

# Trip Attraction Rates of Commercial Land Use: A Case Study

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## Abstract

**Background:** Due to the high growth rate of urbanization in developing world leads to increase in vehicular traffic. Travel demand models are useful in managing the increased travel demand. **Statistical Analysis:** Trip generation step is essential in planning of transportation facilities for any city. This paper mainly focuses analyzing the trip attraction rates of commercial land use in different cities of Andhra Pradesh and Telangana states. As a part of the study, a total of seven commercial centres are studied by defining the four broad commercial centre typologies. Various factors considered for defining these typologies are physical features of study area (sq. ft), parking spaces, number of employees, number of stores, number of people attracting etc. **Findings:** The very first step in traditional travel demand modelling process is trip generation. It is very important for a planner to estimate the impact of changes due to establishment of new facilities like offices, shopping centres and any residential land use. In the study area, the shopping trips constitute the second largest share of trips after the work trips. Because of its major share, these trips not only influence the individual travel behaviour but also showing great impact on transport network. Unlike the previous studies, this study defined the typologies for commercial areas based on their physical characteristics and the same is used for the analysis. These typologies are defined based on the various characteristics of commercial area like floor area, number of stores and number of employees. **Improvements:** The accuracy of this analysis can be improved by considering more number of commercial areas. Since there are no earlier studies reported in estimating trip attraction rates in the study area, this study might provide an insight to the future researchers. Also the in depth literature study while defining typologies of commercial areas and more factors for analysing trip rates might further helpful in accurate prediction of trip rates.

**Keywords:** Commercial Land Use, Developing World, Land Use, Trip Attraction, Urbanisation

## 1. Introduction

One of the major problems facing by the developing countries is rapid urbanisation. Due to the rapid growth of urbanization coupled with the increase in demand for transportation services makes the travel supply remained unmatched to travel demand. If the impact on a current road way increases people tends to take an alternate route to it far away from it. Road pattern and length changes accordingly to accessibility needs of people and desire to reach their dimension. These situations insisted more on managing travel demand rather than increasing infrastructure.

Travel demand models are useful in this regard. Travel demand models are continually evolving based on experience and research each year. This process consists mainly of four stages. They are trip generation, trip distribution, modal split and traffic assignment. Trip generation is to estimate the number of trips of each type that begins or end in each location, based on the amount of activity in an analysis area. Trips are aggregated to a specific unit of geography (ex: TAZ (Traffic Analysis Zone)). The output of trip generation model is to estimating the trip production and attraction rates by traffic analysis zone and by purpose trip attraction rates are more specific to consider for specific land use activity. One of the most important

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factors for trip attraction is work trips. Commercial or shopping trips are main category after work trips. As India does not have any standard trip attraction rates, this study deals with the estimation of trip attraction rates of shopping centres.

The first zonal based trip generation analysis is done in the Chicago area<sup>1</sup>. In the later analysis, the approach developed at CATS (Chicago Area Transportation Study) was considerably modified. Earlier, many researchers are explored these trip generation studies) and developed various models for estimating trip generation rates. Most of these studies related to residential land use. Commercial centres are one of the major trip attraction areas in any part of the world. Some of the researchers have made an attempt to estimate the trip attraction rates of various commercial centres<sup>2-5</sup>.

A study was done to examine various variables that would affect the trip generation of people, which included both physical characteristics of the area and socio-economics characteristics of trip makers. They developed multiple regression models and concluded that trips are mostly attracted by socio-economic characteristics and also found that land use mix plays a minor role<sup>6</sup>.

Another study was based on the major factors affecting shopper's destination choice. They have considered several variables related to the characteristics of shopping centres. Further, they proposed a regression model for examining the trip attraction rates, in order to predict the future trips that are going to be attracted for commercial development with specific characteristics<sup>7</sup>.

