4	5	11,000	0
5	5	4,500	1
6	15	17,000	3
7	7	9, 500	1
8	4	9,000	0
9	6	7, 000	1
10	13	19,000	3
11	8	18,000	1
12	9	21,000	1
13	9	7, 000	2
14	11	11,000	2
15	10	11,000	2
16	11	13,000	2
17	12	15,000	2
18	8	11,000	1
19	8	13,000	1
20	9	15,000	1

Example 2: Computing Trips Generated in a Suburban Zone

Consider a zone that is located in a suburban area of a city. The population and income data for the zone are as follows.

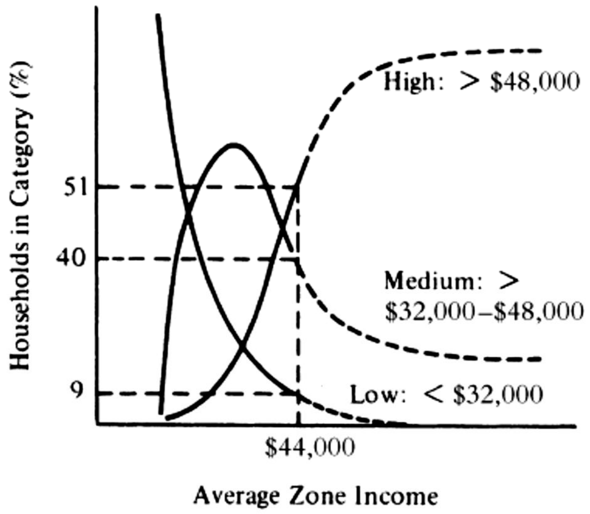
Number of dwelling units: 60

Average income per dwelling unit: $44,000

Determine the number of trips per day generated in this zone for each trip purpose, assuming that the characteristics depicted in Figures 12.2 through 12.5 apply in this situation.

Solution:

The problem is solved in four basic steps.



Average Zonal Income versus Households in Income Category

Figure 12-2 Average zonal income

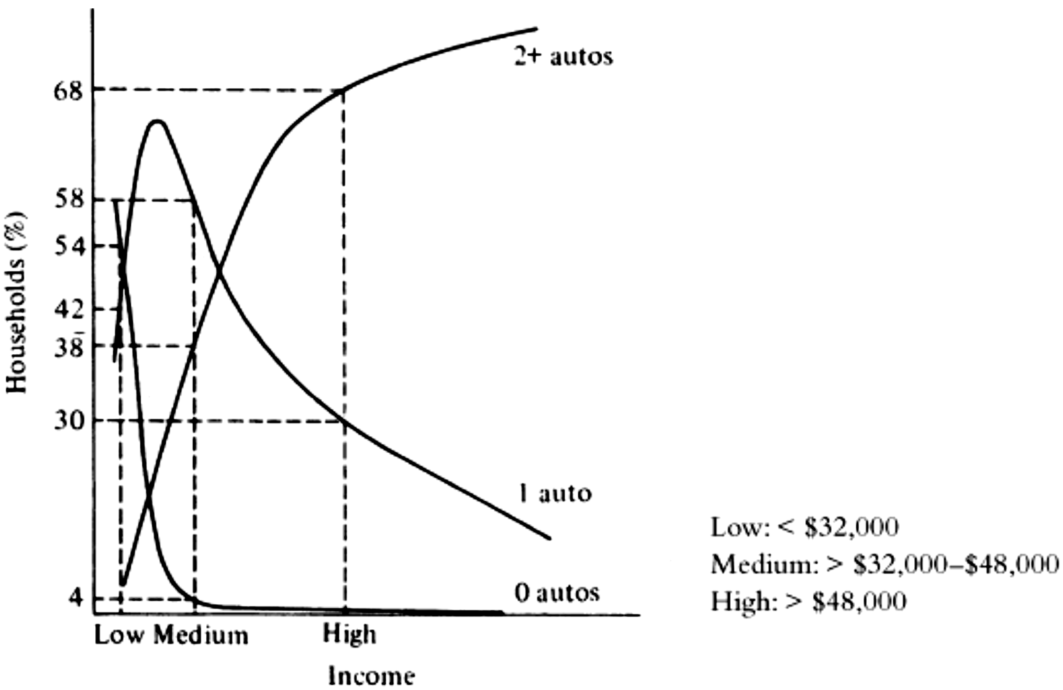


Figure 12-3 Households by Automobile Ownership and Income Category.

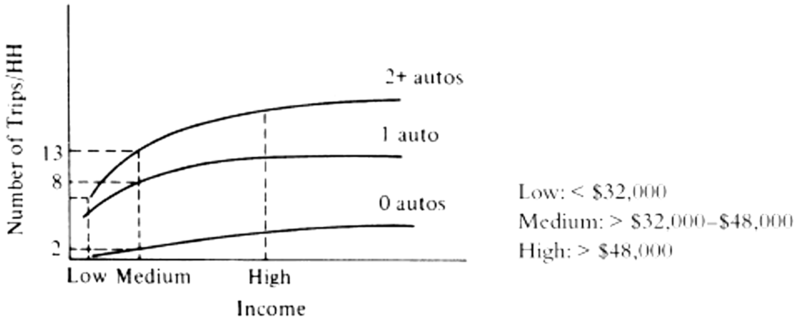


Figure 12.4 Trips per Household per Day by Auto Ownership and Income Category

SOURCE: Modified from *Computer Programs for Urban Transportation Planning*, U.S. Department of Transportation, Washington, D.C., April 1977.

