3.6 trips/shop/hour.

Grand Average of peak hour person trip attraction rate was found 7.9 person trips/1000 ft²/hour for all six shopping centers. The range of values were between 6.2 to 9.5 trips /1000 ft²/hour for different shopping centers and with a standard deviation (S.D.) of 1.2 (trips/1000 ft²/hour). Again,Grand Average of peak hour person trip attraction rate was found 226 trips/100 employee/hour. It was observed that the range was between 136 to 401 trips/100 employee/hour with a standard deviation (S.D.) of 94.3 (trips/100 employee/hour). From the analysis, grand Average of peak hour car trip attraction rate was found 8.3 car trips/10,000 ft²/hour. Range of values started from 4.3 car trips/10,000 ft²/hour to 15.1 car trips/10,000 ft²/hour for different shopping centers and with a standard deviation (S.D.) of 3.5 car trips/ 10,000 ft²/hour.
The average of peak hour car trip attraction rate was found 276 car trips/10 parking spaces/hour. Minimum value was 136 car trips/10 parking spaces/hour where maximum was calculated as 357 car trips/parking spaces/hour for different shopping centers and with a standard deviation (S.D.) of 5.1 car trips/10 parking spaces/hour. Grand Average of peak hour person Trip Attraction Rate is estimated 276 trips/entry.
gate/hour. Minimum value is 136 trips/entry gate/hour and maximum is 357 trips/entry gate/ hour for different shopping centers and with a standard deviation (S.D.) of 80.2 trips/entry gate/hour. Grand Average of peak hour person Trip Attraction Rate is found 14 trips/shop/hour. Minimum value is 3.6 trips/shop/hour whereas, maximum is 52.1 trips/shop/hour for different shopping centers and with a standard deviation (S.D.) of 18.8 trips/shop/hour.

Trip Rate Analysis method was used to estimate average Trip Attraction Rates for different parameters. The average Trip Rate Analysis method was applied because it is comparatively suitable method than regression model for analyzing the Trip Attraction Rates for small sample size like we had.

IV. CONCLUSIONS

The shopping trips constitute the second largest share of trips after the work trips in Dhaka. The number of shopping centers is increasing day by day in Dhaka City particularly in Dhanmondi area. Beside this, the size of a shopping center has become very large, e.g. Rapa Plaza, Metro Shopping Mall and Bashundhara City; hence the travel pattern in the region is greatly affected by the size and activities of the shopping centers. In this study data were collected on trip attraction rates of shopping centers in Dhanmondi Area and the Trip Attraction Rate was calculated as a function of physical features of the shopping centers. This report has showed a Trip Attraction data obtained at six shopping centers in study area.

Trip Attraction Rate is fundamental in planning of transportation facilities. The trip attraction rates that are calculated in the study would be useful in the regional transportation network or the channelization of traffic control around a shopping center. The data would be useful in assessing the traffic impacts surrounding a new shopping center, and also the region wide traffic volume impacts. [19-20]

In this study, average Trip Rate Analysis method was used because only six shopping centers were observed. For further research, more independent Trip Attraction variables of activity centers like distance from home to Trip Attraction center, duration of average long and short trip to destination, variety and prize of products available in shopping centers, average annual daily traffic and traffic congestion situation near the shopping malls etc. may be included. Besides this, more shopping centers situated in this study area can be considered to develop simulation model of Trip Attraction Rate of the study area.

The Trip Attraction Rates data obtained from the study can be used for further research to develop a database for the shopping centers in Dhaka City as well as for the shopping centers for the whole country. Since, there is only a few studies regarding Trip Attraction Rates for shopping centers in Bangladesh, this study will help the future researcher. In addition, data obtained from the study has great use on implementing proper transportation facilities for the Dhanmondi Area.

REFERENCES