A study to determine trip attraction rates of shopping centers in Bangladesh. Unlike previous studies, average trip attraction rates are determined for two types of shopping centers: One for medium size (Type 2) and small size (Type 3) shopping centers, located at Dhaka City. It is found that the average attractions rates of small size shopping centers are much higher than the medium size shopping centers. This implies the justification of determining average trip attraction rates of different type shopping centers based on sizes, rather than using same rate for every size shopping centers. Further, models are developed models using multiple regressions which showed that floor area was related to trip attraction. Thirty condominiums within Metro Manila were randomly selected and they conducted a questionnaire survey to collect the data related to the condominiums to know the characteristics of the selected condominiums and for modelling purpose<sup>8</sup>. Another study was based

on latest origin - destination data for model formulation, which ensures the accuracy of the model. This study developed a suitable trip attraction model using multiple regression analysis, to forecast future trips attracted to a commercial node of certain characteristics for a medium sized town in Kerala<sup>9</sup>. Most of the trip generation studies reported in developed countries and few developing countries. Though some of the studies reported in Indian context, but they are very minimal. Hence, by considering the variations in travel behaviour of Indian cities comparing to the other countries, there is a necessity of observing trip attraction rates of shopping centres in Indian context. Keeping track of these issues in mind, the paper first presents a theoretical framework of the analysis, followed by brief outline of the study area and data collection details. The paper then discusses the analysis of trip attraction rates at various shopping centres. Finally, the paper is concluded by highlighting some of the results found from the analysis.

## 2. Methodology

The methodology adopted in this model is provided in the Figure 1. The study is divided into three phases. First phase starts with the understanding the concept of trip attraction, literature review and framing some of the objectives for the study. Phase 2 discusses about the defined typologies of commercial centres. Phase 3 discusses about the data collection effort and the data analysis process.

### 2.1 Phase 1

In the first phase of this study, authors tried to explore the concept of trip generation and trip attraction rates and reviewed several earlier studies conducted on similar area. Later on, authors conducted an extensive pilot study at various commercial centres for the purpose of defining the typologies of commercial centres.

### 2.2 Phase 2

Second phase of the study involves defining the commercial complex typologies. Data collection is one of the major contributions of this study. In order to achieve quality data, commercial centres are classified into four types based on their characteristics. The characteristics considered for defining the typologies are based on previous studies and expert reviews. The characteristics considered are number of departments or stores, total area, number

of employees, whether the shopping area having food court and dedicated parking space availability etc.

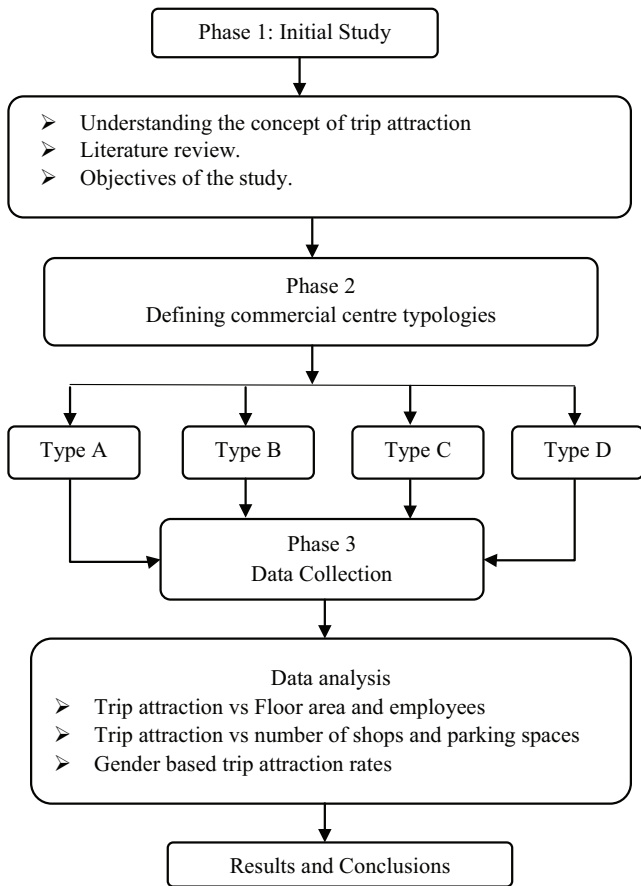


Figure 1. Methodology.