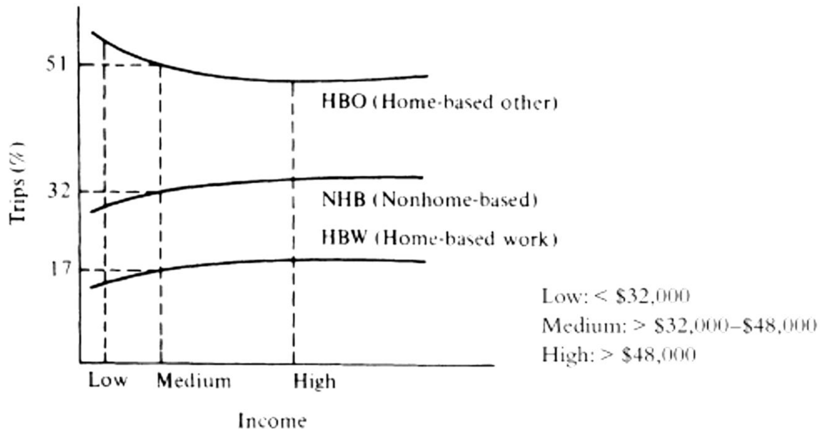


Figure 12.5 Trips by Purpose and Income Category

Step 1: Determine the percentage of households in each economic category. These results can be obtained by analysis of census data for the area. A typical plot of average zonal income versus income distribution is shown in Figure 12-2. For an average zonal income of $44,000, the following distribution is observed.

Income $	Household %
Low	9
Medium	40
High	51

Step 2: Determine the distribution of auto ownership per household for each income category. A typical curve showing percent of households, at each income level, that own 0, 1, or 2_ autos is shown in Figure 12-3, and the results are listed in

Table below. Table shows that 58% of medium-income families own one auto per household. Also, from the previous step, we know that a zone, with an average income of $44,000, contains 40% of households in the medium-income category. Thus, we can calculate that of the 60 households in that zone, there will be (60) * (0.40) * (0.58) = 14 medium-income households that own one auto.

Income	Auto/ houshold		
	0	*1*	*2+*
Low	54	42	4
Medium	4	58	38
High	2	30	68

Step 3: Determine the number of trips per household per day for each income–auto ownership category. A typical curve showing the relationship between trips per household, household income, and auto ownership is shown in Figure 12-4. The results are listed in Table below.

Income	Auto/ houshold		
	0	*1*	*2+*
Low	1	6	7
Medium	2	8	13
High	3	11	15

The table shows that a medium-income household owning one auto will generate eight trips per day.

Step 4: Calculate the total number of trips per day generated in the zone. This is done by computing the number of households in each income–auto ownership category, multiplying this result by the number of trips per household, as determined in Step 3, and summing the result. Thus,

$$P_{gh} = HH \times I_g \times A_{gh} \times (P_H)_{gh}$$

$$P_T = \sum_{g}^{3} \sum_{h}^{3} P_{gh}$$

where

HH = number of households in the zone
I_g = percentage of households (decimal) in zone with income level g (low, medium, or high)
A_{gh} = percentage of households (decimal) in income level g with h autos per household (h = 0, 1, or 2+)
P_{gh} = number of trips per day generated in the zone by householders with income level g and auto ownership h
$(P_H)_{gh}$ = number of trips per day produced in a household at income level g and auto ownership h
P_T = total number of trips generated in the zone

Table 12.6 Number of Trips per Day Generated by Sixty Households

	Income, Auto Ownership	*Total Trips by Income Group*
60 × 0.09 × 0.54 × 1 = 3 trips	L, 0+	
60 × 0.09 × 0.42 × 6 = 14 trips	L, 1+	
60 × 0.09 × 0.04 × 7 = 2 trips	L, 2+	19
60 × 0.40 × 0.04 × 2 = 2 trips	M, 0+	
60 × 0.40 × 0.58 × 8 = 111 trips	M, 1+	
60 × 0.40 × 0.38 × 13 = 119 trips	M, 2+	232
60 × 0.51 × 0.02 × 3 = 2 trips	H, 0+	
60 × 0.51 × 0.30 × 11 = 101 trips	H, 1+	
60 × 0.51 × 0.68 × 15 = 312 trips	H, 2+	415
Total = 666 trips		666

The calculations are shown in Table 12.6. For a zone with 60 households and an average income of $44,000, the number of trips generated is 666 auto trips/day.

Step 5. Determine the percentage of trips by trip purpose. As a final step, we can calculate the number of trips that are HBW, HBO, and NHB. If these percentages are 17, 51, and 32, respectively (see Figure 12.5), for the medium-income category, then the number of trips from the zone for the three trip purposes are 232 * 0.17 = 40, HBW, 232 * 0.51 =118, HBO, and 232 * 0.32 = 74 NHB. (Similar calculations would be made for other income groups.) The final result, which is left for the reader to verify, is obtained by using the following percentages: low income at 15, 55, and 30, and high income at 18, 48, and 34. These yield 118 HBW, 327 HBO, and 221 NHB trips.

2- Regression Analysis

For each of a number of zones a certain number of trip ends - the dependent variable - are observed and each zone has certain measurable characteristics to which this trip generation rate may be related. These characteristics XI. X2, etc. are referred to as the independent variables and are the land-use and socioeconomic factors which have been previously referred to.

The equation obtained by least squares analysis is of the general form:

$Y= b_o +b_1*X_1 +b_2*X_2+ \dots b_n X_n$

where b_O is the intercept term or constant.

B_O, b_1, b_2 .... bn are obtained by regression analysis.

X_1 , X_2 ..... X_n are the independent variables.

In developing regression equations it is assumed that:

(1) All the independent variables are independent of each other.

(2) All the independent variables are normally distributed; if the variable has a skew distribution often a log transformation is used.

(3) The independent variables are continuous.

A typical equation obtained as follows: