

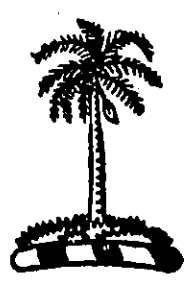
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**URBAN TRANSPORT STUDY
IN
GREATER METROPOLITAN AREAS
OF
GEORGE TOWN, BUTTERWORTH AND BUKIT MERTAJAM
MALAYSIA**

DATA PROCESSING

TECHNICAL REPORT - 13



JANUARY 1980

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DATA PROCESSING

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1.

Introduction

This report outlines the steps taken for data processing by the computer. The principal contents of the report consist of the enlargement of the samples, the production of present and future O-D (Origin-Destination) tables, and the assignment to the road network both in the present (1979) and in the future (1985, 2000).

The data which were used in this report quoted the Technical Reports as below, and these reports are reliable for more details of the surveys.

These Technical Reports were completed in August, 1979.

No. 1 Car Owner Interview Survey

(Taxi, Factory Bus and School Bus surveys)

No. 2 Ferry Survey

No. 3 Cordon Line Survey

No. 4 Screen Line Survey

The computer in USM (Universiti Sains Malaysia) was used for the execution of all the processing in the report.

The study Team wishes to express their sincere thanks to all the persons concerned for the help and cooperation rendered to the Team.

2.

Brief Flow of Data Processing

Figure - 1 shows the simplified flow of data processing of all the calculations through the computer.

Though the flow includes all movements taken by all types of vehicles, those of the Company Buses, which means the scheduled buses, are omitted as objects of analyzing and forecasting, because the routes and the number of the bus operations are fixed and because the precise data concerned are obtained from the authorities. On the other hand, two other kinds of buses, the School Buses and the Factory Buses, are included in the flow since those buses have their own operation each and it is very difficult to collect all the data needed.

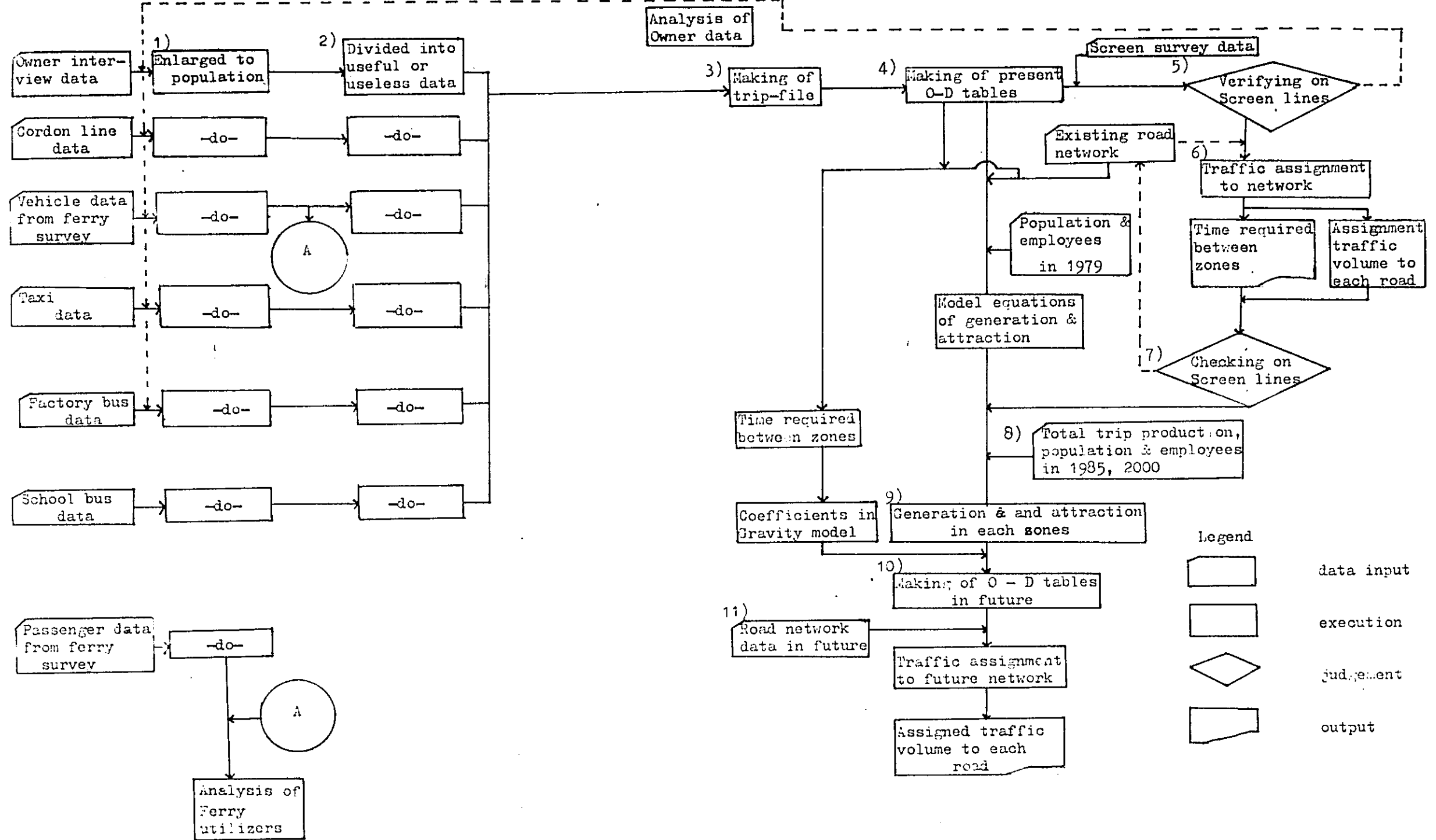
Explanations of the stages in the flow-chart are made according to the numbers:

- 1) The population to which sample data were enlarged, was subject to the number based upon the registered cards of vehicles in each vehicle type for Car Owner Interview, Taxi, Factory and School Bus survey. In case of the population for the other surveys, Cordon Line and Ferry Interview, the counted number of each vehicle type, in each direction and in each time on the survey spots were used.
- 2) As the objective area covered by each survey partially overlapped one another, or as the same movements taken by a certain vehicle might be caught by different surveys, all the data were divided into useful (or alive) data or useless (or dead) ones basing on moving patterns of trips in the study area to avoid double counting.
- 3) As each survey had its own questionnaire with different kind of responses and different sizes of data length according to its purpose, it was very convenient to process the data to make a big trip-file which collected only common data to each survey before producing the O-D (Origin and Destination) tables.

A trip-file consists of such codes or figures as the kind of surveys, vehicle type, origin and destination, alive or dead, enlargement coefficients, etc.

- 4) O-D tables which show the movements in a day during surveying are produced on each type of vehicle and on each kind of trip purpose.
- 5) Verification and corrections shall be conducted on the Screen Lines by comparing the number of vehicles derived from O-D tables with on-the-spot observations of the number of each vehicle types.
- 6) The calculation of traffic assignment includes not only minimum distances, time required and their routes between zones but also total time required, total running distance, total running cost which were taken by all vehicle trips in a day and their averages of one trip.
- 7) Traffic volume which is assigned to main roads using present O-D table is compared by the counted number of vehicles on several points along the route. Their conditions of the network data like combinations of routes, the curves which show the relation between capacity and speed at each road, etc. shall be evaluated and the most satisfactory route is assessed.
- 8) Total number of trip production was derived by analyzing the existing traffic conditions and by forecasting changes of population and increasing of vehicle-owners in future in the study area.
- 9) Trip production mentioned above shall be divided into trip generations or attractions of each zone in each vehicle type and in each trip purpose by applying the existing inclination or relation of generation or attraction with population and employees in each zone.
- 10) Gravity model, of which coefficients were decided by the existing patterns of traffic movements, shall be applied to produce O-D tables in future (at 1985 and 2000).
- 11) Several combinations of roads networks in future are prepared according to those including roads under construction, and under planning, newly proposed roads, and improvement of existing roads.

FIGURE - 1 BRIEF FLOW OF DATA PROCESSING



3.

Relationship between each Survey and Vehicle Movements

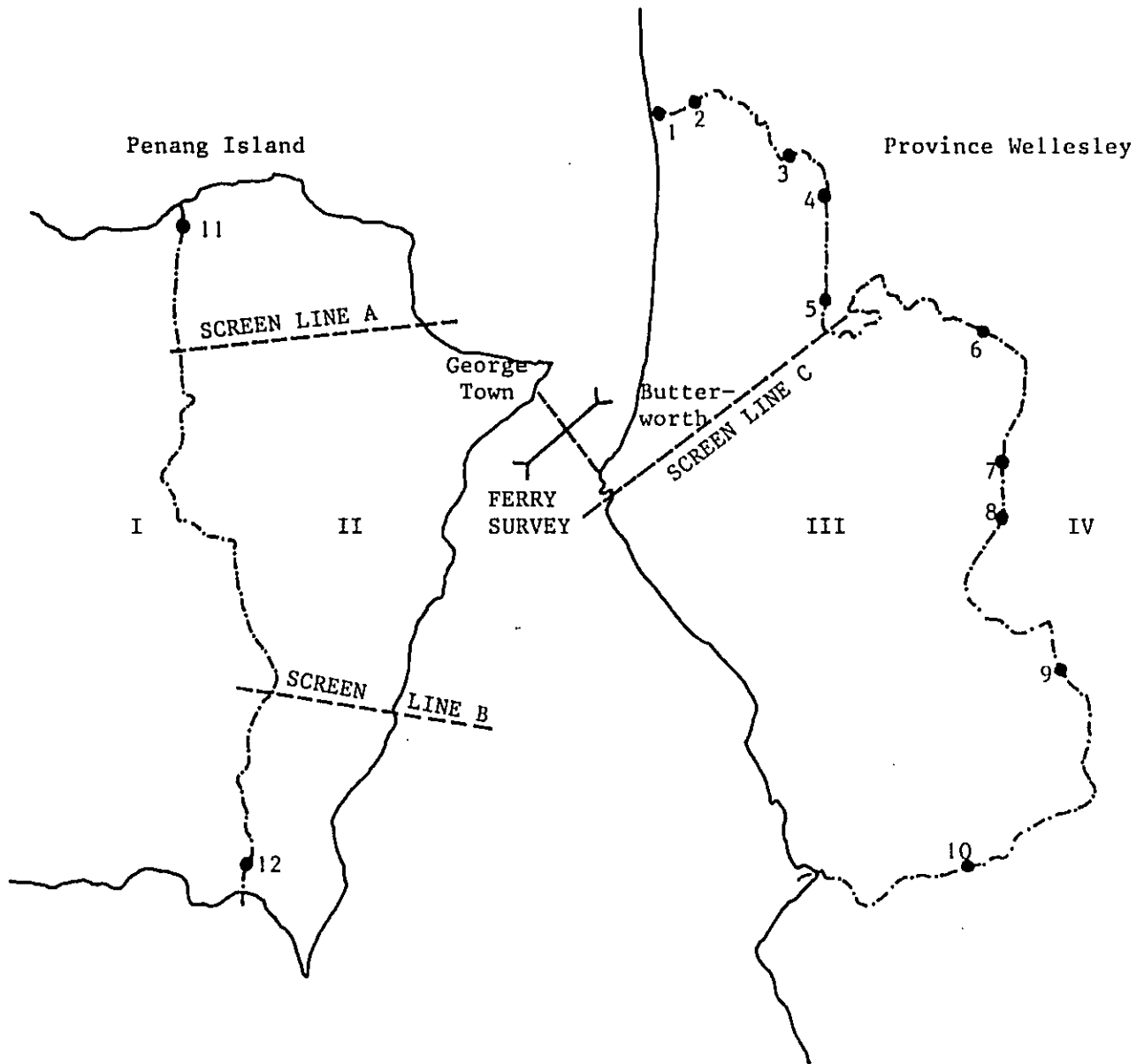
In order to recognize the existing traffic condition as precisely as possible, several kinds of surveys were carried out. Each survey had its purpose and covered vehicle movements in a distinct area. For example, vehicles which crossed the border line of the Study Area were counted and a certain percentage of them were interviewed at any one of the 12-cordon stations (by Cordon Line Survey), those which crossed the channel were also interviewed on board (by Ferry Survey for vehicles), and a certain percentage of vehicle owners who lived in the Study Area shown as II and III in FIGURE-2 were asked about all movements made in a whole day, 24 hours (by Car Owner Interview Survey including Taxis, Factory and School Bus Surveys).

