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DEVELOPMENT OF URBAN TRIP GENERATION MODEL BASED ON RESIDENTIAL AREA: A CASE STUDY OF WARD NO. 09 UNDER KHULNA CITY CORPORATION, BANGLADESH

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ABSTRACT

The aim of this paper is to formulate a trip generation model using Cross-Classification method for the ward no. 09 under Khulna City Corporation based on Boyra Residential Area. Therefore, five key variables (households size, monthly income, car ownership, trip number for specific purposes and trip cost) were used to prepare four basic models of Cross-Classification method i.e. Income sub-model, Car ownership sub-model, Trip production sub-model and Trip purpose sub-model. A household is considered as a sampling unit for primary data collection process. Households interview were used through questionnaire survey on travel behavior, travel characteristics and socio-economic characteristics of the residents. The collected data were analyzed by using the Statistical Package for Social Science (SPSS) software. The result of the analysis shows that trip generation is dominated by the impact of medium income group and produced most of the trips (45.81%) in the study area. On the other hand, most of the trips are produced from low and medium income groups those who do not have any car though the people with higher income have more car ownership (94.41%).The result also indicates that the home based education trips (59.71%) contribute higher among the different trip purposes. The number of trips generated from the study area is strongly influenced by the population, household's size, income level, active workers and students of the area. By using this method trip production of other part of the city will be predicted and will provide a guideline to the city development authority for the smooth operation of transportation management plan.

INTRODUCTION

Trip generation is one of the four steps of conventional transportation modeling (Rahman, 2011). It is widely used for forecasting travel demands. It also predicts the number of trips originating in or destined for a particular traffic analysis zone. The trip generation consists of the trip production and trip attraction. The trip production analysis focusing on residences and residential trip generation is thought of as a function of social and economic attributes of households. At the level of the traffic analysis zone, residential land uses produce or generate trips. Residential land use is the main trip generator in an urban context. Household generated trips comprise a major portion of all trips in an urban area. Actually more than 80% of trips in an urban area are generated by the residents of households in the area. The various characteristics of residential land use such as density, demographic, socioeconomic factors etc. influence the number of trip generated from an area. The household surveys are conducted to obtain the socio-economic as well as trip details of the residential areas (Panackel and Padmini, 2013). From this point of view, the most common methods for trip generation analysis are cross-classification (also referred to as category analysis) and multiple regression analysis. In this study cross-classification method is used to calculate trip generation. Cross -classification is a technique in which the change in one variable trip can be measured when the changes in other variables land use and socioeconomic are accounted for (FHWA, 1975). According to this method, various socio-economic and transportation related data are used for the preparation of trip generation model of selected ward under Khulna City Corporation area. Khulna is a metropolitan city of Bangladesh with huge population and employees has noticeable number of industrial and commercial activities. The population of the study area is increasing day by day, because of its close proximity to Khulna City and also a suitable place for growing industry, trade and commerce. In an urban area, a zone with a larger number of households or employees will generate more trips than a zone with smaller number of those.

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The rate of trip generation is also influenced by population, labor force participation rate, work at home (change in proportion of labor force that works outside the home), daily first work trips per person employed outside the home, morning work trip, peak-period factor (fraction of daily work trips occurring during the morning peak period), non work trip adjustment factor applied to work trips, total morning peak period trip origins and morning peak period work trip destinations i.e. at the place of work (Miller and Briggs, 1998). The objective of the study is to investigate the travel behavior and the travel characteristics such as trip rate, mode of travel, trip purpose, time required to make a trip, cost require etc. in the study area for preparation of a trip generation model. This research also analyzes the inter-relationships of trip generation variables. Based on the trip generation analysis, it is easy to adopt measures for improving transportation facilities for the people of the study area for their convenience and comfort.

