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# TRIP GENERATION ANALYSIS OF SHUGHONDA RESIDENTIAL AREA IN CHITTAGONG CITY, BANGLADESH: USERS PERSPECTIVE

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**ABSTRACT**
As a developing country the transportation system of Bangladesh is facing several problems such as extreme traffic congestion especially in Dhaka and Chittagong. Because of increasing population in Chittagong, the efficiency of the transportation system is becoming more complicated like Dhaka city. Trip generation analysis plays an important role in transportation planning as it is the process of determining the number of a trip that will begin or end in each traffic zone. Depending on the analysis, a smooth transport network can be designed. The study is undertaken to evaluate the total trip generated in different areas of Chittagong city and identify the factors which influencing trips. Shugondha residential area is selected as the study area which is an attractive place for accommodation with all services & facilities and some employment opportunity. Through random sampling, 175 households were taken under a questionnaire survey. The multiple linear regression method is used to predict the trip generation. From the analysis it is found that the variables that mostly affect the trip generation model are trip fare, family size, total time and reliability. The study will be helpful for developing the existing transportation facilities and amenities which conditions are inferior and have a negative impact on total trips.

Keywords: Trip Generation; Travel Analysis Zone; Multiple Linear Regression.

**INTRODUCTION**
Trip generation defines the frequency of origins or destinations of trips in each zone by trip purpose, as a function of land uses and household demographics, and other socio-economic factors. It aims at predicting the total number of trips generated by (Oi) and attracted to (Dj) each zone of the study area (Ben-Akiva, 2006). It usually answers the question: How many trips originate at each zone? A trip generation has two requirements: trip production and trip attraction. Trip is either produced from traffic zone or attracted to the traffic zone (Zenina & Borisov, 2013). Direction and production define the origin and destination of a trip and land use of traffic zone defines the attraction of the trip (kadiyali, 2009). Trips are generally projected by the trip purposes like trip to work, school, shopping, medical center etc. among which work trips can be regular, often during peak hours. Common socio-economic factors considered for trip generation analysis include population, educational qualification, income and auto ownership rates (Zenina & Borisov, 2013) (Arabani & Amani, 2007) (kadiyali, 2009). For the estimation of trip generation, developed countries have their own trips rates or models as well as trip rates from ITE's Trip Generation Manual in absence of their own trip rates. But those trip rates and models are not applicable in our country because of distinctions in land-use pattern, socio-economic characteristics and road network facilities and physical features may have a significant influence on trip attractions (Mamun *et al*., 2017). Trip generation models are divided into three levels: strategic, tactical

and operational ones. Regression is a statistical technique to determine the relationship between different variables. The variables are classified as dependent variables and independent variables. Cross-classification models or category analysis are used for trip generation calculations at the strategic and tactical levels (Zenina & Borisov, 2013). Linear regression models and Rate methods with linear regression equations or with average rates are used to calculate transport generated trips (Lenzini et al., 2008). The regression equations are developed using the data collected from the field. It is not unique as the coefficient of independent variables varies from a different set of data collecting from the field. Trip rate analysis model is based on the determination of the average trip production or trip attraction rates associated with the important trip generators within the region. Different criteria are used for the selection of explanatory variables in regression analysis (Zenina & Borisov, 2013). Cross-classification model may be used as an extension of simple trip rate models (Ortúzar & Willumsen, 2011). In a study of evolution of parameter affecting the trip generation, the stepwise linear regression method was used which suggest the use of a decision making algorithm consisting of a set of income, family-size, trip time and car-ownership parameters to estimate the number of daily trips produced by a household (Arabani & Amani, 2007) and also another study for for the projection of transport demand for New Delhi adopted operational models for the purpose of transport analyses and developed trip-generation models based on the least-square regression analysis method as this method is easier to interpret (Sarna *et al*., 1992).

