

HOUSEHOLD TRIP GENERATION

A PILOT STUDY

by

*J. R. Underwood
Department of Civil Engineering
University of the West Indies
St. Augustine, Trinidad*

and

*R. Ramcharan
formerly
Department of Civil Engineering
University of the West Indies
St. Augustine, Trinidad*

SUMMARY

This article reports the results of a pilot trip generation survey carried out by home interview in the Balmain district of Couva. The relationships derived, relating tripmaking to household size, number of workers, job status and vehicle ownerships are considered realistic. A numerical model is derived and results are compared with studies elsewhere, indicating a comparatively low level of tripmaking activity in the study zone.

1. INTRODUCTION

The development of trip generation relationships forms a vital and integral part of the transportation planning process. The techniques developed are aimed at enabling estimations of future levels of person or vehicle trips to be made, based upon observed present relationships between travel characteristics and identified influencing factors. It is generally assumed [1] that trip making is a function of three basic groups of influences, namely:-

- i) The land-use and development pattern in the area of study
- ii) The socio-economic characteristics of the trip-making population
- iii) The capabilities of the transportation system in relation to the study area.

These factors can be represented by a variety of independent variables. It is normal practice to estimate trip productions and attractions for defined traffic zones, the values thus derived being input to a trip distribution process which uses synthetic models.

Recent transportation studies undertaken in Trinidad [2], [3] have used growth factor models for the trip distribution process, utilising data obtained from roadside origin-destination surveys thus removing the need for the development of detailed trip generation relationships. For projection purposes in areas of stable land use such growth factor methods can be used with success, but it is felt [4] that these methods are fundamentally weak in a situation of rapidly changing land use and development patterns. The development of proper trip generation relationships can, to some extent, avoid this shortcoming.

The objective of the present study is to develop preliminary trip generation relationships in respect of a specific, arbitrarily chosen district of west-central Trinidad, to compare the results with those from comprehensive surveys undertaken elsewhere (Britain and USA) and thus to determine the appropriateness of using the standard methodology in a Trinidad situation.

2. DATA COLLECTION

The area arbitrarily chosen for the study was the village of Balmain, a suburb of Couva located approximately 3 km. east of the town centre and 2 km. from an intersection on the Sir Solomon Hochoy Highway. This location is shown on Figure 1.

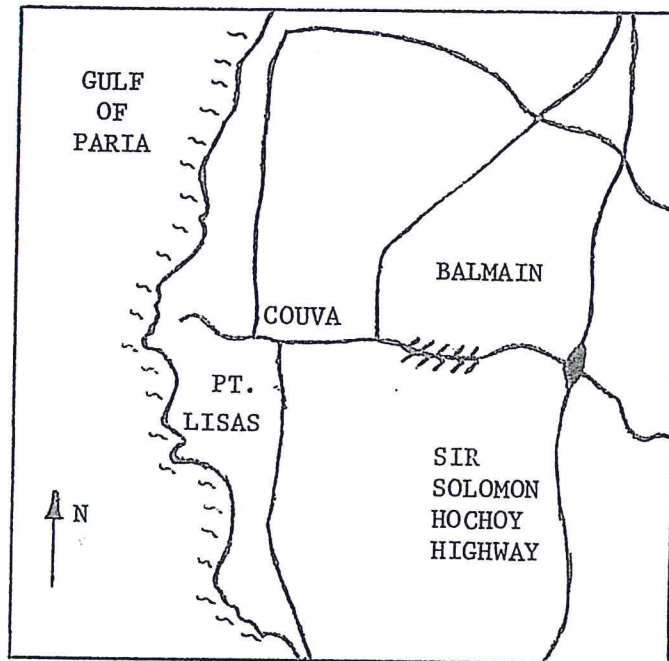


FIGURE 1: LOCATION MAP
(Scale 1: 150,000)

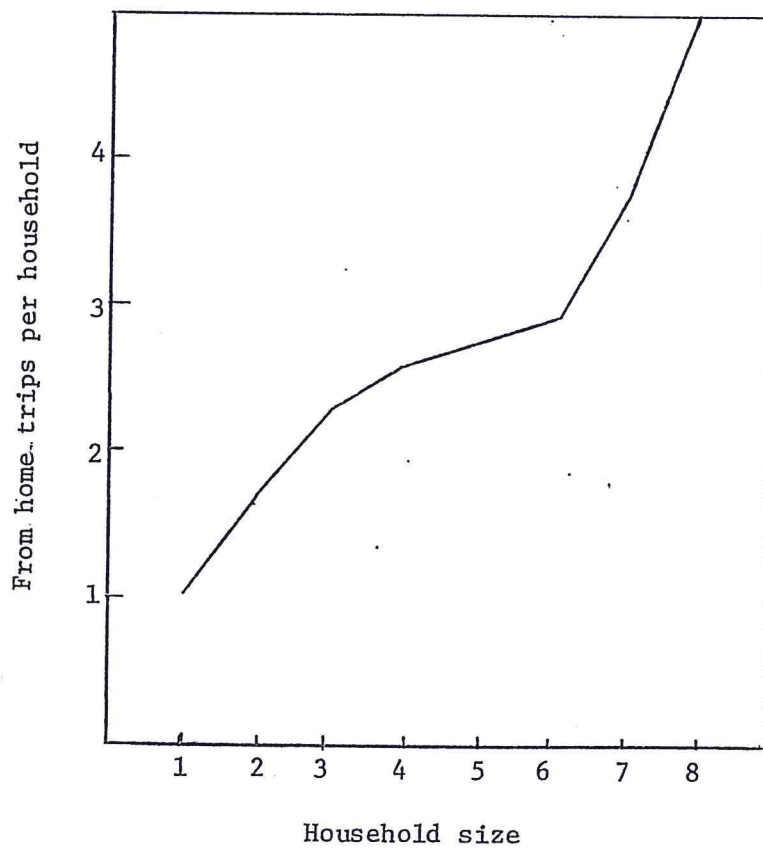


FIGURE 2: FREQUENCY OF FROM-HOME
TRIPS PER HOUSEHOLD AT
VARIOUS LEVELS OF
HOUSEHOLD SIZE

The data collection was undertaken by means of a home interview questionnaire survey, the interviewed households being carefully selected so as to give a range of values of the likely influencing variables such as household size, job status, car ownership and so on. Details of socio-economic characteristics were recorded and the questionnaires were left in the possession of the interviewed person for one week, instructions having been given that the details of all trips undertaken (excluding pedestrian journeys) should be recorded. The questionnaires were then collected at the end of the period. The following items of data were thus collected:-

- i) Household size
- ii) Number of working people in household
- iii) Location of employment
- iv) Number of vehicles in household
- v) Occupation of household head
- vi) Details of trips made
 - a. journey purpose
 - b. mode of travel
 - c. destination location
 - d. time taken for journey

It is to be noted that in respect to details of trips made, journey purpose was categorised into trips connected with work and non-work trips. Trips connected with work include journeys made in the process of work and those made to a place of employment. Non-work trips encompass journeys made for all other purposes for example school, shopping, entertainment and visiting friends.

The study zone is not directly served by the bus network of the Public Transport Service Corporation so the available modes of motorised transit are, therefore, private car and route taxi.

3. INFLUENCING VARIABLES

This section summarises the relationships between the likely influencing variables and the number of trips made per household. Throughout the analysis the trip unit used is "from home trips" per household per day. These are journeys made with the home as the origin.

It is assumed that a corresponding trip with the home as destination will also be made. In addition, certain non-home-based trips will also have been made but these are not accounted for and in any case do not normally exceed 10% of total trips. [5]

3.1 Household Size

This factor is an obvious major determinant of trip making characteristics. Travel being a human activity, it is logical that the larger a family or household size, the greater the number of trips made. The general relationship is illustrated in Figure 2. It may be seen from this graph that, up to a household size of six, each additional person adds a decreasing share to the trip making of the household. It is thought that this phenomenon, in general, reflects the presence of younger children who do not need to use motorised transport to gain access to primary education. It is also noted from Figure 2 that the trip frequency increases rapidly in family sizes greater than six. This is a result of the increased presence of persons of secondary school age who utilise motorised transportation to gain access to their places of education. This is illustrated further in Figure 3 which gives a breakdown of trips against family size by journey purpose, where it is noted that in the large family sizes it is the number of non-work trips which experiences the rapid increase.

3.2 Number of Wage Earners

As would be expected the number of from home work trips per household varies linearly with the number of wage earners in the household as is illustrated in Figure 4. The total number of trips per household reflects a greater than linear relationship with the number of wage earners and this reflects the greater comparative wealth (and hence car-ownership, see 3.4) of households with more than one income. Referring to Figure 3 as a cross-reference, it may be noted that, in general, the number of work trips made does not vary greatly with increasing family size indicating the absence of a strongly intimate relationship between family size and the number of wage earners.

3.3 Job Status

In order to secure maximum co-operation of the interviewees it was considered unwise to ask direct questions concerning the level of household income. However, this problem was avoided by formulating status categories based upon the occupation of the head of the household. Each dwelling unit was placed under one of four status

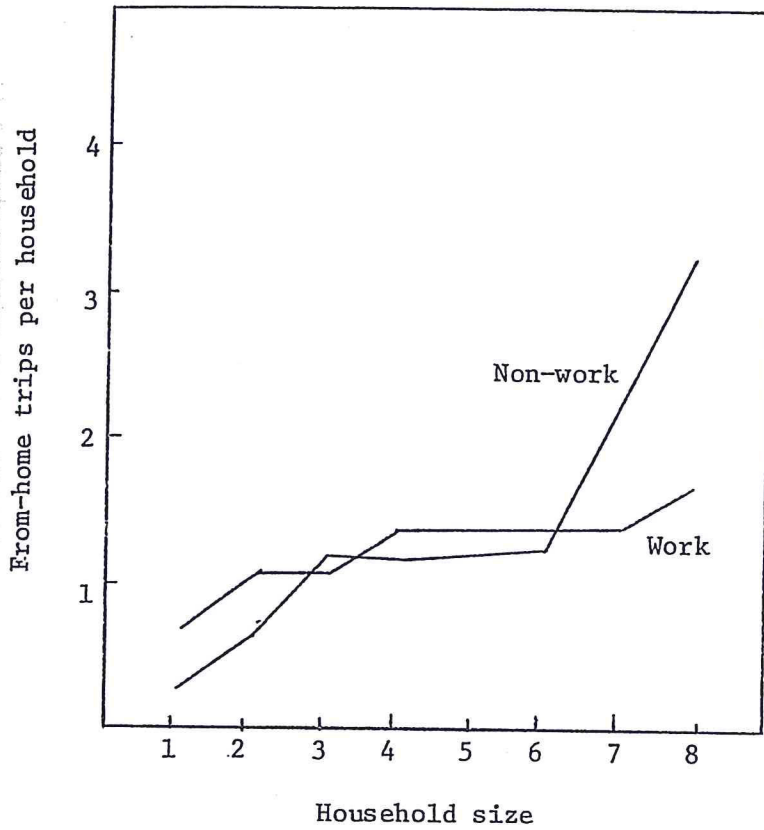


FIGURE 3: FREQUENCY OF FROM-HOME TRIPS PER HOUSEHOLD FOR LEVELS OF HOUSEHOLD SIZE BY JOURNEY PURPOSE

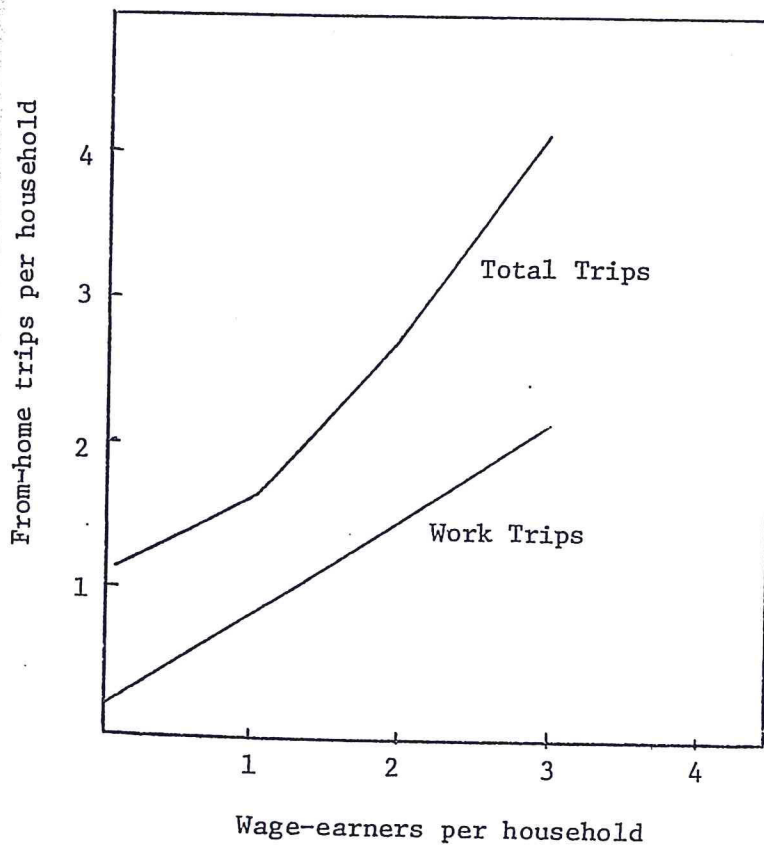


FIGURE 4: FREQUENCY OF FROM-HOME TRIP FOR VARIOUS NUMBERS OF WAGE EARNERS PER HOUSEHOLD

categories defined as follows:-

- i) High: proprietors, managers, professional
- ii) Medium: teachers, salesmen, skilled workers
- iii) Low: semi-skilled and unskilled workers
- iv) Non-gainful: retired, students, unemployed

Occupation status as reflected in income is one of the major determinants of the material standard of living to which a household aspires. As such it is related to trip frequency as well as to other family characteristics such as vehicle ownership which affects trip production.

The relationship between trip frequency and job status is shown in Figure 5 where the expected pattern is observed. However, further analysis reveals that this relationship appears to be more a direct reflection of concurrent variations in family size and vehicle ownership which are, of course, functions of income status.

3.4 Vehicle Ownership

Whilst it is human activity which produces the need for trips, it is the presence of a transportation system which enables trips to be made. In particular, the opportunity to travel, at a personal level, is enhanced by the availability of a car. Consequently, it is to be expected that the frequency of trip making would be a function of vehicle ownership. The relationship between vehicle ownership and the frequency of from home trips per dwelling unit by mode, is illustrated in Figure 6. Travel by the available public transit (route taxi) is seen to decline rapidly between zero and one car owned and car travel grows with increasing car ownership.

High vehicle ownership per household in the survey undertaken was associated with the larger family sizes so the influence of either variable upon trip making tends to be exaggerated by the contributory effect of the influence of the other factor. However, this may be avoided by the development of a multi-variate approach as reported below.

3.5 General Relationships

In the development of numerical trip generation relationships there are, basically, three approaches which have been adopted and are adequately described in the literature. These are the expansion factor

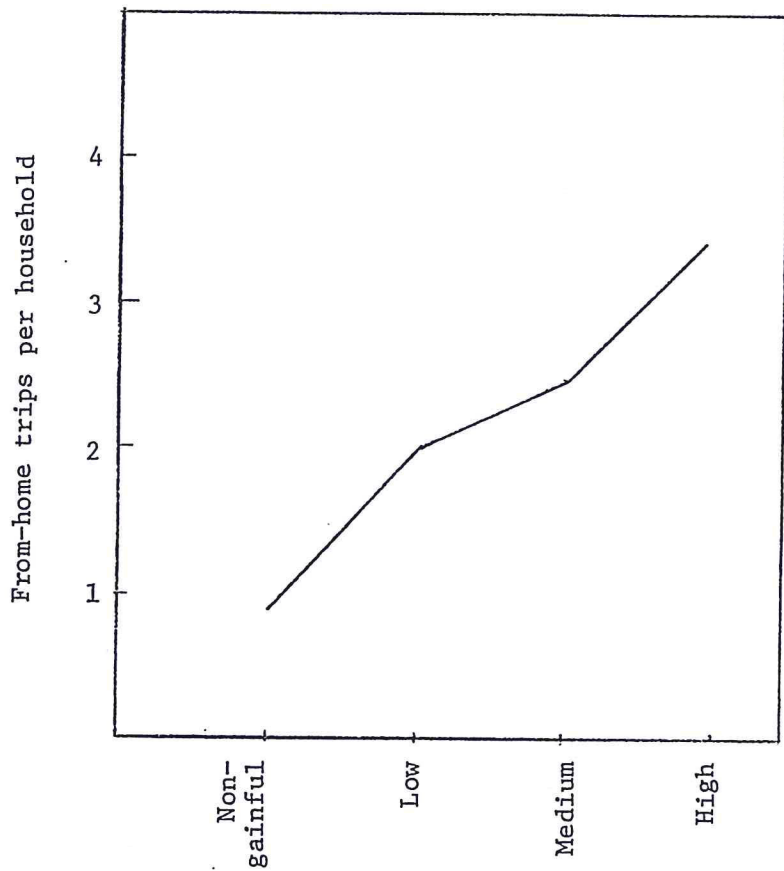


FIGURE 5: VARIATION OF FROM-HOME TRIPS PER HOUSEHOLD FOR DIFFERENT OCCUPATION STATUS

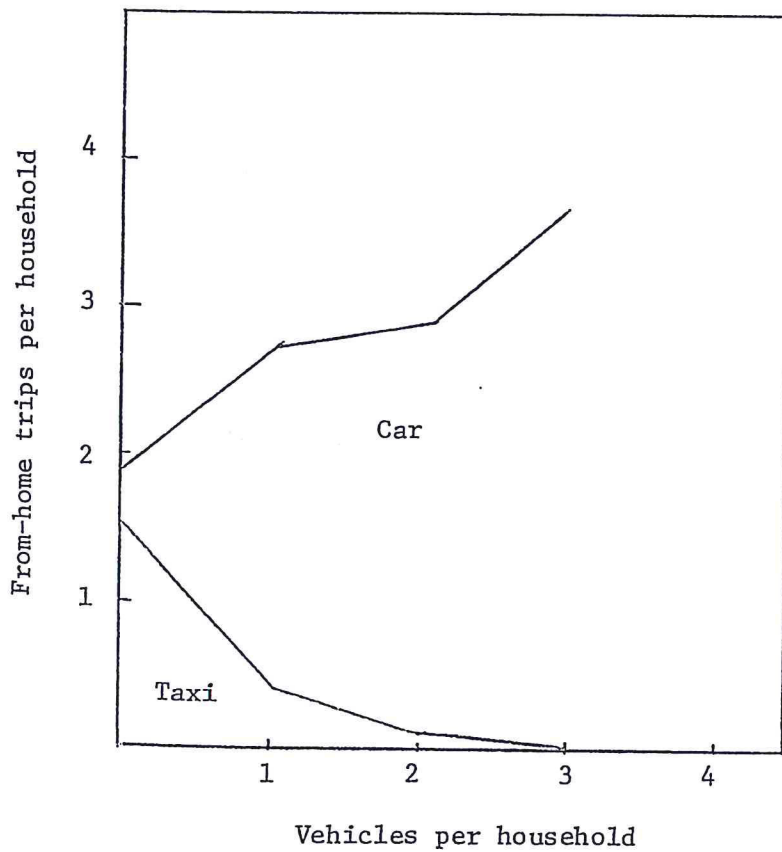


FIGURE 6: FREQUENCY OF FROM-HOME TRIPS PER HOUSEHOLD BY MODE AT VARIOUS LEVELS OF CAR-OWNERSHIP

method [6], multiple regression analysis [7] and category analysis [8]. Expansion factor methods were used in early transportation studies but are no longer thought to be appropriate. The category analysis technique is the most promising for future uses as it is able to utilise fully census-type data classifications; however, in the present study with its limited data collection multiple regression analysis, the most commonly used technique was selected.

The four variables described above (household size, number of employees, job status and vehicle ownership) were input to a regression computer program in order to calibrate a model of the form:

$$T = a_0 + a_1 X_1 + a_2 X_2 + \dots \quad (1)$$

where T = number of trips per dwelling unit

X = independent variables

a = calibration constants

Problems arose in the calibration because of the intimate correlation among the "independent" variables particularly between vehicle ownership and job status and between vehicle ownership and number of employees. For work trips the only significant numerical relationship, within the limitations imposed by the size and nature of the data set which emerged was:

$$T(\text{work}) = 0.193 + 0.676 X_2 \dots \quad (2)$$

where X_2 = number of employees per household

which is, of course, the "work trips" graph exhibited in Figure 4.

For total trips, an equation involving household size and vehicle ownership emerged as follows:

$$T(\text{total}) = 0.681 + 0.170 X_1 + 0.718 X_3 \dots \quad (3)$$

where X_1 = persons per dwelling unit

X_3 = cars per household

This relationship is shown graphically in Figure 7. It should be noted that households owning two or more vehicles have been processed together in an average value. Correlation coefficients for equations 2 and 3 at 76% and 68%, respectively, were significantly different from zero at a 99% level of confidence.

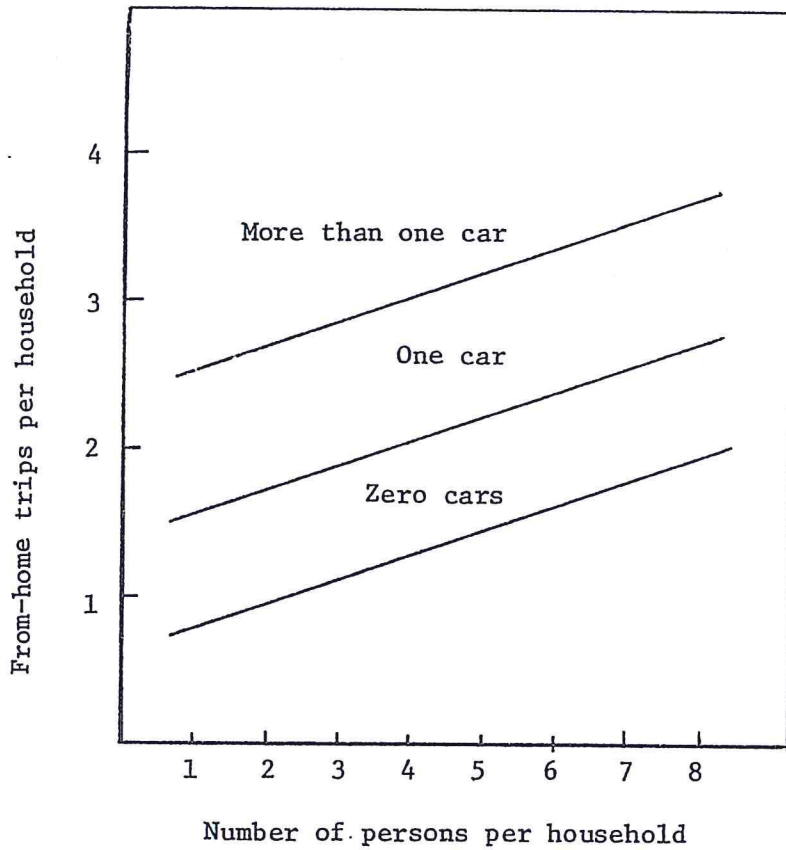


FIGURE 7: DIAGRAMMATIC REPRESENTATION OF THE GENERAL TRIP GENERATION EQUATION. (Equation No. 2)

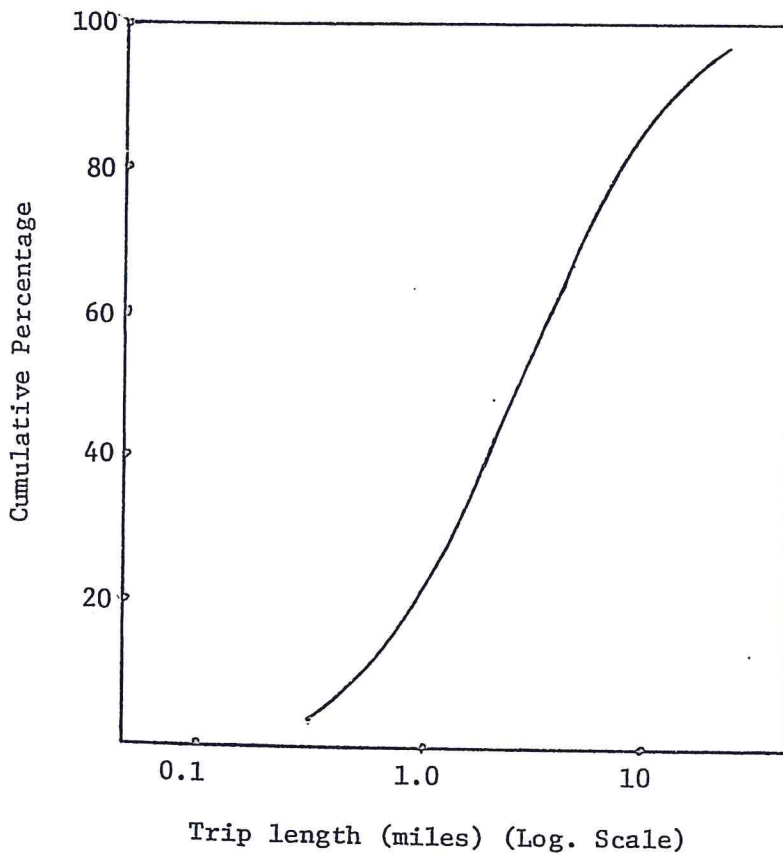


FIGURE 8: CUMULATIVE DIAGRAM OF FROM-HOME TRIPS LESS THAN VARIOUS TRIP LENGTHS

3.6 Trip Distances

It is useful to record the distribution of trip lengths. A cumulative percentage diagram of trips less than a specified distance is shown in Figure 8. A characteristic is the relatively high number of short trips (5 km or less) indicating the attractiveness of Couva as the major activity centre associated with the zone of study. The tendency, in general terms, as car ownership increases is for medium length trips (15 - 35 km) to dominate shorter trips, particularly if associated with declining residential densities. This process is, of course, likely to occur in the future but, in the case under study, is also likely to be offset by the designation of the Couva area as a centre of major development projects.

4. MODEL ASSESSMENT

The foregoing presentation of results produces relationships which are intuitively reasonable so it is indicated that expected patterns have emerged. It is, however, useful to compare the scale of tripmaking activity with studies which have been undertaken elsewhere. In regard to the relationship between household size and number of trips, direct comparison may be drawn between the present study and the results of a review of studies undertaken by Williams et al [9] in Britain, the comparative results of which are reported in Table 1.

PERSONS PER HOUSEHOLD	FROM HOME TRIPS PER HOUSEHOLD	
	WILLIAMS ET. AL.	BALMAIN
1	0.75	0.98
2	1.77	1.71
3	2.96	2.27
4	4.29	2.58
5	4.58	2.75
6	5.29	2.90
7	5.60	3.65

Table 1: Comparison between from home trips per household for various household sizes as derived by Williams et al [9] and in the present study.

The most important emergence from Table 1 is that the scale of transport activity is rather less in the present study than that reported in the comparative paper. This is presumably a result of different household structures and of radically different social attitudes.

The low scale of transportation activity in the present study is emphasized by a more recent British study reported by Bruton [4] and by data derived from the Puget Sound Regional Transportation Study [5] in USA. Adjusting the trip generation equation developed by multiple regression analysis in the British study yields a relationship in terms of persons per dwelling unit (X_1) and cars per household (X_3) approximately as follows:

$$T(\text{total}) = 0.45 + 0.48 X_1 + 0.51 X_3 \dots\dots (4)$$

which gives, for example, a value of from home trips for three persons per household owning a single car of 2.4 as opposed to a value of 1.9 from figure 7 or Equation (3). The equation emerging (using the variables as before) for the American study is:

$$T(\text{total}) = 0.30 + 0.53 X_1 + 1.28 X_3 \dots\dots (5)$$

which yields, for a three person single car household a value of from home trips of 3.2.

The apparent divergence emphasizes the need for comprehensive studies to be undertaken within a Trinidad situation in order to determine more clearly the underlying motivation in respect of trip-making activity, particularly as the society emerges into a more urban industrially oriented nature. Radical changes in social structure are notoriously difficult to accommodate within the transportation modelling process, and the need for care in the application of derived results for projection purposes cannot be overemphasized.

5. CONCLUSIONS

Graphical relationships between household trip generation and the influencing variables of household size, number of employed persons, job status and vehicle ownership have been illustrated. The trends witnessed have been found to be intuitively realistic. A bivariate model relating number of from home trips to household size and vehicle ownership was derived. When compared with similar models developed from studies in Britain and USA, it was found that the tripmaking activity in the zone of study was represented at a low level. This divergence is considered to be related to differing social attitudes and the need for further research is apparent, although it is not unrealistic to assume that the analytical approach adopted is reasonable.

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