In the study cross-classification method is used to prepare the trip generation model. According to the FHWA (Federal Highway Administration), cross- classification method has the following sub-models (FHWA, 1975):

1. **Income sub-model:** Reflect the distribution of households within various income categories (e.g. high, medium and low).
2. **Car ownership sub-model:** Show that the relation between the household income and auto ownership.
3. **Trip production sub-model:** Establish the relationship between the trips made by each household and the independent variables.
4. **Trip purpose sub-model:** Relate the trip purposes to income in such a manner that the trip productions can be divided among various purposes.

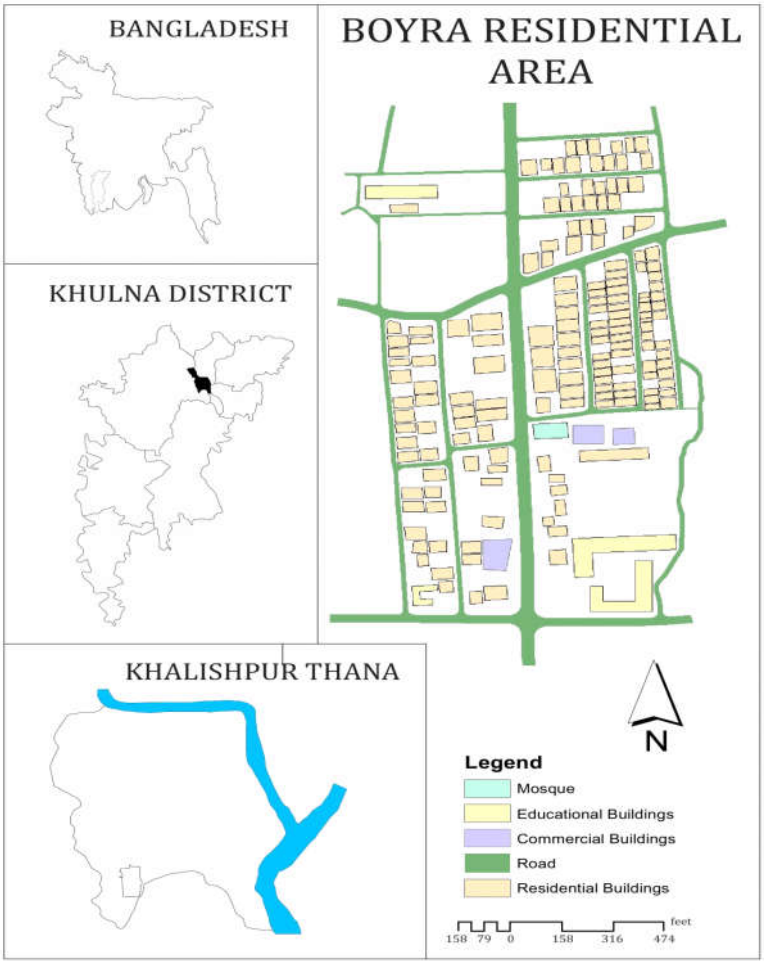

Figure 1. Study Area

Methodology

Boyra residential area under the ward no. 09 of Khulna City Corporation area is selected as the study area. It is in the Khalispur Thana and consists of two different residential areas named "Mujgunni Residential Area" and "Khalishpur H.E. Residential Area". There are total eight (08) mauzas in this ward. Those are- Dakshin Muzgunni, Goalkhali, Goalkhali Bastuhara Colony, Khalishpur H.E. (S.West Block), Madhya Muzgunni, Uttar Bara Boyra, Uttar Muzgunni & Uttar Boyra Junction. A total household in the overall ward is 7451 and located on the northern side of the Boyra Road junction.

In developing trip generation models, several basic decisions need to be made, such as the independent variables, the trip type, and the trip purposes to be used in the analysis. It is suggested that the variables to be used for the trip production models be income and car ownership, and that the trip type be either person trips or auto driver trips, depending on the approach to transit planning. For areas where there is minor transit use currently and no appreciable growth is expected, the trip type may be auto driver trips. The trip purpose stratification is usually dictated by the trip distribution and modal usage models being developed. For internal area travel, the choice of purpose will vary somewhat by size of area. The

larger studies will usually consider five purposes (Horn, 2009)-

- Home based work
- Home based education
- Home based market
- Home based recreation
- Home based others and
- Non home based trips.

In this study only home based trips are considered as trip purposes. For these models the selected variables are: Households size, Monthly Income, Car ownership, Trip number (Work, Education, Market, Recreation, Others) and Trip cost (Work, Education, Market, Recreation, Others). From this point of view, it is needed to determine the appropriate number of sample size for data collection. Sample size selection plays a vital role to show actual scenario according to objectives. A household may be considered as a sampling unit for the questionnaire survey in this study. Here, 150 sample sizes are selected for feasibility of the study. Then, two types of data are collected i.e. primary data and secondary data. The primary data collection process is included preparation of questionnaire for household survey in Boyra Residential Area. The questionnaire was prepared for collection field survey data through direct interview. On the other hand secondary data are collected from various journals, books, Bangladesh Bureau of Statistics (BBS) etc. The data obtained from the primary and secondary sources for Boyra residential area are projected for the overall ward (ward no. 09). The result for the four trip generation model was derived after the completion of data analysis of projected data.

Data Analysis and Findings

Income Sub-model

Income sub-model is the reflection of the distribution of households within various income categories (i.e. High, Medium & Low). The frequency and percentage of the household according to three different classes is calculated. Table 1 shows the calculated frequency and percentage of the households acquired from the sample data and Table 2 shows the calculated value for the total household of Ward no 09. Table 3 is the matrix for income sub-model and Figure 2 represents the income sub-model.

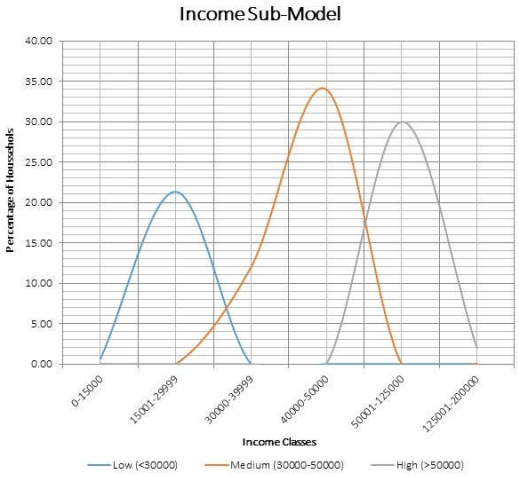

Figure 2. Income Sub-Model

According to income sub-model, the percentage of medium income class group is highest (46%).

Table 1. Percentage of income classes for sample data (150 households)

Income Classes	Frequency	Percentage
Low (<30000)	33	22.00
Medium (30000-50000)	69	46.00
High (>50000)	48	32.00
Total	150	100.00

[Source: Field Survey, 2015]

Table 2. Projected output for the ward no. 09 (7451 households)

Income Classes	Total Number of households
Low (<30000)	1639
Medium (30000-50000)	3428
High (>50000)	2384

Table 3. Income Sub-Model for ward no. 09

	<15000	15001-29999	30000-39999	40000-50000	50001-125000	125001-200000
Low (<30000)	0.67	21.33	0	0	0	0
Medium (30000-50000)	0	0	12.00	34.00	0	0
High (>50000)	0	0	0	0	30.00	2.00

Table 4. Car Ownership Sub-Model for sample data (150 households)

	Frequency			Percentage		
Income Classes	0 Car	1 Car	2+ Car	% of 0 Car	% of 1 Car	% of 2+ Car
Low (<30000)	33	0	0	100.00	0.00	0.00
Medium (30000-50000)	68	1	0	98.55	1.45	0.00
High (>50000)	31	15	2	64.58	31.25	4.17
Total	132	16	2			

[Source: Field Survey, 2015]

Table 5. Car Ownership Sub-Model for ward no. 09 (7451 households)

Income Classes	0 Car	1 Car	2+ Car
Low (<30000)	1639	0	0
Medium (30000-50000)	3378	50	0
High (>50000)	1540	745	99
Total	6557	795	99

Table 6. Trip Production Sub-Model for sample data

	Trip Production			Trip Production/Household		
Income Classes	0 Car	1 Car	2+ Car	0 Car	1 Car	2+ Car
Low (<30000)	719	0	0	21.79	0.00	0.00
Medium (30000-50000)	1660	25	0	24.41	25.00	0.00
High (>50000)	785	422	67	25.32	28.13	33.50
Total	3164	447	67			

[Source: Field Survey, 2015]

Table 7. Trip Purpose Sub-Model for sample data (150 households)

		Trip Production by Purpose				
Income Classes	Total Trip Production	HBW	HBE	HBM	HBR	HBO
Low (<30000)	719	211	413	83	4	8
Medium (30000-50000)	1685	452	998	218	9	8
High (>50000)	1274	356	785	126	5	2
Total	3678	1019	2196	427	18	18

[Source: Field Survey, 2015]

Table 8. Trip Purpose Sub-Model for ward no. 09 (7451 households)

		Trip Production by Purpose				
Income Classes	Total Trip Production	HBW	HBE	HBM	HBR	HBO
Low (<30000)	35715	10481	20515	4123	199	397
Medium (30000-50000)	83700	22452	49574	10829	447	397
High (>50000)	63284	17684	38994	6259	248	99
Total	182699	50617	109083	21211	894	894

So it can be suggests that trip generation in this urban area is dominated by the impact of medium income group. The housing rent of urban area is comparatively high than the sub-urban area that's why the numbers of low income households are fewer in the study area.

Car Ownership Sub-model

Car ownership sub-model represents the relation between the household income and their Car ownership. In the study three categories of car ownership is calculated.

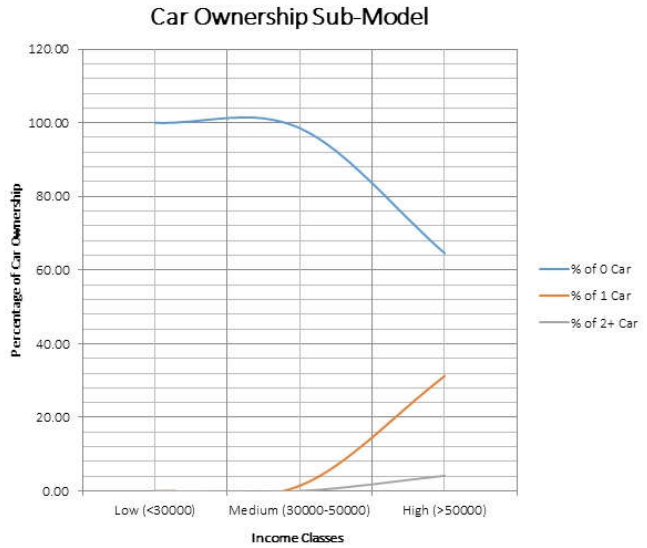

Figure 3. Car Ownership Sub-Model

The households, who do not have any car, are represented by "0 Car". Those who have at least 1 car are represented by "1 Car" and finally those who have more than 1 car are represented by "2+ Cars". Table 4 shows the number of cars according to three different income classes based on sample data and consequently Table 5 shows the calculated value for the total number of households of the Ward no 09. Figure 3 shows the graphical representation of Table 5.

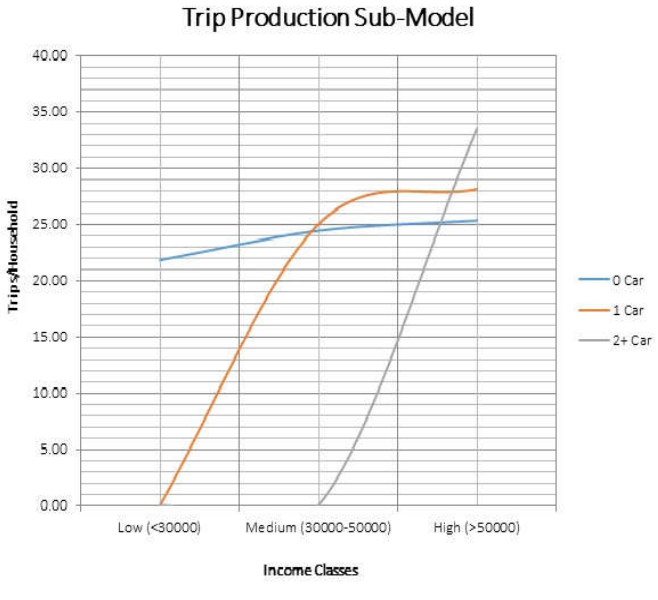

Figure 4. Trip Production Sub-model

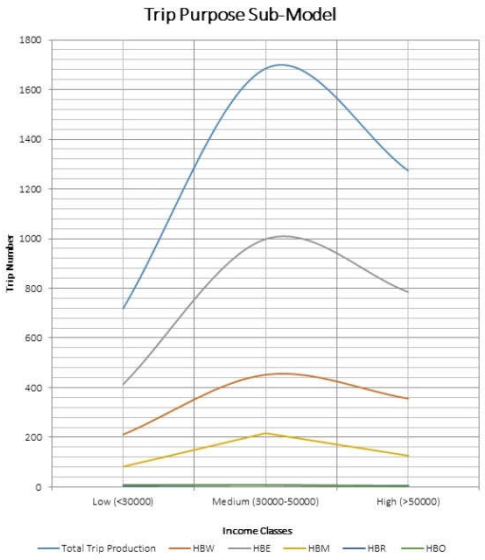

Figure 5. Trip Purpose Sub-model

In context of car ownership the lower income group (range <30000 Tk) are unable to afford any private car. Therefore, the higher income group (>50000 Tk) dominates the higher car ownership (1 Car- 745 & 2+ Car- 99). Alternatively, middle income group afford a small percentage of car ownership (1 Car- 50).

Trip Production Sub-model

Trip production sub-model establishes the relationship between the trips made by each household and the independent variables. In this study the sub-model is created by establishing relationship between income classes and car ownership categories. From the sample data, each household has a trip production data. According to these data, the trip production sub-model is prepared. Table 6 shows the trip production value for each income class with respect to the car ownership category for sample data. It also noticed that trip production sub-model for ward no. 09 is same as Table 6. Figure 4 shows the graphical representation of Table 6. Figure 4 shows that the highest trip is generated from medium income group (1685). Medium income group has more active workforce than the others income group therefore, more active workforce creates more trips. It is also indicates that households size and households composition of middle income group plays a vital role in trip production.

Trip Purpose Sub-model

Trip purpose sub-model relates the trip purposes to income in such a manner that the trip productions can be divided among various purposes. In this study only Home based trips are calculated. The purposes are classified as follow- i) Home-based Work (HBW) ii) Home-based Education (HBE) iii) Home-based Market (HBM) iv) Home-based Recreation (HBR) and v) Home-based Others (HBO).

Various purposes with respect to the income classes of the households are measured in the trip purpose sub-model. Table 7 shows the relation based on the sample data and consequently Table 8 shows the relation based on the total number of households. Figure 5 shows the graphical representation of Table 8.

Figure 5 shows that, highest trip is generated for home-based educational purpose (59.71%) in the study area. On the other hand, the lowest trip is generated for home-based recreational & others purposes (894). As there is a residential park located very close to this area, people generally go to this park for recreational purposes.

Conclusion

Preparation of trip generation model is an important tool in transportation planning. This study has shown the calculation and analysis of trip generation model for ward 09 of Khulna City Corporation area. A number of variables are used in this analysis and it is found that the income level of maximum household is good enough, though the number of car ownership is not so high. So, the favorite modal choice of the people of that area is Easy Bike and Tempu. It is also suggest that the increasing income level increases the trip production per week. This study will provide a basis for preparation of trip generation model in other parts of the city and accordingly the guideline for planning intervention on priority basis. The method of trip generation that is described here may become a guide to city development authority to prepare a transportation management plan.

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