The areas that were covered of vehicle movements by these surveys partially overlapped one another, and the same movements of vehicles might have been interviewed or counted by two surveys or more. In fact the data derived from Car Owner Interview survey included movements of vehicles between Butterworth and George Town or from George Town to other zones out of the Study Area since this survey traced vehicle movements made during a day. The Ferry survey was conducted along the channel and the Cordon Line survey on the border line. FIGURE-3 shows the relation of each survey to the area it covers and concerns how to select useful movements of vehicles. For example trips or movements by Car Owner Interview will be useful only in either area II or III, and others should be disregarded to avoid double-counting by other surveys.

On the other hand, Screen Line survey serves or different function from other surveys mentioned above. On three screen lines in FIGURE-2 the numbers of vehicles were merely counted by vehicle type, and these numbers observed on lines are used for comparing with ones which are derived from O-D tables (Origin-Destination tables) shown in FIGURE-3 which are likely to cross the screen lines. In other word this survey is important for verifying the O-D tables by each vehicle type after being enlarged to population and for correcting them according to the vehicle numbers which were counted on the lines.

FIGURE-2

RELATIONSHIP BETWEEN THE STUDY AREA AND EACH SURVEY



II, III ; The study area

I , IV ; Out of the study area

1 - 12 ; Cordon survey points. (These points are not exactly on the boundary line of the study area)

Ferry survey ; Including two surveys for vehicles and passengers on board.
 Car owner, Taxi, Factory bus and School bus surveys were carried out in Area II and III where these vehicle owners live.

FIGURE-3 CONCEPTUALIZED FRAMEWORK OF O-D TABLE
RELATED TO EACH SURVEY

Within all the trips caught by each survey, those of which movements are shown in the below figure are used and the rests are ignored for making O-D tables.

| O \ D | P.I. | | P.W. | |
|-------|------------------|-------------------|-------------------|------------------|
| | I | II | III | IV |
| I | C _{1,1} | C _{1,2} | F _{1,3} | F _{1,4} |
| II | C _{2,1} | OI _{2,2} | F _{2,3} | F _{2,4} |
| III | F _{3,1} | F _{3,2} | OI _{3,3} | C _{2,4} |
| IV | F _{4,1} | F _{4,2} | C _{4,3} | C _{4,4} |

C: Cordon-line Survey

F: Ferry-Interview Survey for cars and motorcycles.

OI: Owner-Interview Survey including taxis and buses.

Here,

$$C_{1,2} = C_{2,1}, \quad C_{3,4} = C_{4,3}.$$

I, II, III, IV : Areas shown in Figure - 2

4.

Making and Correcting of Sample Data.

There are various kinds of medium by which to feed the data into the computer like cards, optical mark sheets, optical character sheets, etc, and the former two media were valid for the computer system in USM. In this survey punching cards were selected for the input data after considering the fact that there existed several kinds of data corresponding to surveys and each data had varying number of samples and different data length.

35-clerks including 5-assistant supervisors were engaged in the task of converting addresses to zone code numbers, writing down the data on the sheets for punching cards, and checking the data. This was done during a period of one month.

FIGURE-4 shows the processes that were involved in obtaining correct sample data.

The main procedures in the flow chart are as follows.

1) Converting addresses to zone code numbers.

All the addresses like owners' residence, working places, and origins and destinations of trips should be converted into zone codes, which consists of 3 digits, as listed in the Zone Code Dictionary which has 57 small zones inside the Study Area and 9 zones outside.

2) FIGURES in the Appendix show the samples of questionnaire and the coding sheet of Car Owner Interview survey.

3) Checking data by the computer is only limited to finding logical errors like no answer, figures beyond the number of answers, wrong zone codes, inconsistency between departure and arrival time, etc.

Errors which were found through the computer are shown with 'Asterisk *' in FIGURE-5.

4) As errors could occur in the three steps of converting to zone codes, filling in the coding sheets and punching cards, all the data printed on the sheet through the computer should be compared directly and checked against the questionnaires by sight.

FIGURE-4 FLOW CHART OF DATA CHECKING

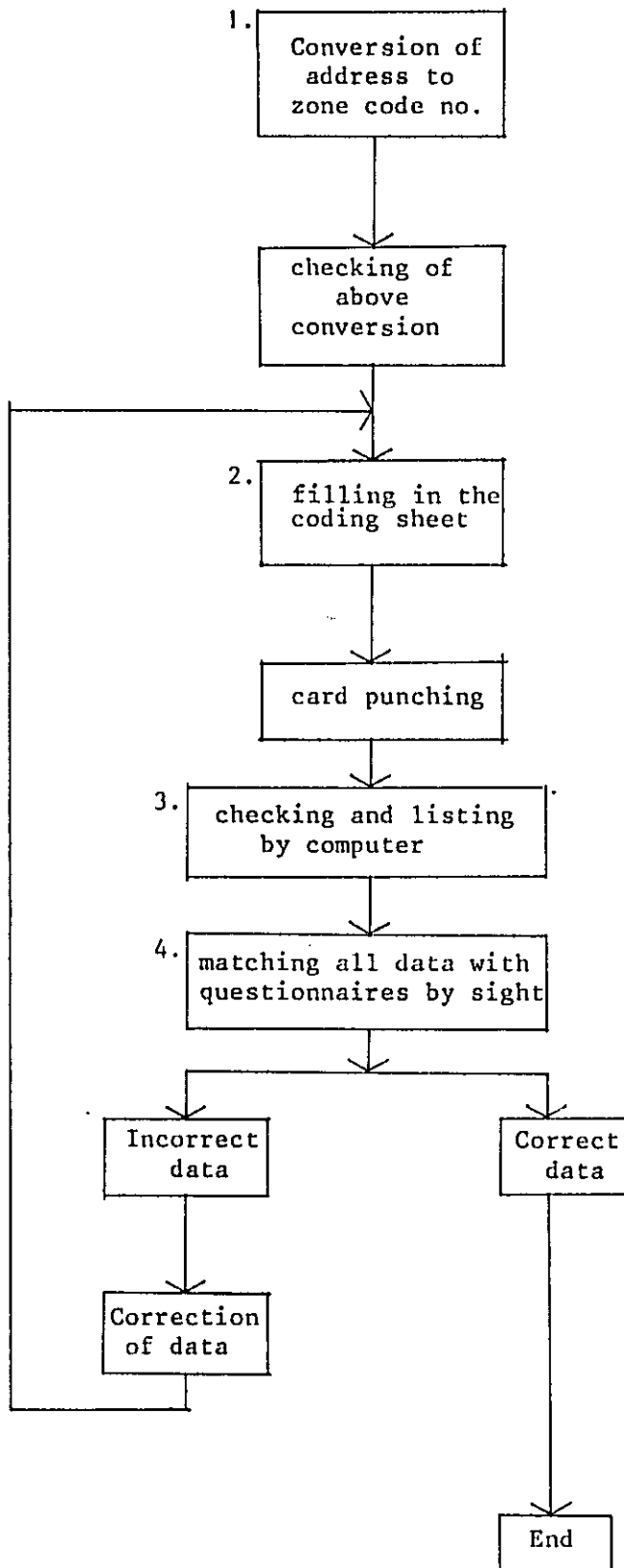


FIGURE -5 A SAMPLE OF DATA CHECKING THROUGH THE COMPUTER

*** PART-I OUTPUT FOR DATA CORRECTION OWNER PAGE= 11

| ERR DAT SHEET | RG AD FMA | NO D T LOD P TS | ADD AV U R NO | ORG. DEP DES | ARR TN PC N TF. | DEP DES | ARR TN PC N TF. | DEP DES | ARR TN PC N TF. | DEP DES | ARR TN PC N TF. | |
|---------------|---------------------------|-----------------|-----------------------|------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-------------------------|-----------------|----|
| NO. | CD CD OFG OC C V CAP O EE | WP ML V M TR | CD.TIME | CD TIME | PE PF P | CE.TIME | CD TIME | PE PF P | CE.TIME | CD TIME | PE PF P | CE |
| 177 | 20612 | BL121 114 | 6 2 1 0.0 2 16 | 124 4 4 0 8 | 121. 7 0 | 121 710 64 12 3 | 00. 715 121 725 64 12 2 | 00. 725 121 735 31 52 1 | 00 | 00. 725 121 735 31 52 1 | 00 | 00 |
| | | | | | | .1330 121 1340 64 12 1 | 00.1340 121 1345 64 12 2 | 00.1345 124 1350 31 52 3 | 00 | | | |
| | | | | | | .1930 331 1955 71 12 2 | 00.2230 121 23 0 31 52 2 | 00. | | | | |
| 178 | 20613 | PUI21 112 | 1 4 1 0.0 2 35 | 131 10 4 0 8 | 121. 730 131 750 12 32 1 | 00. 9 0 92 11 0 22 12 1 | 00.13 0 123 15 0 22 12 1 | 00 | 00.13 0 123 15 0 22 12 1 | 00 | 00 | 00 |
| | | | | | | .1530 211 16 0 22 12 1 | 00.1630 131 1645 12 32 1 | 00.1730 121 1740 31 52 1 | 00 | | | |
| | | | | | | .19 0 331 1915 71 12 1 | 00.20 0 121 2015 31 52 1 | 00. | | | | |
| 179 | 20614 | PM121 114 | 4 2 1 0.0 1 14 | 111 10 4 0 5 | 121. 730 331 8 0 21 12 1 | 00. 910 111 930 12 22 1 | 00.1030 133 1050 21 12 1 | 00 | 00.1030 133 1050 21 12 1 | 00 | 00 | 00 |
| | | | | | | .1130 111 1150 12 22 1 | 00.1615 121 1630 31 52 1 | 00. | | | | |
| 180 | 20615 | PAA121 111 | 7 8 6 0.0 1 00 | 0 6 3 0 2 | 121. 7 0 142 715 64 42 2 | 00.1410 121 1420 31 52 2 | 00. | | | | | |
| 181 | 20616 | PQ121 114 | 6 6 6 0.0 2 35 | 111 30 4 0 4 | 121. 3 0 111 310 12 12 1 | 00.1230 121 1245 31 52 1 | 00.19 0 122 1915 56 12 1 | 00 | 00.19 0 122 1915 56 12 1 | 00 | 00 | |
| | | | | | | .21 0 121 2115 31 52 1 | 00. | | | | | |
| 182 | 20617 | PAB124 125 | 5 9 1 0.0 1 00 | 0 15 4 0 5 | 124. 850 122 9 0 84 12 2 | 00. 9 0 122 9 5 46 21 1 | 00. 940 124 945 31 52 1 | 00 | 00. 940 124 945 31 52 1 | 00 | 00 | |
| | | | | | | .1045 122 1152 84 32 1 | 00.12 0 124 12 5 31 52 2 | 00. | | | | |
| *** 183 | 20618 | PR121 2** **** | 1 0.0 3 31 111 15 4 0 | 4 121. 10 0 111 10 5 12 12 1 | 00.14 0 111 1410 22 11 1 | 00.1440 111 1450 12 12 1 | 00 | 00.1440 111 1450 12 12 1 | 00 | 00 | 00 | 00 |
| | | | | | | .2110 121 2115 31 12 1 | 00. | | | | | |
| *** 184 | 20619 | PAB132 113 | 7 2 1 0.0 2 71 | 121 30 4 0 6 | 132. 9 0 121 920 12 12 2 | 00.12 0 132 1225 31 52 2 | 00.14 0 121 1420 12 12 2 | 00 | 00.14 0 121 1420 12 12 2 | 00 | 00 | |
| | | | | | | .1830 132 1850 31 52 2 | 00.20 0 122 2030 56 12 2 | 00. 0 0 0 0 0 ** **** | 00 | | | |
| 185 | 20620 | PAC121 114 | 8 4 1 0.0 1 32 | 111 7 3 5 0 0. | | | | | | | | |
| * 186 | 20621 | PAC121 112 | 4 2 6 0.0 1 62 | 111 20 4 0 14 | 121. 850 123 835 52 12 1 | 00. 845 111 9 0 12 12 1 | 00.10 0 132 1020 24 32 1 | 00 | 00.10 0 132 1020 24 32 1 | 00 | 00 | 00 |
| | | | | | | .11 0 143 1130 26 12 1 | 00.12 0 111 1230 12 12 1 | 00.13 0 121 1315 31 52 1 | 00 | | | |
| | | | | | | .14 0 111 1415 12 12 1 | 00.15 0 111 15 5 22 12 1 | 00.1535 111 1540 22 12 1 | 00 | | | |
| | | | | | | .1610 111 1615 13 12 1 | 00.17 0 111 17 5 71 12 1 | 00.19 0 111 **10 52 12 2 | 00 | | | |
| | | | | | | .20 0 124 2020 71 12 1 | 00.2330 121 2350 31 52 1 | 00. | | | | |

| | | | |
|---|-----------------------------|-----------------------|-----------------------|
| NOTE | ST | T | N |
| ERROR | OR: Cordon Station No. | V: type of vehicle | P: no. of passengers |
| TYPE | D | F: form of ownership | C: commodity type |
| ***: serious error (must be corrected) | OR: Direction. | R: registered address | CAP: maximum capacity |
| *: small error (not necessary to correct) | T | A | L: loading |
| space: no error | TIM: Time (hours & minutes) | OG: origin code | D: loading |
| | H M | DT: destination code | |
| | N: No. of data. | T: trip purpose | |
| | D | P | |

5. Enlargement of Sample Data to Population

5.1 How to enlarge the number of samples to population

As the result of checking sample data by the method mentioned in the former section, only very few sample data were not corrected and these were errors that were beyond correction like the omission of zones and others.

Accordingly, the number of samples, which were to be used for enlargement to the population was different from that of total samples collected through the surveys.

Though the enlargement coefficients can be easily derived by dividing the population of each type of vehicles by the number of effective samples, the number of vehicle movements which were reproduced on the O-D tables made by using these coefficients, is generally a little different from the actual number of movements which was observed on the screen lines in FIGURE-2. In the case when differences occur between these numbers, they must be corrected by erasing before adding to the coefficients...

In the calculation below, a small correction was made to the enlargement coefficients after the first enlargement coefficients were got, first O-D tables were made and after traffic volume from these O-D tables was compared with the counted numbers of each vehicle type on screen lines.

The final coefficients including these corrections of each survey are given below.

5.2 Enlargement coefficients of Car Owner Interview data.

The number of vehicles which are owned in the State of Penang are registered by vehicle type in R.I.M.V. (Registration and Inspection of Motorcycles and Vehicles).

As samples were uniformly selected with a certain sampling rate, the distribution of the number of vehicles' or motorcycles' owners in each large zone can be reasonably regarded as having a similar distribution to the population.

The registered number by vehicle type which was stated in 'Technical Report-01, Car Owner Interview Survey P.12', was divided into those of each large zone by vehicle type as shown in TABLE-1.1.

TABLE-1.2 shows the number of effective samples which were obtained through strict checking of each vehicle type in each large zone.

TABLE-1.3 shows the enlargement coefficients given by dividing TABLE-1.1 by TABLE-1.2.

TABLE-1.1 POPULATION OF OWNER DATA OF EACH VEHICLE TYPE BY OWNER ADDRESS IN LARGE ZONE.

| Owner address in large zone | | Vehicle type | Car | Van | Medium lorry | Heavy lorry | Bus | Motorcycle | Total |
|-----------------------------|-----------|--------------|--------|-------|--------------|-------------|-------|------------|---------|
| Inside of the study area | 100 | | 33,784 | 2,080 | 2,238 | 3,143 | 683 | 55,279 | 97,207 |
| | 200 | | 1,658 | 45 | 66 | 49 | 10 | 2,017 | 3,845 |
| | 300 | | 4,635 | 121 | 33 | 82 | 70 | 7,156 | 12,097 |
| | 400 | | 1,025 | 38 | 33 | 99 | 10 | 3,318 | 4,523 |
| | 500 | | 7,348 | 558 | 741 | 774 | 60 | 15,694 | 25,175 |
| | 600 | | 2,359 | 151 | 99 | 395 | 30 | 3,985 | 7,019 |
| | 700 | | 4,567 | 226 | 362 | 1,136 | 60 | 14,832 | 21,183 |
| | 800 | | 580 | 75 | 99 | 66 | 0 | 2,862 | 3,682 |
| | Sub-Total | | 55,956 | 3,294 | 3,671 | 5,744 | 923 | 105,143 | 174,731 |
| Outside of the study area | | | 5,718 | 415 | 790 | 1,299 | 150 | 19,841 | 28,213 |
| Total (Penang State) | | | 61,674 | 3,709 | 4,461 | 7,043 | 1,073 | 124,984 | 202,944 |

The number of taxis, 474 is excluded in the above table as being treated separately in Taxi survey.

TABLE-1.2 NUMBER OF EFFECTIVE SAMPLES OF EACH VEHICLE TYPE BY LARGE ZONE.

| Owner address in large zone | Vehicle type | Car | Van | Medium lorry | Heavy lorry | Bus | motorcycle | Total |
|-----------------------------|--------------|-------|-----|--------------|-------------|-----|------------|--------|
| Inside of the study area | 100 | 3,568 | 198 | 70 | 84 | 6 | 3,107 | 7,033 |
| | 200 | 204 | 9 | 2 | 1 | 2 | 105 | 323 |
| | 300 | 516 | 5 | 3 | 2 | 3 | 287 | 816 |
| | 400 | 135 | 6 | 1 | 4 | 0 | 152 | 298 |
| | 500 | 635 | 81 | 49 | 48 | 3 | 604 | 1,420 |
| | 600 | 302 | 34 | 18 | 21 | 0 | 257 | 632 |
| | 700 | 526 | 47 | 23 | 47 | 3 | 747 | 1,393 |
| | 800 | 42 | 8 | 5 | 7 | 0 | 153 | 215 |
| | Sub-Total | 5,928 | 388 | 171 | 214 | 17 | 5,412 | 12,130 |
| Outside of the study area | | 21 | 0 | 1 | 0 | 0 | 24 | 46 |
| Total (Penang State) | | 5,949 | 388 | 172 | 214 | 17 | 5,436 | 12,176 |

Samples answered by owners who lived outside of the study area are disregarded for the enlargement.

TABLE-1.3 ENLARGEMENT COEFFICIENTS OF EACH VEHICLE TYPE BY LARGE ZONE IN OWNER DATA.

| Owner address in large zone | Vehicle type | Car | Van | Medium lorry | Heavy lorry | Bus | Motorcycle | Average |
|-----------------------------|--------------|--------|--------|--------------|-------------|--------|------------|---------|
| Inside of the study area | 100 | 9.469 | 10.505 | 32.971 | 37.417 | 29.696 | 17.792 | 13.750 |
| | 200 | 8.217 | 5.000 | 33.000 | 49.000 | 3.333 | 19.210 | 11.895 |
| | 300 | 8.983 | 24.200 | 11.000 | 41.000 | 8.750 | 24.934 | 14.772 |
| | 400 | 7.593 | 6.333 | 33.000 | 24.750 | 3.333 | 21.829 | 15.144 |
| | 500 | 11.572 | 6.889 | 15.122 | 16.125 | 1.935 | 25.983 | 17.691 |
| | 600 | 7.811 | 4.441 | 5.500 | 18.810 | 1.000 | 15.506 | 11.059 |
| | 700 | 8.683 | 4.809 | 15.739 | 24.170 | 5.000 | 19.855 | 15.174 |
| | 800 | 13.810 | 9.375 | 19.800 | 9.429 | 1.000 | 18.706 | 17.126 |
| | Average | 9.440 | 8.490 | 21.468 | 26.841 | 13.647 | 19.428 | 14.348 |
| Total number enlarged | | 55,958 | 3,294 | 3,671 | 5,744 | * 232 | 105,143 | 174,042 |
| Population | | 55,956 | 3,294 | 3,671 | 5,744 | 923 | 105,143 | 174,731 |

* These bus data are ignored on making O-D tables. Instead, School and Factory bus data are used after enlargement with this bus enlargement coefficient.

5.3

Enlargement coefficients of Cordon Line data.

Interview of sampled vehicles which entered the Study Area from the outside was carried out at twelve cordon stations shown in FIG-2. At the same time the number of all the vehicles was counted by each vehicle type, in each hour and in each direction of the above stations.

Since the survey was not carried out the whole day (24 hours), but only for 18 or 16 hours, certain coefficients should be multiplied to get the population, that is the number of vehicles equivalent to that for 24 hours.

TABEL-2 shows the survey hours conducted and the coefficients by each cordon station by which the total number of vehicles for 24 hours is obtained.

TABLE-3.1 shows the population of the vehicles in each station, TABLE-3.2 shows the number of effective samples to enlarge to the population, and Table-3.3 shows the enlargement coefficients of vehicle type at each station.

The reasons why the enlarged numbers from samples by vehicle types and by stations are not exactly equal to their population in TABLE-3.3 explained as follows.

1) As mentioned before, some trips made across the channel on the ferry among Cordon data should be replaced by the trips which were collected by Ferry survey for vehicle.

The number of these trips among Cordon data is not equal to that given by Ferry survey.

Enlargement coefficients in TABLE-3.3 were finally derived after tentative enlargement coefficients were found, O-D tables were made in accordance with FIGURE-3, and after the number of trips across the channel in Cordon data were replaced by ones in Ferry data.

2) The company bus trips were excluded in TABLE-3.3, since they were treated in Company Bus data separately and the counted bus number on the cordon lines included not only factory buses, school buses but also company buses.

In the Cordon Line survey vehicles travelling from outside to inside of cordon lines interviewed. Vehicles in the opposite direction were produced on the O-D tables on the supposition that these same vehicles would return on the same routes and in some cases with a change in their trip purposes, for example from going to work or going to school to going home.

TABLE-2 SURVEY HOURS AND COEFFICIENTS OF CORDON DATA TO EXTEND TO 24 HOURS.
ONE DIRECTION (FROM OUTSIDE THE STUDY AREA TO INSIDE)

| Cordon Station No. | Interview | | Counting | | | |
|--------------------|---------------|--------------------------|------------------|--------------------------|--------------|------------------------------|
| | Hours | No. of samples collected | Hours | No. of vehicles observed | Coefficients | No. of vehicles for 24 hours |
| 1 | 12 hrs (7-19) | 837 | 16 hrs. (6 - 22) | 5,816 | 1.08 | 6,282 |
| 2 | " | 242 | 13 hrs. (6 - 19) | 293 | 1.34 | 394 |
| 3 | " | 491 | 16 hrs. (6 - 22) | 881 | 1.08 | 952 |
| 4 | " | 365 | " | 549 | " | 592 |
| 5 | " | 712 | " | 2,128 | " | 2,299 |
| 6 | " | 731 | " | 2,070 | " | 2,235 |
| 7 | " | 701 | " | 2,141 | " | 2,311 |
| 8 | " | 450 | " | 1,112 | " | 1,201 |
| 9 | " | 952 | " | 1,112 | " | 4,083 |
| 10 | " | 1,175 | " | 6,537 | " | 7,060 |
| 11 | " | 893 | " | 1,166 | 1.13 | 1,318 |
| 12 | " | 775 | " | 2,895 | " | 3,271 |
| Total | " | 8,324 | | 29,369 | | 31,998 |

TABLE-3.1 POPULATION OF CORDON DATA IN EACH VEHICLE TYPE
AT EACH STATION.

24 HOURS.

| Station No. | Car | Motorcycle | Bus | Van | Medium lorry | Heavy lorry | Taxi | Others | Total |
|-------------|--------|------------|-------|-------|--------------|-------------|-------|--------|--------|
| 1 | 2,594 | 1,827 | 272 | 264 | 638 | 226 | 413 | 48 | 6,282 |
| 2 | 86 | 259 | 19 | 9 | 14 | 7 | 0 | 0 | 394 |
| 3 | 158 | 702 | 10 | 17 | 59 | 2 | 4 | 0 | 952 |
| 4 | 179 | 360 | 16 | 10 | 27 | 0 | 0 | 0 | 592 |
| 5 | 684 | 971 | 89 | 89 | 351 | 54 | 57 | 4 | 2,299 |
| 6 | 684 | 910 | 59 | 89 | 407 | 60 | 26 | 0 | 2,235 |
| 7 | 545 | 1,064 | 96 | 57 | 527 | 14 | 8 | 0 | 2,311 |
| 8 | 272 | 697 | 31 | 11 | 185 | 1 | 3 | 1 | 1,201 |
| 9 | 1,502 | 1,871 | 129 | 176 | 306 | 30 | 65 | 4 | 4,083 |
| 10 | 2,635 | 1,912 | 249 | 362 | 1,013 | 486 | 342 | 61 | 7,060 |
| 11 | 428 | 560 | 59 | 51 | 127 | 7 | 86 | 0 | 1,318 |
| 12 | 861 | 1,686 | 294 | 131 | 217 | 0 | 80 | 2 | 3,271 |
| Total | 10,628 | 12,819 | 1,323 | 1,266 | 3,871 | 887 | 1,084 | 120 | 31,998 |

TABLE-3.2 NUMBER OF EFFECTIVE SAMPLES IN EACH VEHICLE TYPE AT EACH STATION.

| Station No. | Car | Motorcycle | Bus | Van | Medium lorry | Heavy lorry | Taxi | Others | Total |
|-------------|-------|------------|-----|-----|--------------|-------------|------|--------|-------|
| 1 | 392 | 212 | 2 | 38 | 69 | 67 | 54 | 2 | 837 |
| 2 | 36 | 162 | 0 | 4 | 13 | 0 | 0 | 0 | 215 |
| 3 | 102 | 216 | 5 | 12 | 45 | 8 | 3 | 0 | 391 |
| 4 | 69 | 189 | 8 | 4 | 11 | 8 | 0 | 0 | 289 |
| 5 | 219 | 238 | 6 | 28 | 33 | 24 | 15 | 1 | 666 |
| 6 | 211 | 274 | 2 | 23 | 142 | 19 | 13 | 0 | 684 |
| 7 | 105 | 235 | 0 | 17 | 124 | 3 | 0 | 0 | 484 |
| 8 | 66 | 242 | 3 | 6 | 72 | 9 | 1 | 2 | 403 |
| 9 | 325 | 425 | 2 | 33 | 89 | 8 | 12 | 2 | 896 |
| 10 | 380 | 421 | 0 | 52 | 126 | 88 | 37 | 4 | 1,108 |
| 11 | 183 | 279 | 9 | 35 | 87 | 9 | 53 | 0 | 655 |
| 12 | 213 | 352 | 0 | 26 | 51 | 15 | 21 | 0 | 678 |
| Total | 2,301 | 3,245 | 37 | 278 | 962 | 258 | 209 | 11 | 7,306 |

TABLE-3.3 ENLARGEMENT COEFFICIENTS IN EACH VEHICLE TYPE AT EACH STATION

| Station No. | Car | Motorcycle | Bus | Van | Medium lorry | Heavy lorry | Taxi | Others | Average | Total number enlarged | Population |
|-----------------------|--------|------------|-------|-------|--------------|-------------|-------|--------|---------|-----------------------|------------|
| 1 | 6.62 | 8.62 | 10.0 | 6.95 | 9.64 | 3.37 | 7.65 | 24.0 | 7.24 | 6,058 | 6,282 |
| 2 | 2.26 | 1.60 | 1.0 | 3.38 | 1.51 | 1.0 | 1.0 | 1.0 | 1.74 | 374 | 394 |
| 3 | 1.55 | 3.25 | 2.0 | 2.68 | 2.27 | 1.0 | 1.33 | 1.0 | 2.60 | 1,016 | 952 |
| 4 | 2.59 | 1.90 | 2.0 | 2.50 | 3.68 | 1.0 | 1.0 | 1.0 | 2.12 | 612 | 592 |
| 5 | 3.12 | 4.08 | 10.0 | 4.29 | 2.64 | 2.25 | 3.80 | 4.0 | 3.06 | 2,037 | 2,299 |
| 6 | 3.24 | 3.32 | 10.0 | 3.87 | 3.01 | 3.16 | 2.0 | 1.0 | 3.24 | 2,216 | 2,235 |
| 7 | 5.17 | 4.52 | 1.0 | 5.31 | 6.61 | 4.67 | 1.0 | 1.0 | 5.23 | 2,529 | 2,311 |
| 8 | 4.11 | 2.88 | 5.0 | 1.83 | 2.78 | 1.0 | 3.0 | 1.0 | 3.00 | 1,209 | 1,201 |
| 9 | 4.62 | 4.40 | 10.0 | 5.69 | 4.17 | 3.75 | 5.42 | 2.0 | 4.52 | 4,049 | 4,083 |
| 10 | 6.94 | 4.54 | 1.0 | 7.20 | 8.04 | 5.52 | 9.24 | 15.25 | 6.16 | 6,826 | 7,060 |
| 11 | 2.34 | 2.01 | 5.0 | 2.32 | 2.21 | 1.0 | 1.62 | 1.0 | 2.14 | 1,402 | 1,318 |
| 12 | 4.04 | 4.79 | 1.0 | 5.04 | 4.91 | 1.0 | 3.81 | 1.0 | 4.45 | 3,020 | 3,271 |
| Average | 5.49 | 3.95 | 5.57 | 5.05 | 4.35 | 3.56 | 5.14 | 10.82 | 4.29 | - | - |
| Total number enlarged | 12,621 | 12,816 | 206 | 1,404 | 4,186 | 919 | 1,076 | 119 | - | 31,348 | - |
| Population | 10,628 | 12,819 | 1,323 | 1,266 | 3,871 | 887 | 1,084 | 120 | - | - | 31,998 |

Enlargement coefficients of vehicles and passengers
in Ferry data

Ferry data include two kinds of surveys, one is for vehicles on the ferry, and the other for passengers on the ferry. In both surveys interview of samples and hourly counting were carried out as in the Cordon survey.

Since the survey was conducted from 0600 hours to 2200 hours the figures offered by P.P.C. (Penang Port Commission) on the same survey day was used to obtain the population for 24 hours.

Ferry data were given the highest priority to that of other surveys when being enlarged to the population. Enlargement coefficients were easily obtained by dividing the population by the number of effective samples because it was supposed that these data would reproduce the trip movements more accurately than others as the survey site was limited on board the ferry.

TABLE-4.1 shows the number of population and effective samples. TABLE-4.2 shows the enlargement coefficients for vehicles in Ferry data and TABLE-5 shows those for passengers.

TABLE-4.1 TOTAL POPULATION BY EFFECTIVE SAMPLES OF VEHICLES
IN FERRY SURVEY.

24 hours for population

| Direction | Time range | | Car | Motor-cycle | Bus | Van | Medium Lorry | Heavy Lorry | Taxi | Others (trishaw) | Total |
|----------------------------|----------------|---------------|--------|-------------|-----|-------|--------------|-------------|------|------------------|--------|
| from G.T. to B.W. | 0600 - 1000 | Population | 1,134 | 2,389 | 33 | 69 | 128 | 33 | 4 | 0 | 3,790 |
| | | Sample number | 113 | 34 | 3 | 4 | 20 | 3 | 0 | 6 | 183 |
| | 1600 - 1900 | P. | 738 | 1,057 | 6 | 33 | 87 | 25 | 2 | 0 | 1,948 |
| | | S. | 98 | 38 | 0 | 6 | 30 | 0 | 0 | 10 | 182 |
| | other time | P. | 2,237 | 3,102 | 27 | 175 | 437 | 104 | 34 | 0 | 6,116 |
| | | S. | 242 | 106 | 2 | 23 | 67 | 2 | 3 | 24 | 469 |
| | total | P. | 4,109 | 6,548 | 66 | 277 | 652 | 162 | 40 | 3 | 11,857 |
| | | S. | 453 | 178 | 5 | 33 | 117 | 5 | 3 | 40 | 834 |
| from B.W. to G.T. | 0600 - 1000 | Population | 568 | 1,262 | 4 | 49 | 152 | 29 | 8 | 0 | 2,072 |
| | | Sample number | 79 | 14 | 6 | 10 | 22 | 9 | 1 | 7 | 148 |
| | 1600 - 1900 | P. | 1,256 | 2,276 | 11 | 70 | 72 | 10 | 18 | 2 | 3,715 |
| | | S. | 108 | 38 | 1 | 11 | 21 | 4 | 0 | 13 | 196 |
| | other time | P. | 2,399 | 3,136 | 33 | 188 | 447 | 83 | 27 | 5 | 6,318 |
| | | S. | 231 | 101 | 0 | 18 | 52 | 6 | 3 | 20 | 431 |
| | total | P. | 4,223 | 6,674 | 48 | 307 | 671 | 122 | 53 | 7 | 12,105 |
| | | S. | 418 | 153 | 7 | 39 | 95 | 19 | 4 | 40 | 775 |
| Both ways (total) | Population | 8,332 | 13,222 | 114 | 584 | 1,323 | 284 | 93 | 10 | 23,962 | |
| | Sample | 871 | 331 | 12 | 72 | 212 | 24 | 7 | 80 | 1,609 | |

TABLE-4.2 ENLARGEMENT COEFFICIENTS FOR VEHICLES IN FERRY DATA

| Direction | Time range | Car | Motor-cycle | Bus | Van | Medium Lorry | Heavy Lorry | Taxi | Others |
|----------------------------|----------------|-------|-------------|-------|-------|--------------|-------------|-------|--------|
| from G.T. to B.W. | 0600 - 1000 | 10.04 | 70.27 | 12.0 | 17.25 | 6.40 | 14.33 | 1.0 | 1.0 |
| | 1600 - 1900 | 7.53 | 27.82 | 1.0 | 5.50 | 2.90 | 1.00 | 1.0 | 1.0 |
| | Other time | 9.24 | 29.26 | 15.0 | 7.61 | 6.52 | 59.50 | 13.0 | 1.0 |
| | mean | 9.07 | 36.79 | 13.20 | 8.39 | 5.57 | 32.40 | 13.3 | - |
| from B.W. to G.T. | 0600 - 1000 | 7.19 | 90.14 | 5.67 | 4.90 | 6.91 | 3.22 | 14.0 | 1.0 |
| | 1600 - 1900 | 11.63 | 59.90 | 14.00 | 6.36 | 3.43 | 2.50 | 1.0 | 1.0 |
| | Other time | 10.39 | 31.05 | 1.00 | 10.44 | 8.60 | 13.83 | 13.0 | 1.0 |
| | mean | 10.10 | 43.62 | 6.86 | 7.87 | 7.06 | 6.42 | 13.25 | - |

TABLE-5 TOTAL POPULATION, EFFECTIVE SAMPLES AND ENLARGEMENT
 COEFFICIENTS FOR PASSENGERS IN FERRY DATA.
 24 hours for population

| Direction | | Population | No. of effective samples | Enlargment coefficients |
|----------------------------|------------|------------|--------------------------|-------------------------|
| from G.T to B.W | Passengers | 17,718 | 474 | 37.38 |
| | Bicycles | 1,608 | 34 | 47.29 |
| | Total | 19,326 | 508 | 38.04 |
| from B.W. to G.T. | Passengers | 16,115 | 434 | 37.13 |
| | Bicycles | 1,437 | 11 | 130.62 |
| | Total | 17,552 | 445 | 39.44 |
| Both ways | Total | 36,878 | 953 | 38.70 |

Enlargement coefficients of other survey data

(1) Taxi survey data

In taxi survey ten main taxi stations were selected to obtain the total number of parked taxis by each station and to interview the drivers who were picked up as samples among them. These taxi stations belonged to any one of the traffic zones in the Study Area, and the number of taxis which were owned in each zone had been already known by the same method in Car Owner data, so the population of taxis were decided with reference to both the counted numbers at taxi stations and registered ones.

TABLE-6 shows the sample number, the population and the enlargement coefficients in Taxi data.

(2) Factory and School Bus data

The registered number of all types of buses, that is, Company, Factory and School Buses, was 923 in the Study Area. The number of Company buses was known to be 407 by the bus Company survey which was carried out separately from the other traffic surveys mentioned above with cooperation from R.I.M.V.

Accordingly, it may be supposed that the difference between 923 and 407 may give the total number of Factory and School buses. These buses, however, include not only ordinary size buses or mini-type buses but also vans and other type of vehicles, and yet the latter two were not registered as buses.

So TABLE-7 was made on the supposition that the number of Company buses was almost equal to that of other type vehicle in Factory and School buses.

In TABLE-7 samples which were obtained in Car Owner Interview survey include any one of Company, Factory or school bus data.

TABLE-6 SAMPLE NUMBER, POPULATION AND ENLARGEMENT COEFFICIENTS IN TAXI DATA

| Zone Code | No. of samples | Population | Enlargement coefficients |
|-----------|----------------|------------|--------------------------|
| 111 | 60 | 127 | 2.117 |
| 124 | 13 | 20 | 1.538 |
| 413 | 42 | 100 | 2.381 |
| 511 | 84 | 196 | 2.333 |
| 732 | 11 | 31 | 2.818 |
| Total | 210 | 474 | 2.257 |

TABLE-7 SAMPLE NUMBER, POPULATION AND ENLARGEMENT COEFFICIENTS IN BUS DATA.

| Large zone | No. of samples | | | | Population | Enlargment coefficients |
|------------|----------------|------------|---------------------------|-------|------------|-------------------------|
| | Factory bus | School bus | Sample from owner interv. | Total | | |
| 100 | 6 | 11 | 6 | 23 | 683 | 29.696 |
| 200 | 1 | 0 | 2 | 3 | 10 | 3.333 |
| 300 | 5 | 0 | 3 | 8 | 70 | 8.750 |
| 400 | 3 | 0 | 0 | 3 | 10 | 3.333 |
| 500 | 22 | 6 | 3 | 31 | 60 | 1.935 |
| 600 | 33 | 0 | 0 | 33 | 30 | 1.000 |
| 700 | 7 | 2 | 3 | 12 | 60 | 5.000 |
| 800 | 3 | 3 | 0 | 6 | 0 | 1.000 |
| Total | 80 | 22 | 17 | 119 | 923 | 8.756 |

6. Making of Present O-D Table

6.1 O-D Trip File

To produce various kinds of O-D tables easily, one big trip file called O-D Trip File was made in the storage area in the computer. One record of the trip file consisted of 9 types of data (used 27 columns) shown in FIGURE-6, and this corresponded to one trip which comprised of one origin and one destination.

All the data collected from six surveys mentioned above were broken down to trips and combined to this big trip file.

FIGURE-6 Composition of Trip File

1 record consists of 9 types of data

| Kind of survey | Vehicle type | Origin zone | Destination zone | Trip purpose | Alive or dead | Enlargement coefficient | Reserved | Owners' address |
|----------------|--------------|-------------|------------------|--------------|---------------|-------------------------|----------|-----------------|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| No. of columns | | | | | | | | |
| 1 | 1 | 3 | 3 | 1 | 1 | 7 | 7 | 3 |
| (11) | (11) | (13) | (13) | (11) | (11) | (F7.3) | (F7.3) | (13) |

Each data in the record of the trip file have the figures which show the contents as below.

(1) Kind of survey

This column has any one of the digit 1 to 6, and each digit shows the kind of survey as follows:

1. Car owner interview survey
2. Cordon line survey
3. Ferry survey for vehicles
4. Taxi survey
5. Factory bus survey
6. School bus survey

(2) Vehicle type

1. Car
2. Van
3. Medium lorry
4. Heavy lorry
5. Bus
6. Motorcycle

7. Taxi
8. Others and none
9. Mini-bus

(3) Origin zone

(4) Destination zone

These data have small zone codes which consists of 3 digits like 111, 121, 723.

(5) Trip purpose

1. Going to work
2. Business engagement
3. Going home
4. Shopping/marketing
5. For food/entertainment
6. Going to school
7. Social visit
8. Others and none

(6) Alive or dead

If the digit has 1, this trip shows useful data for making O-D table, and if the digit has 0, then the data is useless. All the trips have 1 or 0 according to the rule mentioned in section 2.

For example in case of Car owner interview survey, those trips which had both origin and destination in area II or III in Figure-2 are useful or alive, and other trips which overlapped in two areas or more are useless or dead.

(7) Enlargement coefficients

Coefficients which were calculated in the previous section were written here.

FIGURES-7 and -8 show the process starting from correction of data to obtaining O-D table including production of the trip file in Car owner and Cordon line data.

FIGURE-7 FLOW CHART OF MAKING O-D TABLE IN THE CASE OF OWNER INTERVIEW SURVEY.

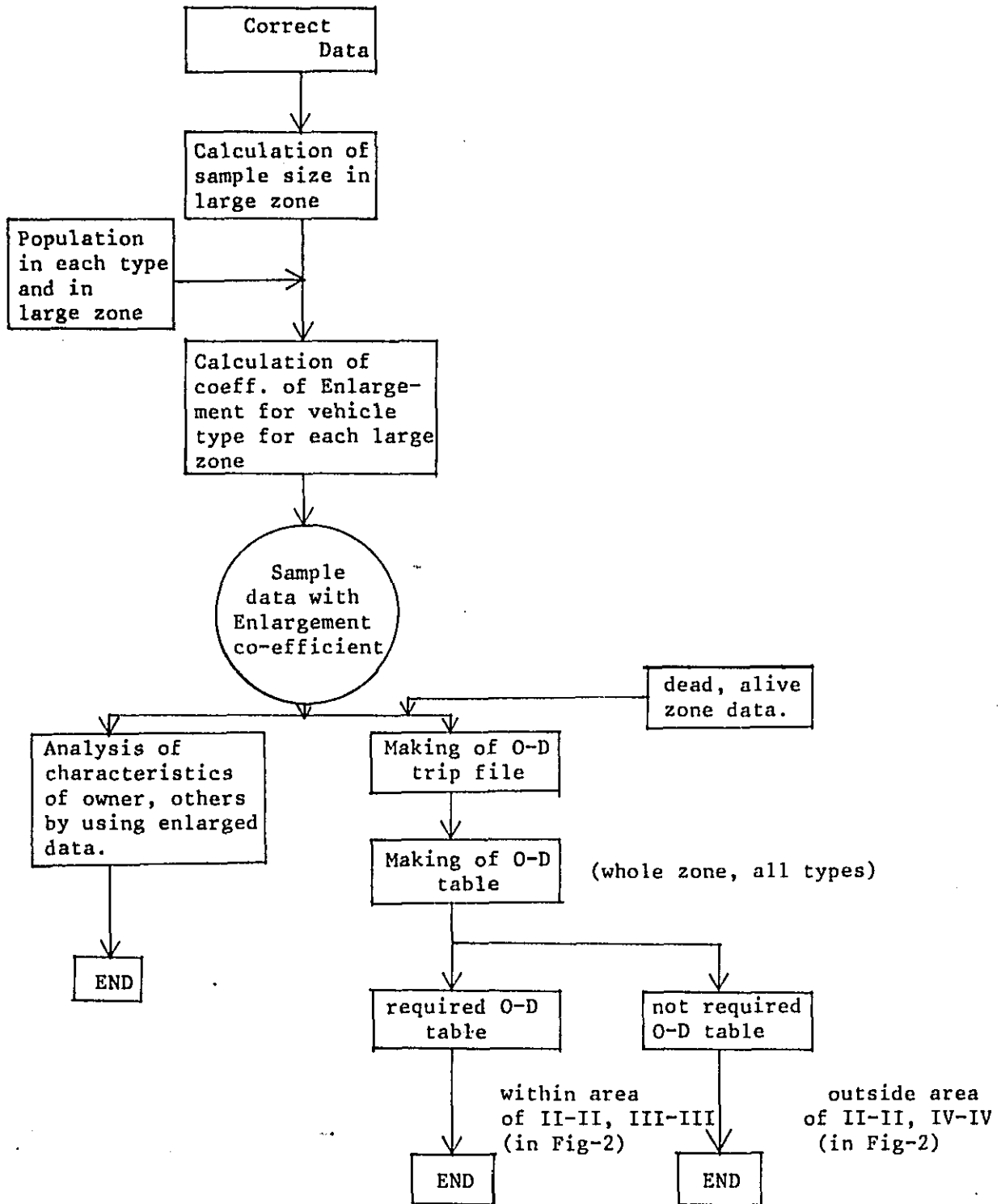
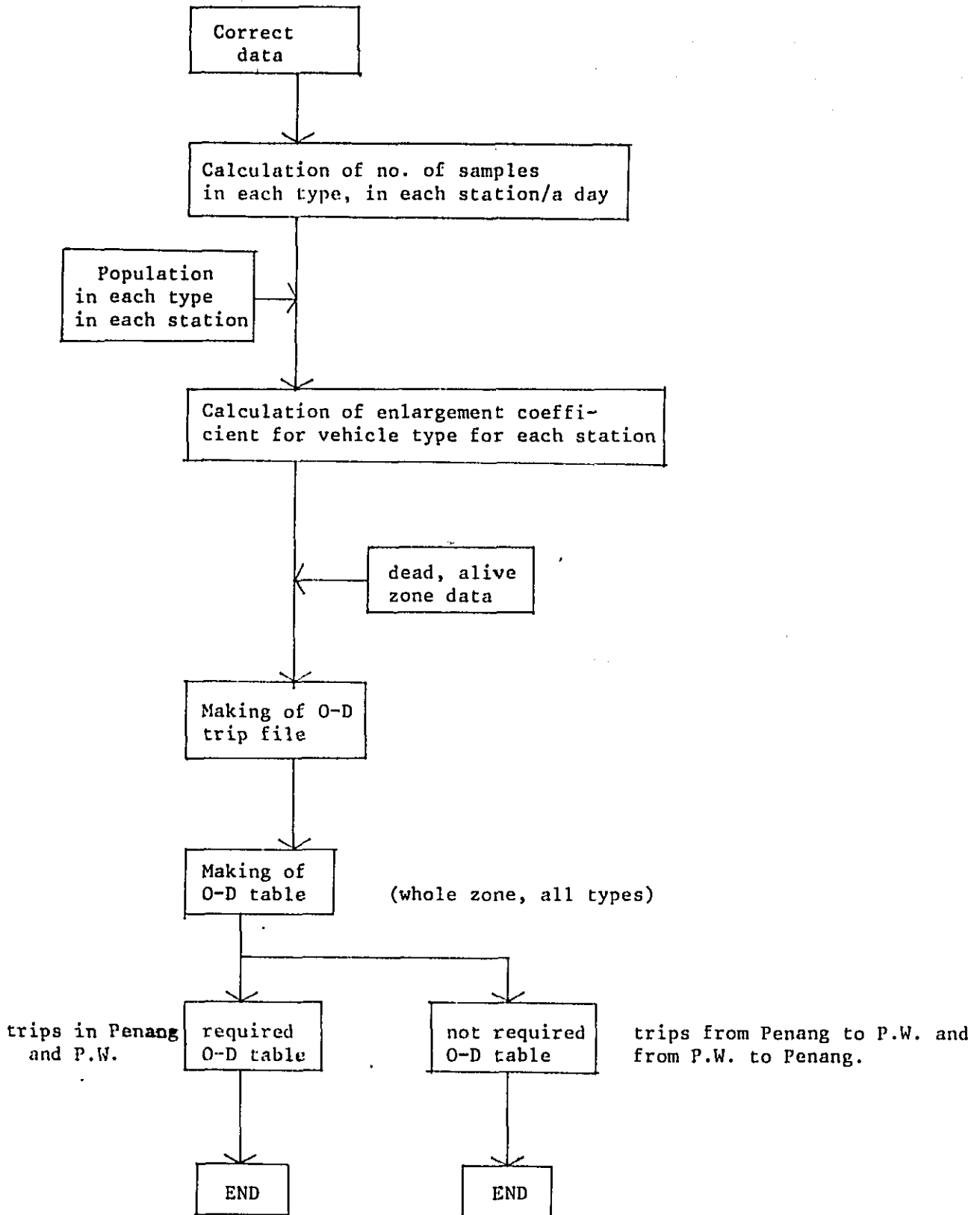


FIGURE-8 FLOW CHART FOR MAKING O-D TABLE IN CORDON SURVEY



6.2

Making of present O-D tables

Once the trip file is made, it is quite simple and easy to produce various kinds of O-D tables from the trip file, because this file is derived from the necessary data in all surveys and includes only the information required for O-D tables.

For example, when the O-D table which shows movements of motor-cycles with trip purpose 'Going to work' is required, data which are in accordance with vehicle type 1, trip purpose 1 and alive are looked for, and are put into cells or matrices after they are multiplied by their enlargement coefficients.

O-D tables are produced for all vehicles, for each vehicle type, for each trip purpose, and for crossing of these items as well. The number of O-D tables, therefore, was more than 100 tables, and they were utilized according to the various requests for analysing the existing traffic conditions or forecasting future demand.

Each O-D table consists of three tables, they are Large zone O-D table shown by 17 x 17 cells, Middle zone by 29 x 29 and Small zone by 66 x 66 for present traffic movements. The type of O-D tables produced are stated in section 10.

7 Assignment of Present O-D Tables to the Existing Road Network.

7.1 How to Assign O-D Table to Network.

Since O-D table just shows the traffic volume from some zone i to other zone j, it is unknown which road shall be actually selected by the trips from i to j. Traffic assignment includes the process of finding the minimum path which may be used to make a trip, of assigning them to each link of network and accumulating assigned trips to each link, and of counting the total running distance, total running hours and running costs.

Traffic Assignment has 3 main steps of calculation which are ~~iterated~~ several times below and the method used in this process is called 'All or Nothing method with capacity constraint'. 'All or Nothing' means assigning all trips from i to j to the minimum path between i and j.

Step-1

Finding the path from origin zone i to destination j which requires the minimum amount of time to travel between i and j

Step-2

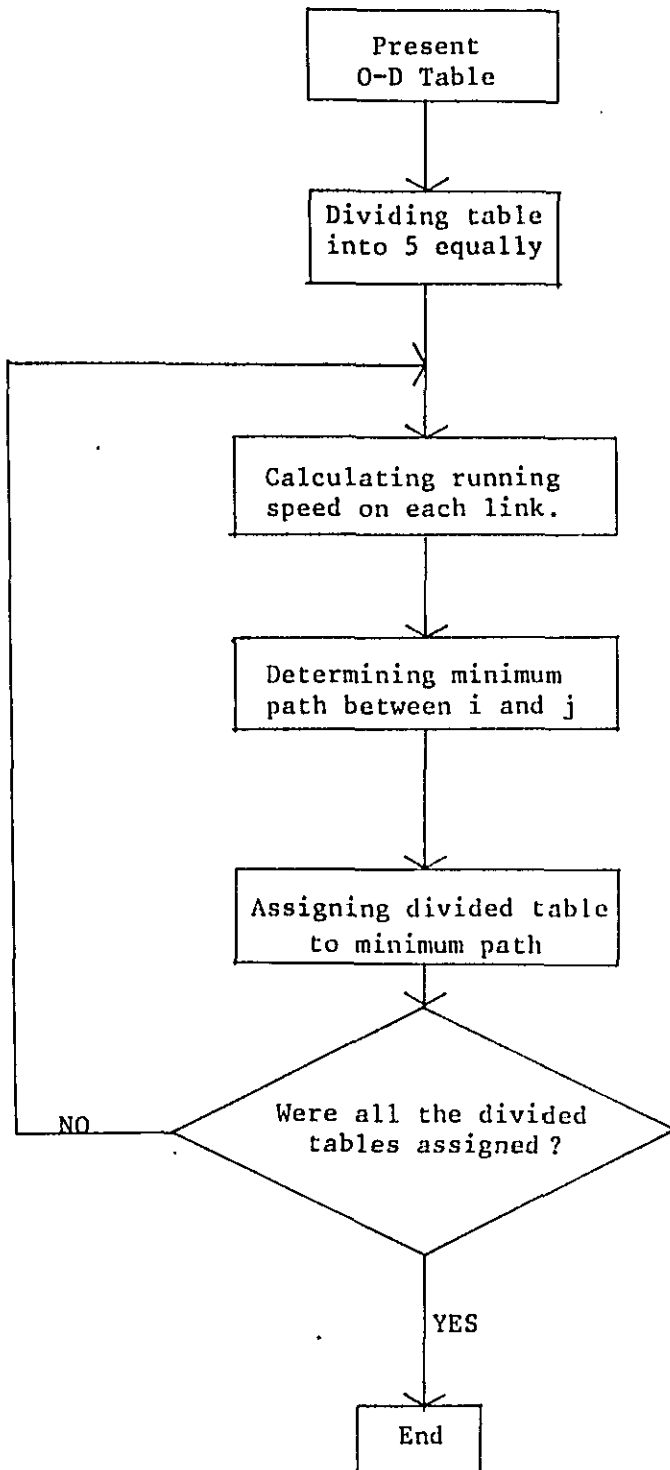
Assigning a certain portion of the trips from i to j to the minimum path determined in Step-1.

Step-3

Deciding the running condition of each link in network for finding the minimum path the second time in Step-1 based upon the relationship between running speed and traffic volume which were already assigned in Step-2.

Figure-9 shows the appropriate flow of the steps above, and in this process O-D table was divided into 5 equally, and thus this procedure was repeated 5 times.

FIGURE-9 FLOW CHART OF ASSIGNMENT.



7.2

Input Data for Assignment

Data necessary for the assignment are as follows.

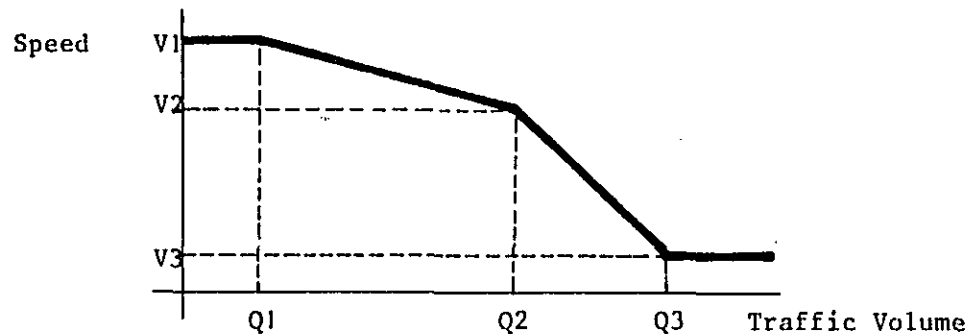
1) Network of roads in the Study Area

This includes how to combine links with each other, length of links, distinction of one way or two ways, and each link having the number of curves which give the relation between running speed and traffic volume.

2) Curves between speed and traffic volume

These data are called formula for capacity restraint and given as the diagram below for each kind of road.

Curves which show the relation between speed and traffic volume.



Tolls can also be taken into account with this data.

3) O-D table being assigned and its division ratio

4) Data for determining origins and destinations of trips which pass the specified links.

5) Data for the relation between running speed and running cost.

7.3

Output from Assignment

The following output is derived from execution of assignment in each process.

1) Routes of minimum path and distances between zone i and j .

2) Time required between zone i and j .

3) Assigned traffic volume to each link and degree of congestion.

4) Total vehicle-hours, vehicles-kilometers, running costs and their average per trip.

Trip Generation and Attraction and O-D Tables in Future.

The process starting from forecasting trip generation and attraction and ending in producing O-D tables in future is divided into 3 main steps shown in FIGURE-10.

Step-1 produces future trip generation and production in each small zone for each vehicle type, step-2 prepares the data for trip distribution in step-3 and for this purpose coefficients of gravity model and time required between zones are offered, and finally step-3 produces future O-D tables based on the results of step-1 and step-2.

Target year for forecast is 1985 and 2000.

Trip Generation and Attraction (Step-1)

Trip production which means total number of trip movements in the Study Area is given as one of input data before executing step-1. This figure was estimated on the basis of trends of car ownership ratio per capita, population, economical activity, land use pattern, and etc. for each vehicle type.

Trip generation and production is, accordingly, the process of how to allocate the trip production to each small zone.

It could be affirmably supposed that traffic volume generated or attracted in some zone *i* is closely related to the size of population, the number of employees, commercial activity, or total areas of buildings' floors, and etc. of zone *i*. For example it is clear that the number of trip generation with the trip purpose 'going to work' in zone *i* is in proportion to the number of residents in zone *i*, while that of attraction in zone *j* is in proportion to that of employees there.

In this step population and/or employees were selected according to each trip purpose. After the relation between trip generation and attraction, and the number of the population and employees were modeled by the regression analysis of the existing condition, the trip production was allocated to each small zone based on its share derived from the results of the model.

8.2

Preparation for Trip Distribution in Future (Step-2)

Application of Gravity model to producing trip distribution in future which means O-D table, is supposed desirable in such a case as it is predicted that the patterns of land use will change widely or strongly, or road network in an objective area shall be improved influentially upon traffic movements.

In fact, the Study Area has been regarded to possess these two condition in future, so we decided to apply this model to get trip distribution.

Gravity model is indicated as below.

$$t_{ij} = K \frac{T_i^A \times T_j^B}{D_{ij}^C}$$

Here,

t_{ij} ; the number of trips which generate in zone i and attract in zone j.

T_i ; the number of trip generation in zone i.

T_j ; the number of trip attraction in zone j.

D_{ij} ; time required between zone i and j.

K, A, B, C ; definite constants which are decided based on the traffic pattern in an objective area.

In step-2, firstly constants K, A, B and C for each vehicle type were decided by the regression analysis in which O-D tables and time required D_{ij} in 1979 were used as input data. Secondly, time required D_{ij} in 1985 and 2000 was obtained by searching the minimum path which included improved road network in future.

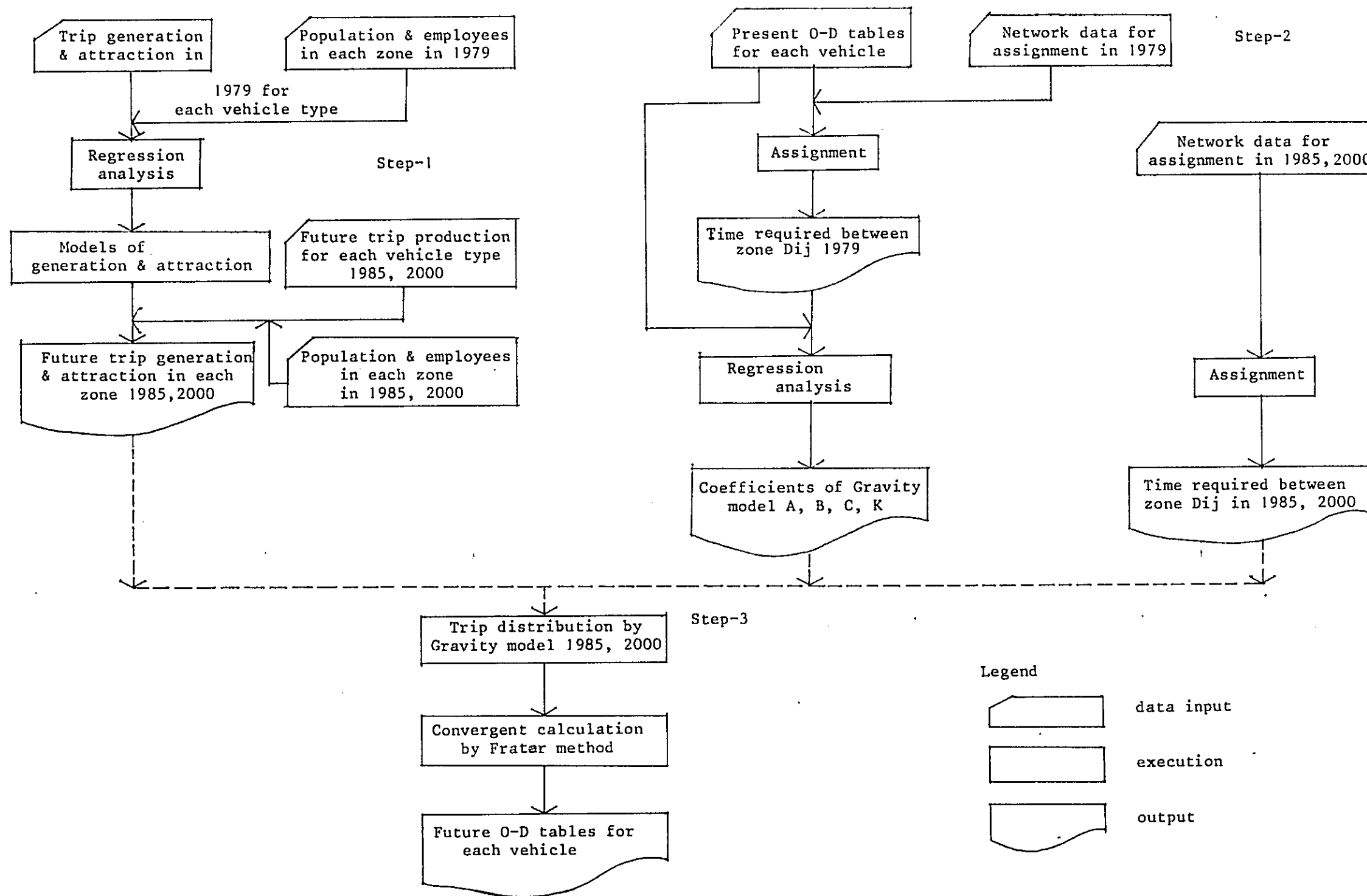
8.3

Production of Future O-D Tables (Step-3)

Gravity model is applied for producing the trip distribution or O-D table in future. Now that figures in future which are put in the model, like T_i, T_j and K, A, B, C, D_{ij} , were obtained from step-1 and -2 respectively, it is very easy to calculate t_{ij} from the model.

However, the added number of trip distribution t_{ij} concerning i or j which were produced from the model is not generally equal to T_i and T_j which were given in Step-3. For the purpose of erasing these differences and making the total of t_{ij} equal to T_i or T_j , Fratar method was used for each O-D table.

FIGURE-10 FLOW CHART FOR MAKING FUTURE O-D TABLES



Assignment of Future O-D Tables to Future Road Network

The procedure in this section is exactly the same as the one in section 7, but only input data are different.

The purposes for which the results of assignment in future were used are stated below.

They are,

- 1) to find defaults of the existing road network by assigning the future O-D tables to the existing one,
- 2) to evaluate the effect of new roads or improved ones which were added to network, and to decide the priority of the construction or the arrangement for them,
- 3) to evaluate the proposed alternatives with each other and to select the most desirable one,
- 4) and to give road planners necessary information regarding the traffic volume of any road section for the changes of conditions which are predicted, etc.

For the purposes above more than 100 cases of assignment were executed.

Data for future assignment has the following dimension.

- 1) Number of zones
72 zones
- 2) Number of nodes
about 400
- 3) Number of links
about 1,200 for both ways
- 4) Number of kinds of roads (Number of capacity restraint curves)
about 30
- 5) Number of repetition for assignment
5 times (20% each)

10. Contents of the Computer Output

The principal output obtained through the computer are as follows:

A. O- D tables and assignment

10.1 Present O-D tables

- 1) for each survey
- 2) for each vehicle
- 3) for each trip purpose by vehicle type
- 4) for bus passengers

10.2 Future O-D tables (in 1985 and 2000)

- 1) for all vehicles except motorcycles
- 2) for motorcycles
- 3) for bus passengers

Each of the above O-D table consists of 3 cases. They are 'parking control in the central area of George Town', 'parking control in the central area of George Town and arrangement bus exclusive lanes', and 'doing nothing'.

- 4) detailed O-D tables for the central area of George Town.

10.3 Assignments

- 1) for the existing road network
- 2) for several alternatives of road network in 1985 and 2000 by each case of O-D tables above.
- 3) for bus passengers in 1979, 1985 and 2000
- 4) for the central area of George Town
- 5) for several cases of Penang Linkage with different tolls.

B. Analysis on Car Owner Interview survey and other surveys

10.4 Analysis on Car Owner Interview survey

- 1) The number of owners by their attributes like male or female, age, occupation, or by vehicle type, by residential zone, etc.
- 2) The average number of trips taken a day by owners' attributes, by vehicle type, by zones, etc.
- 3) The distribution of trip generation or attraction by hour for Penang Island and Province Wellesley for each trip purpose.

- 4) The number of trips for each trip purpose by owners' attributes and others.
- 5) The average number of trips by vehicle type, and the average number of passengers by vehicle type for trip purpose.

10.5

Analysis on Ferry survey for vehicles

- 1) The number of trips by each direction, by vehicle type, by each trip purpose, etc.
- 2) The number of passengers by each direction, by vehicle type, by each trip purpose, etc.
- 3) Analysis on commodity type and its weight.

10.6

Analysis on Ferry survey for passengers

- 1) The number of passengers by their attributes.
- 2) Analysis on the transport means before and after the ferry for each trip purpose.

10.7

Analysis on car parking in George Town, Butterworth and Bukit Mertajam.

- 1) The number of parking vehicles by each trip purpose, place of parking, charged or free for the small zones.
- 2) The distribution of the numbers of parked cars by time length for each parking place for each vehicle type.

10.8

Analysis on others

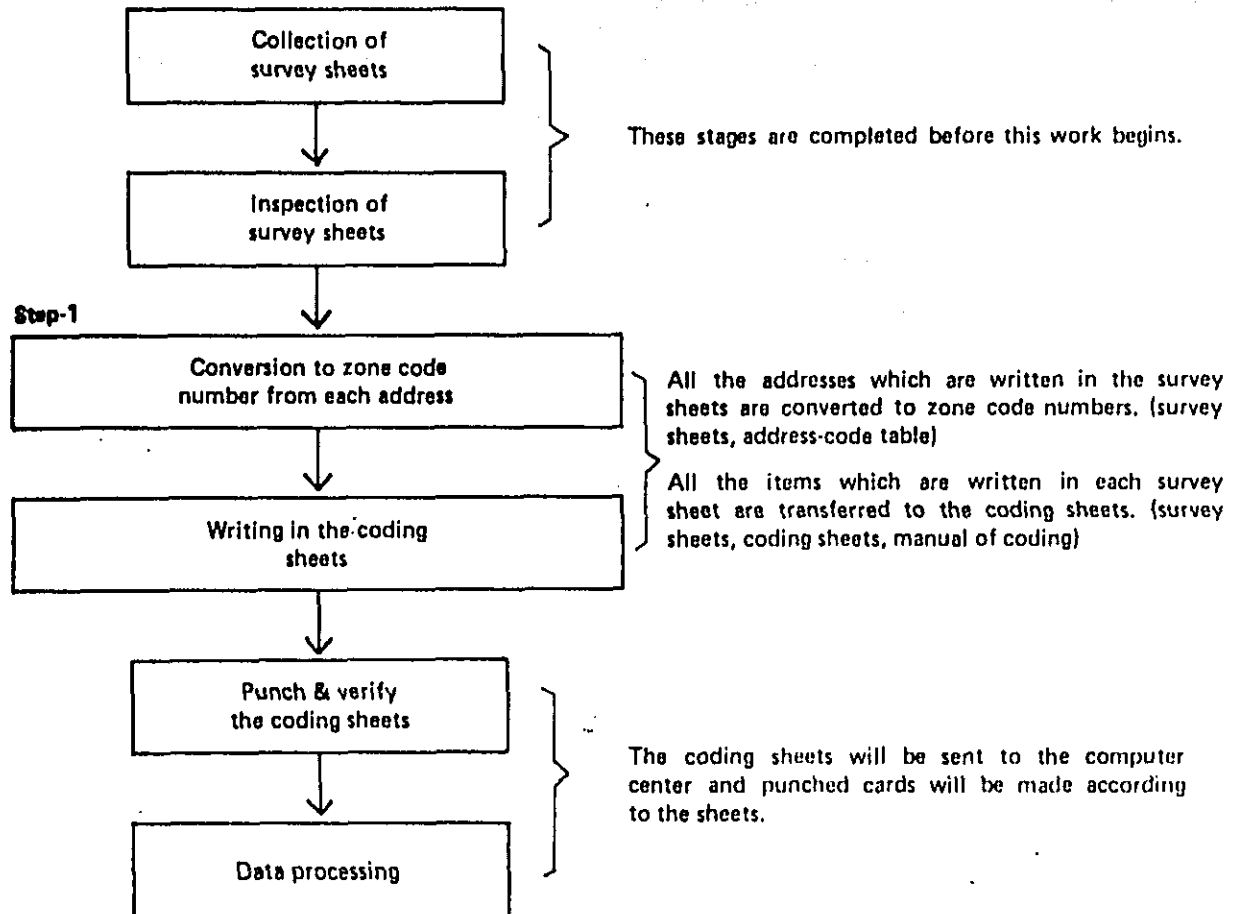
- 1) Analysis on Bus Passenger survey.
- 2) The number of commodity type vehicle for each commodity.
- 3) O-D tables for each commodity.

APPENDIX

Outline of coding work after collection of the
survey sheets -----1
Manual of coding -----2

Out-line of coding work after collection of the survey sheets.

1. Stages of work.



Step-1 Conversion to zone code number from address.

Items which are necessary for converting in the survey sheets are question No. 2, 13, 17, 19.

Use a red pen and write the zone code number in the same space where the question is written.

Question:

- 2 : This address code should have been written in before this work is done. Write the code number in cases where this has not already been done.
- 13 : Address of working place may not be always written in because the car owner in the survey sheet may be a student, a housewife or unemployed.
- 17 : Only the 'origin' address of 1st trip among several trips (i.e. car movement) is converted to the zone code number. This is because the 'origin' address of the 2nd trip would be just the same as the destination address of the 1st trip, and respectively.
- 19 : All the destination addresses must be converted to the zone code number.
- 9 : If the answer is given in "gallons", then convert the figure to "tons" by using 1 gallon = 0.004545 ton. For Qn. 9 we have 3 columns. If loading capacity in tons is 10 or greater then we write: e.g. 10. or 12. or 17. i.e. put a dot in the 3rd column. If loading is less than 10, then you should write as follows: e.g. if in survey sheet is 4.5 tons, then you code as 4.5, if it is 5 then you code it as 5.0.

Step-2 Writing in the coding sheets.
Refer to "MANUAL OF CODING".

MANUAL OF CODING

This is the document that explains how to code or write in the coding sheet from the traffic survey sheet (i.e. the questionnaire). Those who are engaged in this work, should write very carefully and clearly. This is because the sheets written by them are sent to the computer centre, and are punched according to what is written by them.

Before the work of coding can be undertaken, the following must be done.

1. Through examination of the collected survey sheets.
2. Conversion of all addresses in the sheets to appropriate zone numbers.

There are 7 forms of coding sheets namely A, B, C, G according to the survey sheets.

All the figures should be written from left to right within each specified columns respectively. Please pay attention so as not to confuse one form of coding sheet with another.

Below is an explanation of Form A.

A. FORM-A

Form-A is for car-owner interview survey and for motorcycle owner interview survey. Items to be written are divided into two parts, owner data and trip data. The number of items for owner data is fixed, but it is variable for trip data according to the number of trips made.

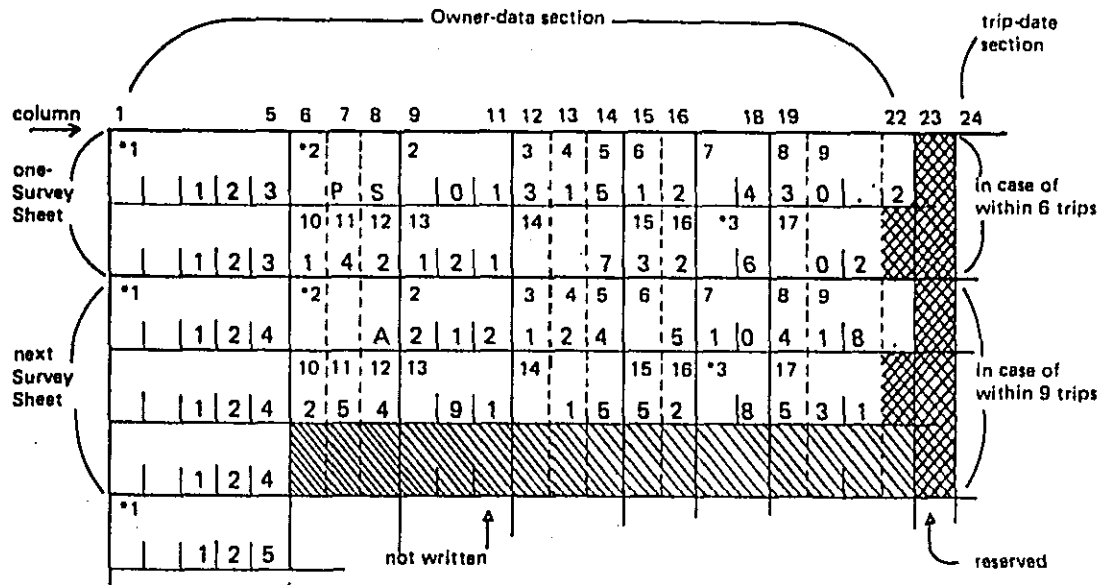
Coding Sheet

| owner data | trip data | | |
|-------------|-----------|-----|-----|
| first sheet | trip - 1 | - 2 | - 3 |
| | - 4 | - 5 | - 6 |
| next sheet | trip - 1 | - 2 | - 3 |
| | | | |
| | | | |

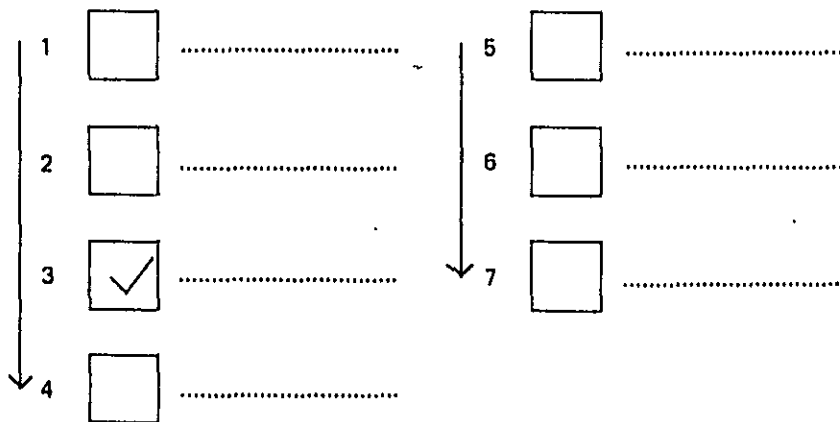
Again, pay attention to the rule that all the letters and digits should be written right-wards within each specified columns respectively. This rule is applied to all the forms through A to G (7-forms).

The section for 'Owner-data'

The section for owner-data is derived from one survey sheet and is always written over two rows as shown below. So, the next owner-data is written from the 3rd row without leaving any blank spaces if the trip data ends within two rows. On the other hand the next owner data i.e. the data from the next survey sheet is written from 4th row if the trip data extends over 3 rows. As mentioned later it is possible to write 3-trips in each row. Thus, the number of rows that are necessary for coding one survey sheet is at least two, if the number of trips made is 6 or less, and 3 rows if the number of trips made is 9 or less, and so on.



Some of the answers in the survey sheet are indicated by , and the method of counting is as follows.



Please write "3" in the appropriate column, if the tick is made in box 3.

The order of writing in the coding sheet is from left to right and from top to bottom.

The encircled number in the coding sheet as shown above is equal to that written in the survey sheet.

- *1 : Sheet number.
The figure from 1 to about 99,999 can be written in.
- *2 : The 'letter' part of the registration number.
If the registration number is PS8175, write only PS.
- (2) Zone code of the address such as 01, 02, . . . 212, 335 . . .
Zone code numbers are written in the survey sheets before this coding is done.
- (3) No. of 'form of ownership.'
Any one of digit 1 to 3 is selected according to the answers.
- (4) Distinguish between male or female.
Write 1 for male and 2 for female.

(5) Classification of ages.

Any one of digit 1 to 5 is selected according to the ticked answer in the blank spaces.

| | | | | | |
|---|-------------------------------------|-------|---|--------------------------|-------|
| 1 | <input type="checkbox"/> | | 4 | <input type="checkbox"/> | |
| 2 | <input checked="" type="checkbox"/> | | 5 | <input type="checkbox"/> | |
| 3 | <input type="checkbox"/> | | | | |

(6) Number of occupants

(7) Occupation.

Any one of digit 1 to 10 is selected.

(8) Type of vehicle.

Any one of digit 1 to 6 is selected according to the ticked answer of as below.

| | | | |
|---|--------------------------|-------|------------------------------|
| 1 | <input type="checkbox"/> | | } continued to next item (9) |
| 2 | <input type="checkbox"/> | | |
| 3 | <input type="checkbox"/> | | |
| 4 | <input type="checkbox"/> | | |
| 5 | <input type="checkbox"/> | | |
| 6 | <input type="checkbox"/> | | |

(9) Loading capacity by tons.

This item is written only when the answer is 2, 3, or 4 in the above item (8), otherwise it is ignored. Answer is given by way of two measures, tons and gallons, and the figure by tons should be adjusted and rounded to 1 decl. pt. . . . (for example, 2.4 1.5). Gallons should be converted to tons by the value: 1 gallon = 0.004545 ton and then rounded to 1 decimal place.

(10) Period of ownership.

(11) Type of establishment.

(12) Size of employment.

(13) Same as the above item (2).

(14) Average mileage per day.

The figure should be rounded as 7, 15, 70, etc.

(15) Usage of vehicle per week.

Any one of digit 1 to 4 is selected.

(16) Reason number for no movement.

***3 Number of trips (No. of car movements)**

Notice that number of car movement is written on both sides, the front and the back of the survey sheet.

By this number the computer can recognize the number of car movements made, from where, to where, what for, . . . etc.

(17) Zone code number for the origin of the 1st trip.

Item No. (17) to (25) belong to the section for trip data as mentioned later. However concerning item (17) only the origin of the 1st trip is written in and this is to be written in this section. Of course there is no need to write anything, if there's no trip movement recorded.

The section for 'Trip Data'

In this section detailed movements of the car as recorded on the survey sheet are written in the coding sheet form as shown below. It is possible to write three trips, or three car movements in one row. So if there are 4 trips, then one row and the first part of second row should be used for this purpose.

If there are 8 trips, two rows and first and second part of the third row will be necessary. Here, first part means column 24 to 42, second, 43 to 61, and third, 62 to 80. And the number of trips written here should be equal to that of the trips written in item *3 in the section for owner data. There is no need to write in item (17) which is zone number for origin in this section.

| Owner-data section | trip-data-section | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|------------------------------------|----|----|----|----|----|----|----|----|----|----|----|-------------------------|----|----|----|----|----|-------------------------------|--|--|--|--|--|
| | 1st trip (4, 7, 10 trip) | | | | | | | | | | | | 2nd trip (5, 8, 11 . .) | | | | | | 3rd trip (6, 9, 12) | | | | | |
| column | 23 | 24 | 27 | 28 | 31 | 35 | 36 | 37 | 38 | 39 | 41 | 42 | 43 | 61 | 62 | 80 | | | | | | | | |
| row-1 | 18 | h | m | 19 | 20 | h | m | 21 | 22 | 23 | 23 | 24 | 25 | 25 | 18 | 25 | 18 | 25 | | | | | | |
| row-2 | 18 | 7 | 5 | 3 | 3 | 1 | 7 | 4 | 5 | 1 | 1 | 4 | 1 | 3 | 6 | 3 | | | | | | | | |
| row-3 | 18 | 1 | 9 | 4 | 5 | 0 | 3 | 2 | 0 | 5 | 3 | 5 | 5 | 2 | 1 | 0 | | | | | | | | |
| -3 | 18 | | | 19 | | | | | | | | | | | | | | | | | | | | |
| -4 | 18 | | | | | | | | | | | | | | | | | | | | | | | |
| -5 | | | | | | | | | | | | | | | | | | | | | | | | |

reserved

(18) Departure time of the trip.

Example in the figure shows 7:5 (a.m.) in 1st trip and 19:45 (p.m.) in 4th trip.

(19) Zone code number of destination.

(20) Arrival time of the trip.

Example shows 1st trip arrived at 7:45 (a.m.) at zone code number 331, and 4th trip arrived at 20:5 (p.m.) at zone code number 03.

(21) Purpose of Trip.

(22) Nature of establishment.

- (23) Place of parking.
Concerning item (23) two answers are offered. First answer is written in column 37, and second is written in column 38.
- (24) Number of passengers including the driver himself.
- (25) Type of commodity.
There are two parts to this answer. There's no need to write in anything unless there's an answer. If there's an answer, write in the first part in column 41, and second part in column 42.

| TRIPS MADE DURING THE LAST 24 HOURS | | | | 21 TRIP PURPOSE | 22 NATURE OF ESTABLISHMENT | 23 PLACE OF PARKING | | 24 | 25 TYPE AND AMOUNT OF COMMODITY CARRIED (for van/medium lorry/heavy lorry) | | |
|-------------------------------------|-------------------------------|-------------------|----|------------------------------------|---|---------------------|---------------------|--|---|---|--|
| TRIP NO. | 17 ORIGIN (Name & Address) | 18 DEPARTURE TIME | | 19 DESTINATION (Name & Address) | 20 ARRIVAL TIME | | 1 charged 2 free | NUMBER OF PASSENGERS - INCLUDING DRIVER | 25 | | |
| | | AM | PM | | AM | PM | | | 1 no luggage 2 agriculture, fishery and meat products 3 timber, lumber or wood products 4 minerals 5 metal product and machinery 6 product of light industry 7 chemical products 8 miscellaneous | 1 full 2 ½ full 3 ¼ full 4 ⅓ full 5 less than ¼ | |
| 6 | | AM | : | | AM | : | | | | | |
| | | PM | : | | PM | : | | | | | |
| 7 | | AM | : | | AM | : | | | | | |
| | | PM | : | | PM | : | | | | | |
| 8 | | AM | : | | AM | : | | | | | |
| | | PM | : | | PM | : | | | | | |
| 9 | | AM | : | | AM | : | | | | | |
| | | PM | : | | PM | : | | | | | |
| 10 | | AM | : | | AM | : | | | | | |
| | | PM | : | | PM | : | | | | | |
| 11 | | AM | : | | AM | : | | | | | |
| | | PM | : | | PM | : | | | | | |
| 26 NAME OF ROADS FREQUENTLY TAKEN: | | | | | 27 COMMENT/RECOMMENDATION FROM INTERVIEWEE: | | | | 28 NAME OF INTERVIEWER: | | |

Thank you!

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