By using this classification different commercial complexes in cities of Andhra and Telangana were surveyed and seven commercial typical shopping areas were selected. The shopping centres that are selected are Best Price, Life Style, Reliance Trends, Eat and play, Maxx, Jack and Jones and Celio.

### 2.3 Phase 3

Third phase of the study involves the steps survey administration, data collection and data analysis efforts. The data collected in the form of manual counting procedure and the surveyors positioned themselves at the entrance and parking area, to collect the data of the total number of people and vehicles entering into the commercial centres. To understand the daily variation between the trip attraction rates, two day data was collected, one is on weekday and other one is on weekend for a span of three hours

(5:00 pm - 8:00 pm). Next section describes about the detailed classification of identified typologies.

## 3. Description of Study Area

From Table 1 we can identify the characteristics of selected locations.

Table 1. Characteristics of defined commercial area typologies

Defined Typology	Study area Characteristics				
	No. of stores	Area (Sq. ft)	No. of emp.	Food court	Parking space
Type A	>50	>50 k	>50	Yes	Yes
Type B	20-50	10 k-50 k	30-50	Yes	Yes
Type C	5-20	3 k -10 k	20-30	No	No
Type D	<5	< 3 k	<20	No	No

- Type A commercial complex:** These are very large commercial centres having an area over 50,000 Square feet, with more than 50 departments containing a food court, gaming, which are maintained by more than 50 employees. This type has very large parking area. Walmart which is the largest commercial complex in Guntur, Andhra Pradesh and lifestyle located in Hyderabad, Telangana comes under this category.
- Type B commercial complex:** These are medium sized commercial centres having an area between 10,000 to 50,000 Square feet with departments in range of 20-50, employees ranging from 30-50 persons, medium sized food courts, gaming and medium sized parking area. Reliance Trends comes under this category.
- Type C commercial complex:** These are small shopping centres having an area between 3,000 to 5,000 Square feet, departments in the range of 5 to 20, employees are ranging from 20 to 30. These complexes do not provide any dedicated parking area. Maxx, Eat and Play comes under this category.
- Type D commercial complex:** This type contains only one store of area less than 3,000 Square feet, departments less than 5 and employees less

than 20. These stores do not have any food court or parking space. Celio and Jack and Jones come under this category. Next section provides the descriptive analysis on effect of commercial area characteristics on trip attraction rates.

### 4. Data Analysis and Results

From the pilot study, it was observed that most of the commercial centres are having its peak business hours in between 5 pm to 8 pm. Hence, in this study, authors collected the data between 5 pm to 8 pm. The collected data of people and vehicles analysed for every 15 minutes interval. The highest hourly data was taken as peak hour trip rates for each commercial centre. This process is followed for both weekday and weekend analysis. Table 2 shows the average trip rates attracted by the each type of commercial zone in weekday and weekends respectively. From the table, it is clearly depicted that all the commercial areas are attracting more number of trips in weekends. Further, the table shows the peak hours at various shopping areas in weekday and weekends. From the analysis, it can be inferred that weekday peak starts later than the weekend peak hour.

**Table 2.** Average trip rates of commercial areas

Commercial area Type	Peak hour trip rate characteristics			
	Weekday		Weekend	
	Peak hour	Trip rate/hour	Peak hour	Trip rate
Type A	6:30 - 7:30 PM	235	5:00 - 6:00 PM	353
Type B	6:30 - 7:30 PM	101	5:30 - 6:30 PM	255
Type C	7:00 - 8:00 PM	149	6:15 - 7:15 PM	253
Type D	6:00 - 7:00 PM	15	6:00 - 7:00 PM	33

Various other factors considered for the analysis of trip attraction rates are person trips/1000 square feet/peak hour (A), person trips/100 employees/peak hour (B), person trips/shop/peak hour (C). Table 3 provides the analysis of trip attraction rates based on the characteristics of commercial areas.

From Table 3, it can be observed that weekday person trips per 1000 square feet floor area are greater than the weekend person trips per 1000 square feet floor area.

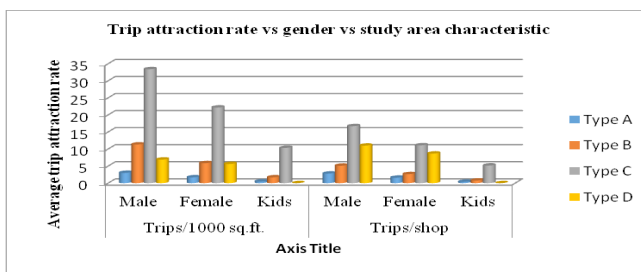
From this result, it can be inferred that commercial centre with more floor area attract more number of trips. This might be due to people wants to spend their leisure time at shopping areas. Further, shopping areas with more than 100 employees are attracting more number of trips in weekends rather than weekdays.

**Table 3.** Trip attraction rates based on the study area characteristics

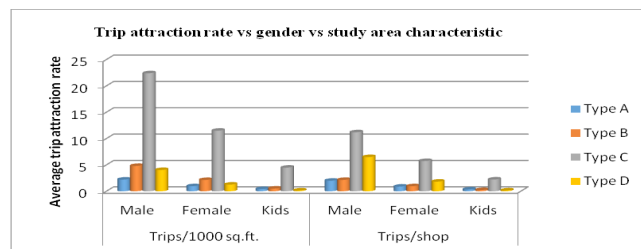
Type of commercial area	Trip attraction rates					
	Weekday			Weekend		
	A	B	C	A	B	C
Type A	3.6	347.5	3.26	5.18	512.2	4.8
Type B	7.48	288.6	3.37	18.9	728.57	8.5
Type C	38.68	705	19.34	66	1188	33
Type D	5.47	134.5	8.5	12.53	311.9	19.67

Similar with the case of person trips per shop in peak hour. It can be inferred that commercial area with more number of shops attracts more number of trips. From the table 3, it is also observed that type C is attracting more number of trips when it compared to other commercial areas, this might be due to the accessibility at nearby areas.

Further, the study also analysed the impact of study area characteristics on trip attraction rates based on gender.



**Figure 2.** Variation in trip attraction rate based on gender in weekend.



**Figure 3.** Variation in trip attraction rate based on gender in weekday.

From the Figures 2 and 3, it can be observed that males are making more number of trips when compared with the females and kids both in weekdays and weekends. These statistics shows that men are actively involving in shopping related activities compared with the female and children. By observing the statistics of weekdays and weekends, it can be inferred that females are making greater number trips in weekends rather than weekdays.

## 5. Summary and Conclusions

This study analyses the trip attraction rates at the major shopping areas. In the study area, the shopping trips constitute the second largest share of trips after the work trips. Because of its major share, these trips not only influence the individual travel behaviour but also showing great impact on transport network. Unlike the previous studies, this study defined the typologies for commercial areas based on their physical characteristics and the same is used for the analysis. These typologies are defined based on the various characteristics of commercial area like floor area, number of stores and number of employees.

Number of people attracting to the study area depends on the commercial area characteristics, time of day and day of the week. The complexity of analysis is increased due to the variations in the trip attraction rates. By observing overall statistics, it can clearly be inferred that weekend trip attraction rates of shopping areas are more than the weekday trip attraction rates. Further, male trip rates in are more when compared to female and children in both weekdays and weekends.

Trip attraction rate is the very first step and more fundamental aspect in planning of any transportation facilities. The trip attraction rates estimated in this study would be useful in analysing the traffic volume in and around the shopping centre.

The major limitation of this study is the limited number of commercial areas. The accuracy of this analysis can

be improved by considering more number of commercial areas. Since there are no earlier studies reported in estimating trip attraction rates in the study area, this study might provide an insight to the future researchers. Also the in depth literature study while defining typologies of commercial areas and more factors for analysing trip rates might further helpful in accurate prediction of trip rates.

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