According to the perspective of Bangladesh trip production and attraction is usually related to the three variables which considered a number of factors that are density of land use affecting production and attraction (i.e. number of dwellings, employees etc. per unit of land and higher density), social and economic characters of users influencing production, such as average family income, education and car ownership, and location like traffic congestion and environmental conditions (Rahman, 2011) (Mousavi, 2016). The location and intensity of land use are important variables to understand the relationship between land use and the volume of urban travel (Hurst, 1970). In a study of trip generation model development in the perspective of a developing country's city, Dhaka, Bangladesh, variables considered to influence trip making are–household income, region, household size, the number of employed persons and the number of students in the household region type has the least effects for all the trip purposes (Hasan & Hoque, 2015) and also another research use income, family-size and car-ownership parameters to estimate the number of daily trips production (Arabani & Amani, 2007). The aim of the study is to determine of the trip generation model of *Shugondha* residential area of Chittagong city. As people who live in the study area belong to different income groups, i.e. higher, middle- and lower-income groups. The travel behaviour of inhabitants of the study area depends on trip maker's socio-economic characteristics and the purposes of traveling within or outside of the study area. The total number of trips generated from the area has a significant impact on the overall transport system of the city.

## METHODOLOGY

*Sugondha* residential area is selected as the study area which is situated at the western part of Chittagong City Corporation. This area is very near to Panchlaish police station and Chittagong medical college which is considered as one of the finest and well functioned residential units in Chittagong. Though it's a residential area, there is also some other land use like commercial, mixed, education etc. for convenience of the inhabitants. To conduct this study a consecutive methodology has been adopted. For primary field data collection random sampling process has been adopted and total 175 samples of household have been taken from the field through home interview process about frequency (origin and destination) of trips, total household's trip etc. Some socio-economic, accessibility data are collected from the field through questionnaire survey for the trip generation analysis. After completing the field work and data collection, SPSS software has been used to analyse the data through multiple linear regression method. Regression equation is established for the trip generation model on the basis of different dependent and independent variables (Arabani & Amani, 2007). Applying the linear regression model is a common form of using a correlation model as follows**:**

$$Y = a + b_1 x_1 + b_2 x_2 + \ldots + b_n x_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1)$$

From the equation (1), Transport generated trips are expressed as the number of trips per unit x, where x the factor that describes the independent variables and Y- the dependent variable (trips/household), $x_1$, $x_2$…....independent variables , $b_1$, $b_2$…….$b_n$ – regression coefficients that show to what extent Y

changes, if $x_n$ variable increases (Zenina & Borisov, 2013). For regression analysis different explanatory independent variable are taken such as accessibility status access time, egress time, access mode, egress mode etc. also analysed and represented through graph, chart etc. The current paper considers various information systems for trip generation calculation based on regression equations. After data analysis the output is interpreted and on the basis of it final conclusion of the analysis is reached.
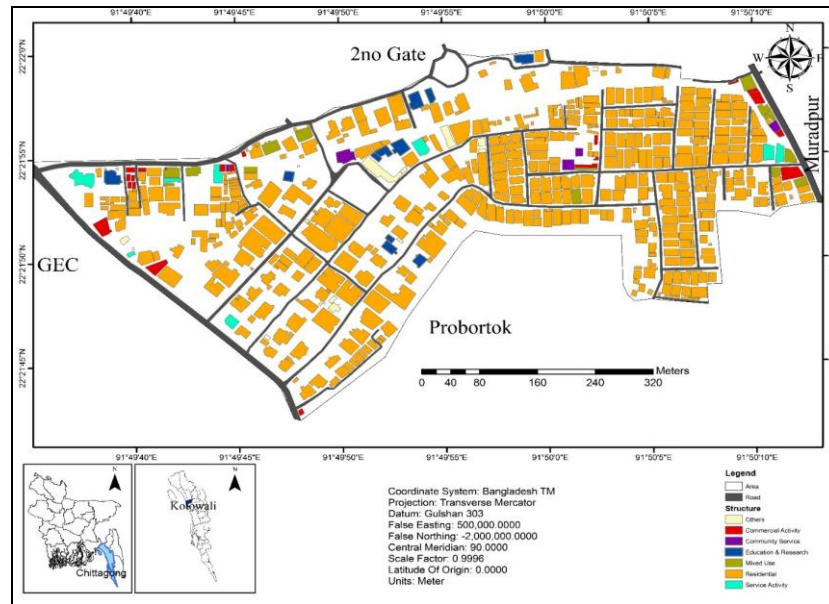


Fig.1: Location and Land-use Map of Sughondha R/A

**RESULTS AND DISCUSSIONS**

*Regression*

The results of these investigations are accomplished by statistical software through the regression method. Several independent variables are selected for determining the regression equations of the trip generation model.

Table 1: Coefficient Table of Explanatory Variables

| | **Coefficients[a]** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Model** | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** | **Sig.** | **95.0% Confidence Interval for B** | |
| | **B** | **Std. Error** | **Beta** | | | **Lower Bound** | **Upper Bound** |
| (Constant) | 4.27 | .979 | | 4.364 | .000 | 2.333 | 6.208 |
| Family size | .374 | .074 | .387 | 5.065 | .000 | .228 | .520 |
| Total trip time | .031 | .004 | .763 | 7.889 | .000 | .023 | .038 |
| Ownership of mode | -.012 | .098 | -.008 | -.127 | .055 | -.207 | .182 |
| Comfort | -.060 | .109 | -.040 | -.544 | .087 | -.276 | .157 |
| Fare | .012 | .083 | .014 | .142 | ..022 | -.153 | .177 |
| Reliability | .019 | .106 | .016 | .183 | .855 | -.191 | .230 |
| **a. Dependent Variable: Total number of trips** | | | | | | | |

The variables are mode ownership, family size, reliability, total trip time, comfort and fare. It is known that explanatory variables should be highly correlated to the dependent variables but they should not be highly correlated among them. Table 1 and 2 representing the coefficient correlation value of the explanatory variables. From the correlation table 2 showing the Pearson correlation and significance (2-tailed) among the four variables which are main mode, comfort, fare and reliability and the mode choice of the residents are highly correlated with the fare and reliability. Here people tend to choose the

mode of travel where comfort and reliability correspond to the fare, they actually have to pay to commence the travel.

As shown in table 1, the number of trips produced by a household is highly dependent on family size and household structure. The number of the trip increases with the extended family size. Another factor affecting the number of household trips is its trip time. As the coefficient of total time .031 increases with higher number of trip generation, household with higher number of people spent more time in trip purpose. Whether different household members use a private car or public mode of service, the availability of alternative modes of transport and average income level also reflects the number of trips originated in that community. So, the number of trips made by each mode of transport is under the influence of comfort, fare and level of services of that mode to the community. The coefficient of comfort is -0.060, which indicates that with the increase in the average number of household trips, the comfort of the people decreases. Since, the coefficient of trip fare is 0.012, which means with the low fair rate in trips the average number of household trip will be increased. The reliability depends on the level of service of transportation modes and with the increase rate of reliability .019, the number of trip also increases.

The final estimated total number of trip equation is

$Y= 4.27+.374X_1+.031X_2-0.012X_3-.060X_4+.012X_5+.019X_6$

Here $X_1, X_2, X_3, X_4, X_5, X_6$ are explanatory variables which represents the value of family size, total trip time, comfort, fare and reliability respectively.

Table 2: Correlation Table of Explanatory Variables

| Correlations | | Main mode | Comfort | Fare | Reliability |
|---|---|---|---|---|---|
| **Main mode** | Pearson Correlation | 1 | .162* | .221** | .139 |
| | Sig. (2-tailed) | | .042 | .005 | .082 |
| **Comfort** | Pearson Correlation | .162* | 1 | .498** | .657** |
| | Sig. (2-tailed) | .042 | | .000 | .000 |
| **Fare** | Pearson Correlation | .221** | .498** | 1 | .644** |
| | Sig. (2-tailed) | .005 | .000 | | .000 |
| **Reliability** | Pearson Correlation | .139 | .657** | .644** | 1 |
| | Sig. (2-tailed) | .082 | .000 | .000 | |

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 3: Model Summary

| Model | R | R Square. | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .774a | .599 | .572 | 1.01291 |

a. Predictors: (Constant), Reliability, Educational qualification, Family size, Ownership of mode, Comfort, Total trip time, Fare

The table 3 represents the total model summary of the multiple regression analysis of trip generation model. From the table it has been seen that the value of R is 0.774 and the value of $R^2$ is 0.599 indicating that the explanatory variables (dependent variable) entered into the model explain 59.9% of the variation of the trip generation model where the significance level is less than .05.

Table 4: ANOVA for regression

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 183.782 | 8 | 22.973 | 22.391 | .00a |
| | Residual | 123.118 | 120 | 1.026 | | |
| | Total | 306.899 | 128 | | | |

b. Dependent Variable: Total number of trips

The results obtained from the ANOVA table 4 shows the analysis of total variance (regression and residual) in the dependent variables. The degree of freedom found for the regression is 8 and for residual is 120.

*Socio-economic analysis:*

The relation between occupation and income is shown in Figure 2. Among the high-income class people, most of them are mainly associated with job or service occupation. Another profession found in the residential area is business class people working in different parts of Chittagong city. The middle-income class people are dominated by government or private jobs than business which is very common among the higher income class people. In middle-income class dominating profession is job than business. The lower income class people correspond to almost the same number of professions like job, business or others.
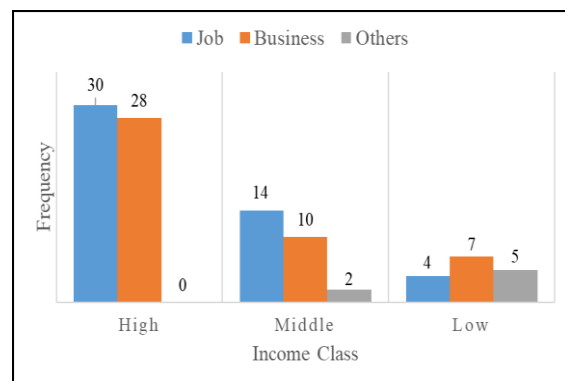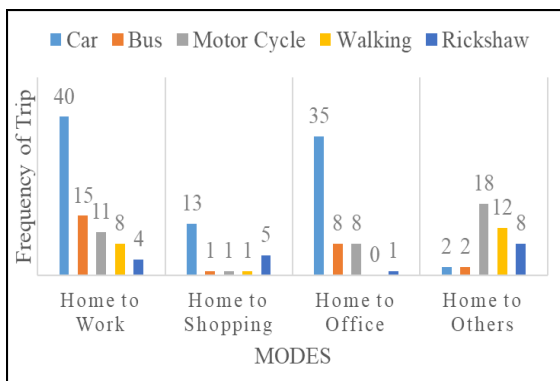


Fig.2: Relation between Occupation and Income    Fig.3: Frequency of Trip with different Modes

The scenario of different types of trip frequency with mode of transport is described in figure 3. Car trip frequency is high for home to work, home to office and home to shopping trips. Some people also use other modes of transport for their trip. Mostly the high-class groups use the car to reach their destination and this is maximum. The lowest usage of car is in the home to others as the middle and lower classes are major here. The variation of the required time to reach the destinations by different modes of transportation is explained in figure 4. The required time of the high-class groups is the lowest. It's because of the rich use car or motorcycle or other motorized private vehicles and faster than the other non-motorized vehicles like the rickshaw. So, they can get to their destination at the shortest period of time. On the contrary, the middle- and lower-class group's required time for making a trip is higher, especially highest for the lower class groups.
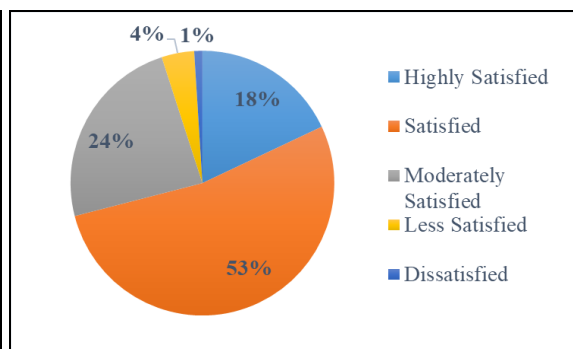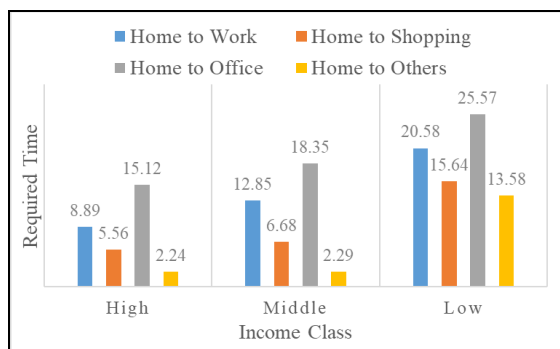


Fig.4: Relation between Time with Income class    Fig.5: Satisfaction with Comfort of Trip Mode
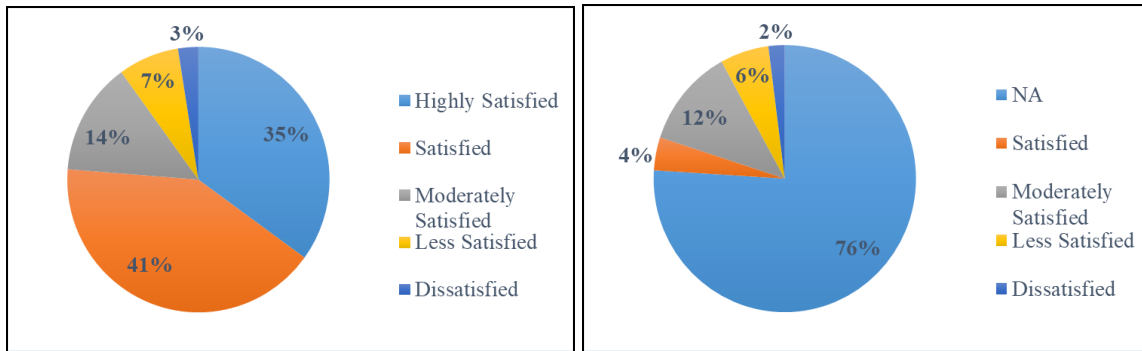
Fig.6: Satisfaction with Reliability of Trip Mode    Fig.7: Satisfaction with Fare of Trip Mode

The graph 6 shows, the satisfaction level of the residents on the reliability of the transport mode they use for their daily purpose. Among the total respondents 33% people are satisfied and 28% people are highly satisfied with the reliability of transportation mode as most of them have their own vehicle ownership more specifically car ownership as a transport mode. It is found from the analysis that 31% of the total respondents are moderately satisfied with the reliability of the transport mode as for reliability even the car owners cannot rely completely on it as the traffic jam severe someday. The satisfaction level of the residents of the residential area on the fare of the transport mode is shown in figure 7. Among the total respondents, 76% people didn't respond their comments on this as most of them have their own vehicle ownership they don't need to pay the fare of transport mode. The percentage of moderate and less satisfied respondents are respectively 12% and 6% with the fair of the transport mode. Only 4% people are satisfied with fair and 2% people are completely dissatisfied as shown in Fig 7.

**SUMMARY AND FINDINGS**

Trip generation model is the first step of four stages Travel Demand Model. It determines the total number of trips generated from a parcel to the others parcel of the city. Transportation trip generation models were evaluated taking into account the socio-economic character, accessibility status, and land use and transport infrastructure availability in the research area. Derived findings from the research work are given below

- The results obtained from this research are variables mostly affect the trip generation model are Family size, total trip time comfort, fare and reliability respectively and among them some are positively and rests are negatively related.
- It is found that among the high-income class people, most of them are mainly associated with job or service occupation and rest of them are found to be businessman.
- In this research, it was observed that in middle-income class people are dominated by the profession of Government or private job.
- In transport mode and work purpose relationship, it is seen that car trip frequency is high for home to work, home to office and home to shopping trips.
- Also found that the required time of the high-class groups to reach the destination is the lowest as the rich use car or motorcycle or other motorized private vehicles and they are faster than the other non-motorized vehicles like rickshaw.
- On the contrary, the middle- and lower-class groups required time is higher, as they depend on the non-motorized vehicle or public buses.
- It was also observed that among all the total respondents most of the people are satisfied with the comfort and reliability of transportation mode as most of them have their own vehicle ownership.

**CONCLUSIONS**

Traffic generation analysis plays an important role in transportation planning. Shugondha residential area, because of its good transport system is an attractive place to people for accommodation with all services & facilities and some employment opportunity. The population of the study area is increasing day by day and the increasing population pressure increasing the total trip generated from the study area rapidly. In the study area, there is some potential employment opportunities for people, who live there

and as well as for people who come from outside of the study area. Depending on the analysis of trip generation, a smooth transport network can be designed for the study area. The factors which have the negative impact on the total trip generation from the study area should be taken into the consideration. Measures should be taken to fix the problems of those factors. Since the generation of trips from any particular area has a significant impact on overall transportation planning, especially to determine travel demand and modal availability for the inhabitants of the study area. The study should be done on regular basis for development, improvement and upgrading the transport facilities. The design of the street should also be made after forecasting the total number of trips to ensure accessibility of modes operating in the study area. Proper emphasis should be given for the development of road network of the study area by determining the total number of trips generated from the study area for smooth operation of traffic and as well as for proper management of the traffic system

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