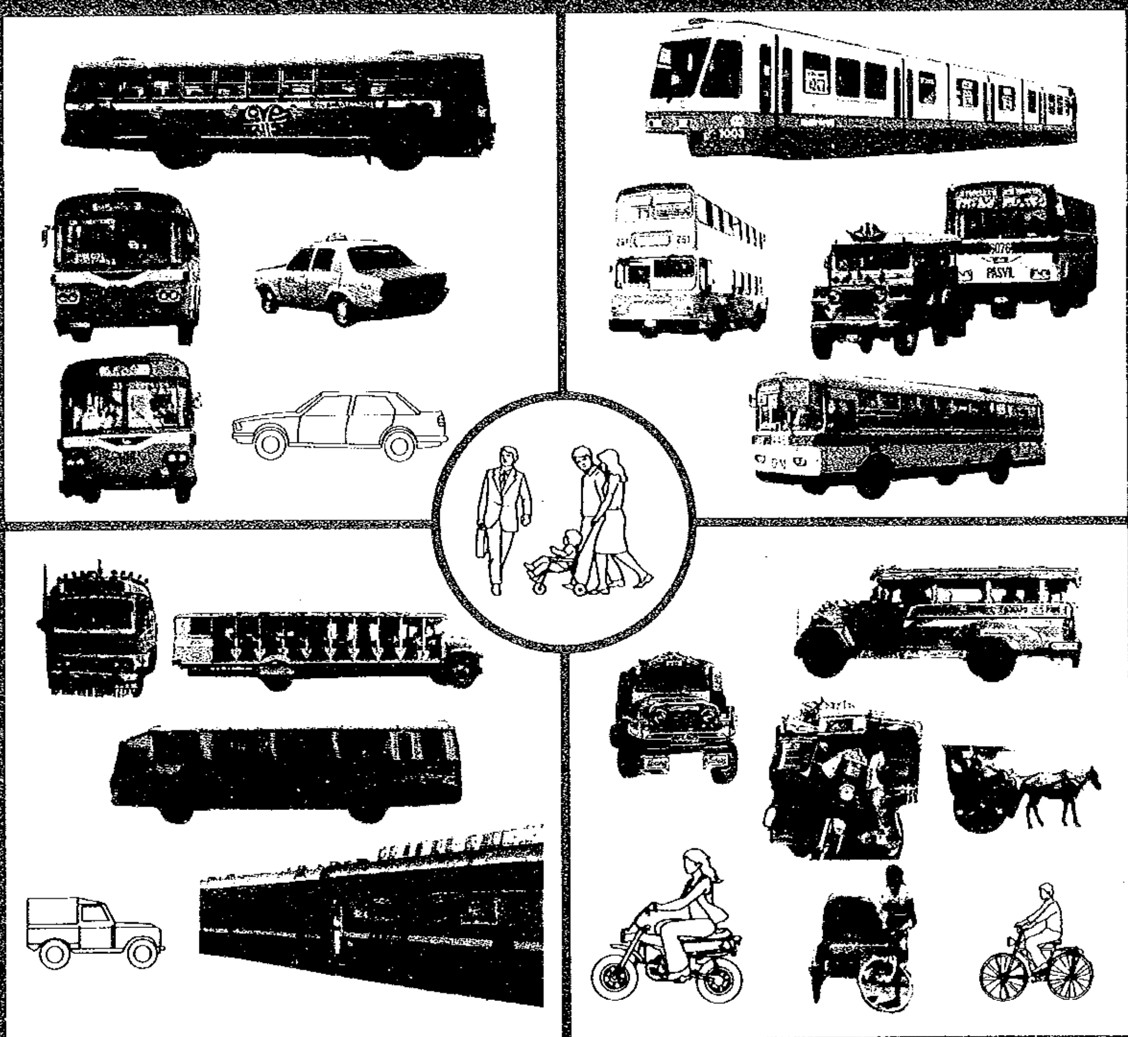
REPUBLIC OF THE PHILIPPINES

THE METRO MANILA TRANSPORTATION PLANNING STUDY (JUMSUT)

FINAL REPORT

SUPPORTING DOCUMENTS/MANUALS

No. 4 : Transportation Planning Procedures Manual



March 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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1. INTRODUCTION

- This report describes the characteristics of a computer program package called TRANSTEP, its structure, behavior and main features, as well as changes made in the JUMSUT Study for program improvement.

  The TRANSTEP User's Manual is already available with the Ministry. Specifically, this manual discusses the following aspects:

  1) Outline of the whole TRANSTEP and the interaction between the Public Transport Assignment Module and other modules
  2) Guidelines on how to use TRANSTEP better. These were identified based on an extensive application and analysis of some 100 alternative cases.
  3) Improvement made in JUMSUT on the original TRANSTEP PROGRAM.

2. OUTLINE OF THE PUBLIC TRANSPORT ASSIGNMENT MODULES OF TRANSTEP

2.1 STRUCTURE OF TRANSTEP

- TRANSTEP is a suite of programs designed to tackle land-use and/or transportation problems. The package consists of twelve program modules. Seven (7) modules perform utility functions, while the remaining five (5) perform core modeling functions.

  The core modeling modules are:

  a) Activity Patterns Model
  b) Modal Split
  c) Assign Trips
  d) Land-use Analysis and Projection
  e) Public Transport Assignment

  The utility modules are:

  a) Update Land-use
  b) Compute Air Distance
  c) Build Network
  d) Matrix Manipulate
  e) Plot Contours
  f) Edit Public Transport
  g) Public Transport Paths

- Figure 2.1 illustrates some sample applications and the interactions of the TRANSTEP modules.

2.2 DESCRIPTION OF CORE MODULES

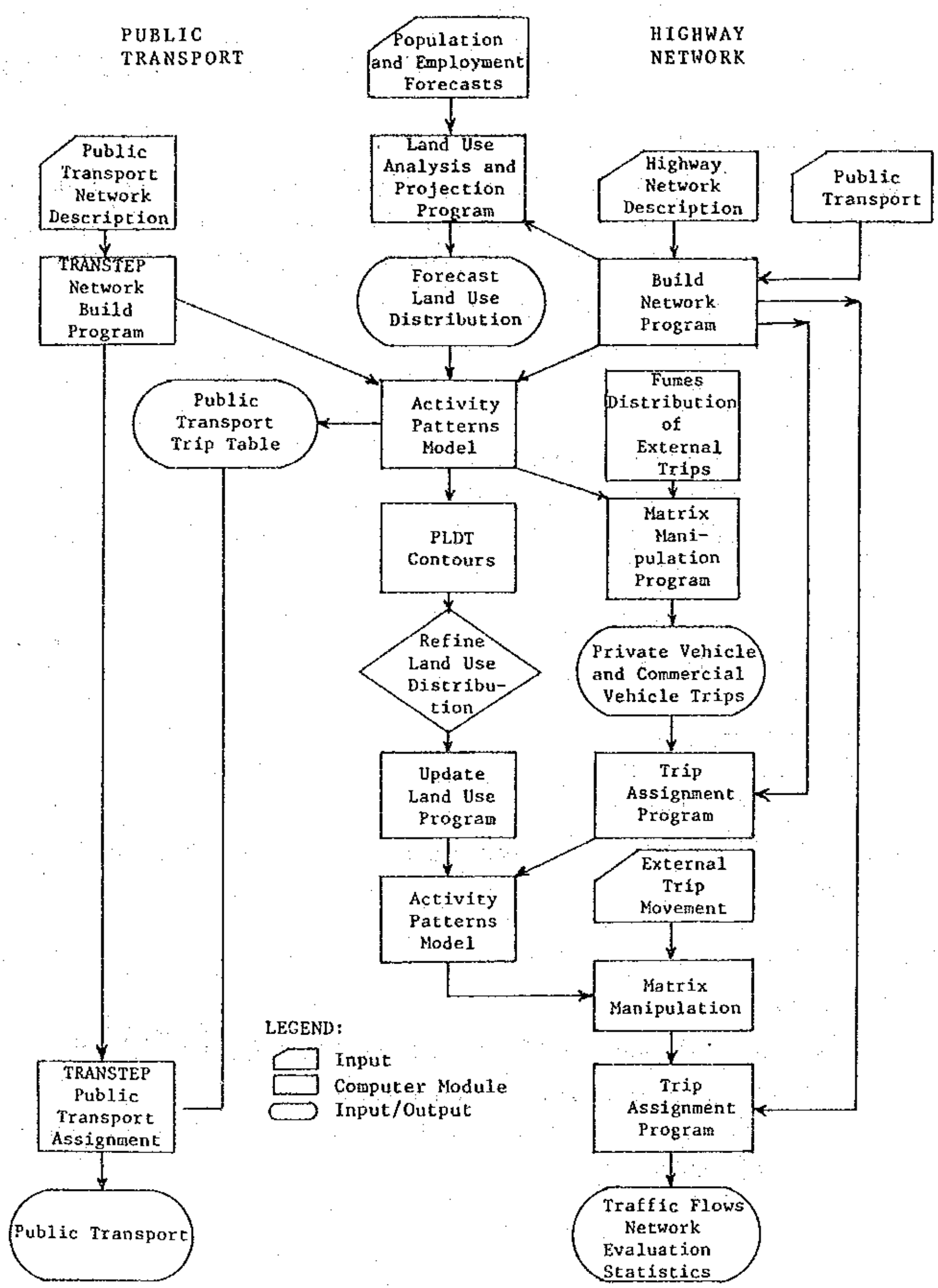
1) Activity Patterns Model

   - This is the core model of TRANSTEP. Its functions are twofold:

     a) To produce a valid interzonal trip file, and
     b) To produce zonal accessibility data in printed form and in a form suitable for plotting.

- The interzonal trip file is produced using a method which is different from the traditional four-step transportation suite. In TRANSTEP, the trip generation and trip distribution are processed simultaneously and not sequentially, as in the four-step model, making TRANSTEP particularly adaptive to modeling equilibrium between trip generation and degree of congestion. Trip generation is a function of accessibility. This means that a change in the transport network and/or in land-use distribution results in a change in average zonal trip generation rates. This may happen even if the total land use distribution for the study remains constant.

Figure 2.1
Structure of TRANSTEP
(Land Use – Transport Interactive Testing Procedure)



- The trip distribution process in the Activity Patterns Model is different from a Gravity Model in that the Gravity Model relies on the selection of "friction curves" which are themselves dependent on land use distribution. The Activity Patterns Model utilizes a preference function which enables the "friction curve" equivalent to be derived automatically.
- The module may be used to produce zonal values of the following accessibility variables:

  a) Attraction or Production Potential
  b) Net Employment Potential
  c) Attraction or Production within a Specified Travel Time
  d) Accessibility to Attraction or Production
  e) Average Trip Length

  The above variables may be plotted to provide visual presentation of the accessibility inherent in the land use transport system.

2) **Modal Split**

- The function of this module is to split an interzonal person trip matrix, as produced by the Activity Patterns Model, into two interzonal person trip matrices: one for car driven trips and another for public transport trips.
- The splitting is done using the following equation, thus:

$$\text{PERCENT} = \frac{1}{1 + e^{\text{expon}}}$$

Where:

PERCENT = the percentage of all person trips that are public transport passengers.

EXPON = COEF (1) × Residential Density +
COEF (2) × Employment Density +
COEF (3) × Trip Generation Rate +
COEF (4) × Average Zonal Income +
COEF (5) × Public Transport Skim/Highway Skim +
COEF (6) × Highway Skim

Any variable in the EXPON calculation may be excluded by setting its corresponding coefficient, COEF, to zero. The value of the array COEF may be derived through calibration of the model using home interview or roadside interview survey data.

3) **Assign Trips**

- The primary function of the Assign Trips Model is to carry out the assignment of an interzonal vehicular trip matrix onto the highway network. Its secondary functions involve the production of a congestion-constrained generalized cost skim table, summary evaluation results, and congestion-constrained public transport link speeds.

  a) **Speed/Flow Relationship:** The model uses a single speed/flow relationship which may be specified by the user. Up to 10 points on this relationship can be defined. Each point is defined in terms of the ratio between assigned volume and capacity and speed. The model automatically calculates the points to the right of input values in the speed/flow curve to ensure that all points follow a monotonously decreasing curve.

b) **Generalized Cost Formula:** Interzonal separation may be defined in terms of distance, time or generalized cost for assignment purposes. Generalized cost is calculated using the following formula:

Generalized Cost = A x distance + B x time + GAMMA

Where:

GAMMA = terminal cost, such as parking cost or transfer penalty

A, B = coefficient of distance and time, respectively

If the minimization of the generalized cost in the network defines the objective function, the values assigned to A, B and GAMMA are of primary importance. The derivation of the coefficients involves the valuation of travel time.

4) **Land Use Analysis and Projection Model (LANDAL)**

- LANDAL has a twofold function, as follows:
  - a) To provide a series of statistical relationships between land-use variables to assist in the analysis of urban relationships, and
  - b) To provide a model for distributing regional forecasts of urban activities to the zonal level.
- **Land Use Analysis:** The first function of the module provides graphical outputs of relationships between land-use variables as follows:
  - a) Distribution of Income by Population
  - b) Population Density vs. Accessibility to Attractions
  - c) Land Price vs. Accessibility to Attractions
  - d) Land Price vs. Average Zonal Income
  - e) Population Density vs. Average Zonal Income
  - f) Accessibility to Attractions vs. Average Zonal Income
  - g) Employment Density vs. Accessibility to Productions
  - h) Up to five Lorenza curves, plotting cumulative of each of the five activity fields against the cumulative % of area they take up for the region.
- **Land Use Projection:** The model produces a zonal distribution of the predicted study area growth in the land use activity parameters. This is done by analyzing the characteristics of the land use distribution and then distributing the additional population and employment for each planning year, as required, on the basis of calibrated density/accessibility relationship, land supply/demand situation, and accessibility to production or attraction, whichever is appropriate. This module also maintains an inventory of land use which is updated as land is taken up by new developments. The model is extremely flexible and allows a high degree of manual control relating, for example, to:
  - a) Alternative strategies or proposed activity patterns, and
  - b) Committed or proposed employment and population generating projects and capital investments.

5) **Public Transport Assignment**

- The LOAD PUBLIC TRANSPORT, PUBLIC TRANSPORT PATHS, and EDIT PUBLIC TRANSPORT modules were written especially for the MMUTIP Study. The functions of the Load Public Transport module are as follows:

  a) To simulate passenger loadings on a public transport network and to provide line information suitable for detailed planning and economic evaluation;
  b) To simulate choice between public transport sub-modes and amend service frequencies to achieve a balance between passenger demand and service capacity on each line; and
  c) To update the public transport skim file PTSKIM.

2.3 PUBLIC TRANSPORT ASSIGNMENT MODULES

- The public transport assignment program aims to simulate passenger loading on a public transport network and to provide line information suitable for planning and economic evaluation. The program can also simulate choices between public transport submodes and amend service frequencies to achieve a balance between passenger demand and service capacity on each line. In order to deal comprehensively with the alternative public transport network configuration for the size of cities like Metro Manila, the use of computer programs is recommended.
- The interrelationship of the TRANSTEP public transport assignment modules is shown in Figure 2.2. The structure and the main features of the model can be described as follows:

  1) **Outline of the Assignment Model:** Public transport passenger demand prepared in the form of an OD table will be loaded by increments onto the public transport network which comprises the routes of different modes (Love Bus, Bus, Jeepney, etc.; note that up to six modes can be dealt with). Although the smaller and more numerous the increments of OD table the greater is the accuracy in the final equilibrium loading, the whole OD was subdivided into five cells in JUMSUT considering the computer run time and capacity. For each assignment, a passenger chooses the minimum path in terms of generalized cost.[1/] For the second assignment, however, the minimum path might differ from the one selected in the first assignment due to changes in generalized cost components.

     The generalized cost explains not only the selection of feasible paths but also the modal-split between bus and jeepney by giving different ratios to generalized cost components. For example, waiting time of love bus passengers can be valued higher than that of ordinary bus passengers. By changing the values of the mode coefficients (ratios given to each generalized cost component), the model aims to explain the modal split.

  2) **Input Data:** Those required for the model are as follows:

     a) Public transport passenger trip matrix
     b) Public transport line configuration with line data indicating nodes, operational

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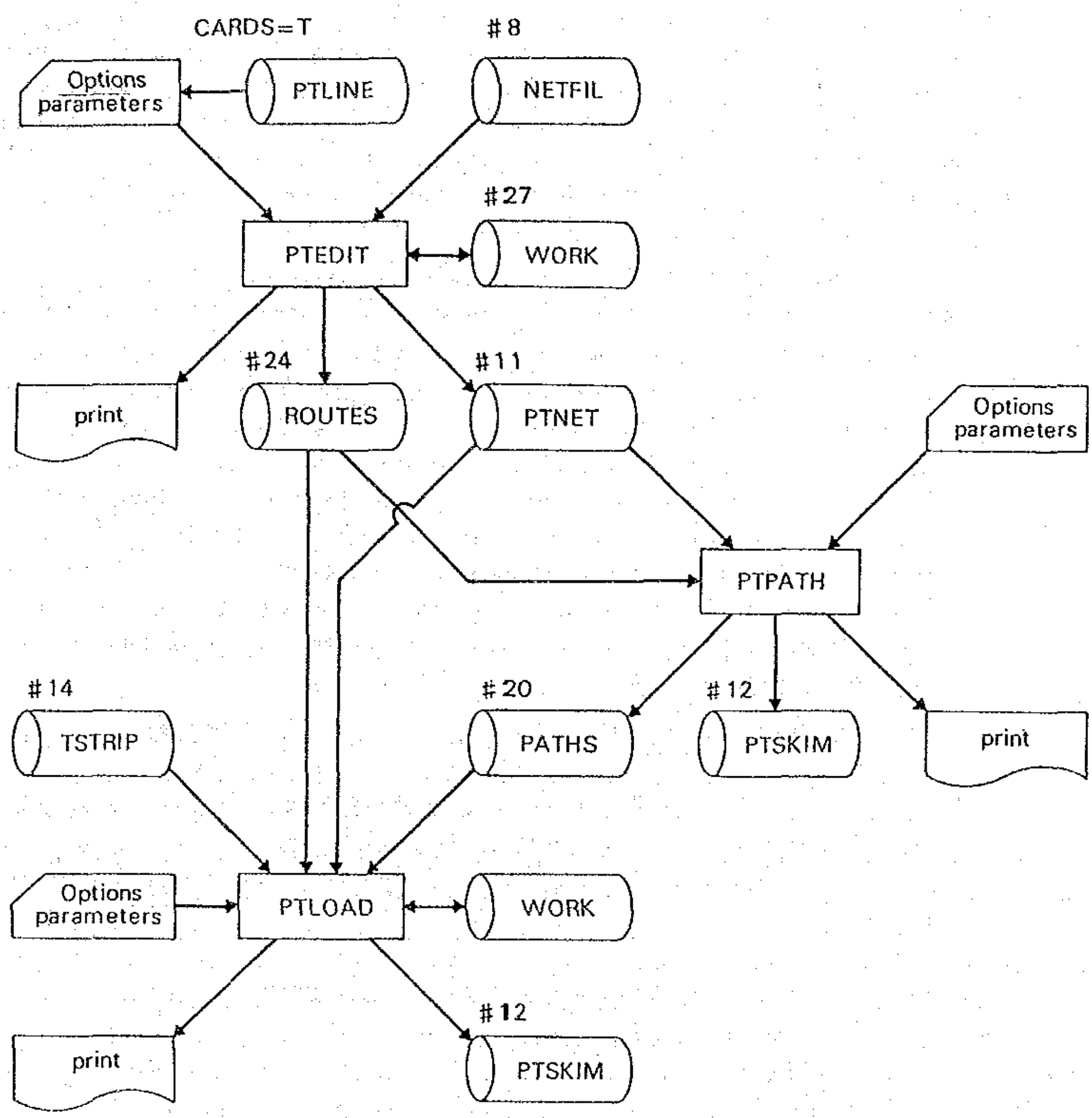
[1/] Generalized cost is the cost of travel expressed either in terms of minutes or pesos which consists of walking, waiting, loading, traveling, transfer times, fare and discomfort.

modes, headway, scheduled speed

c) Generalized cost data for respective modes, including walking, waiting, loading, traveling, transfer times, fare, and discomfort capacity restraint factor, together with time value of public transport passenger
d) Highway network with link data indicating nodes, length, number of lanes, and speed flow curves
e) Private vehicular traffic OD

Figure 2.2
Interrelationship of TRANSTEP Transit Assignment Modules



3) **Output Data:** Those required for the model are as follows:

   a) Detailed loading report by direction (up/down) and by node for each line, including:

      - number of boarding and alighting passengers
      - number of transfer passengers
      - total number of passengers carried
      - volume capacity ratio

   b) Line report by direction and by mode for each line, including:

      - line distance and travel time
      - initial and final headway
      - number of passengers
      - passenger hours and kilometers
      - route hours and route kilometers
      - amount of fares

   c) Mode report, including:

      - number of passengers
      - passenger hours and kilometers
      - route hours and kilometers
      - amount of fares

4) **Characteristics of the Model:** Although the model provides useful data for public transport planning, it is noteworthy to mention the following points for future application of the model:

   a) Existence of a large number of jeepney routes makes the preparation of the necessary data and the application of the model very complicated and difficult. This problem is amplified due to the physical size of the study area to be covered or the restriction of the model or the capabilities of the computer used. Since the model aims to simulate passenger loading on a public transport network and to achieve balance between passenger demand and service capacity on each line, the size of the zoning and the public transport line configuration should be made finer to explain how the jeepneys greatly affect bus transport.

      On the other hand, it is not practical to have finer zoning and public transport lines because this will tremendously increase computer run time and data preparation work. The areas where the model can be more adequately applied are intermediate-size cities. For the model to be applicable in Metro Manila, it is, therefore, recommended that the model be expanded to such a level that at least 500 lines can be accommodated.

   b) To meet the capacity restriction of the model, the existing jeepney routes had to be integrated. Since the assignment model for public transport passengers is explained by detailed generalized cost, this simplification would affect the accuracy of the results of each line. The extreme integration also makes it more difficult to interpret the results.

   c) Estimate of generalized cost and determination of mode coefficients for each generalized cost component are critical factors in the use of the model. The most critical factor is valuation of time in terms of pesos; this is done to add the fare and time costs on the same basis. If the time value is low, path finding is explained more by fare, while if the time value is high, it will be explained more by travel time. Under these conditions, where congestions are widely spread, as seen in Metro Manila, the assignment results of bus and jeepney will not be greatly affected. However, with the introduction of the elevated Light Rail Transit (LRT) which is free from congestion on the surface roads, the choice of the routes will be significantly different, depending upon the valuation of time. Difficulties will also be experienced in giving a relative ratio to each mode coefficient of different modes.

d) Since there is hardly a precise way to theoretically determine the values of these coefficients, it is always important to verify the model in comparison with the actual situation before applying the model for alternative plans.

3. INPUT DATA PREPARATION FOR TRANSTEP PUBLIC TRANSPORT ASSIGNMENT MODULES

- This chapter describes the methodology of data preparation required as input to the TRANSTEP public transport assignment modules. Refer to the TRANSTEP User's Manual for computer operation.

3.1 REQUIRED DATA

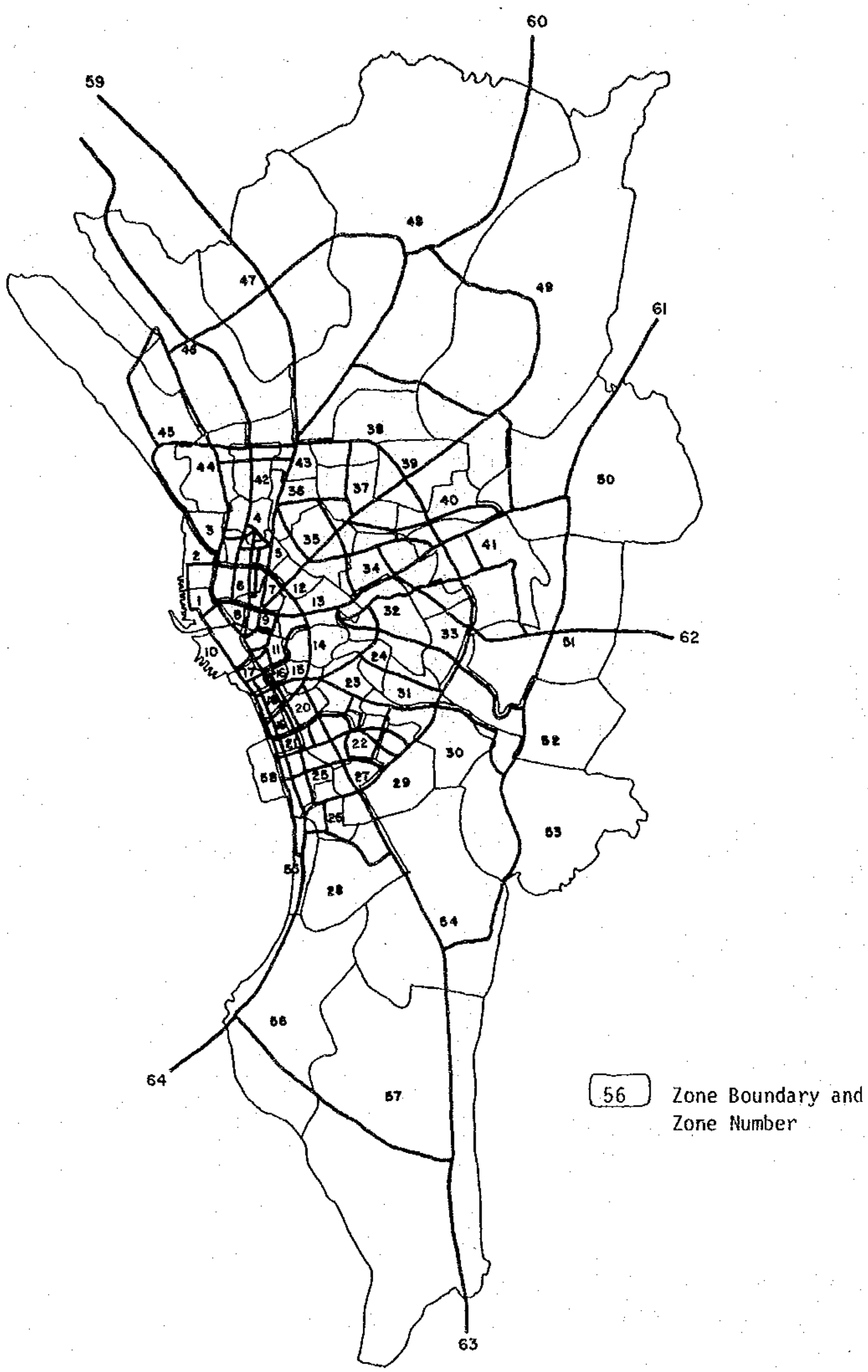
- The following data are required to operate the TRANSTEP public transport assignment modules:
  - Zoning
  - Road/Railway Network
  - Public Transport Route Configuration
  - Public Transport Passenger OD Table
  - A Set of Mode Coefficients
  - Other Parameters including COST LIMIT and MAXPATHS
- Among the above, zoning, road/railway network and the public transport passenger OD table are dependent solely on the planning purpose. However, the public transport route configuration must be prepared based on the planning purpose and the computer capacity. Mode coefficients and other parameters are a matter of technique rather than planning.

3.2 ZONING

- Although zoning is closely related to other necessary data including road/railway network, public transport route configuration and OD tables, it is purely a matter of planning separate from the consideration of computer operation.

  However, if the zoning is too fine, the computation time becomes large, making it difficult to run the programs on various cases. Therefore, as long as the purpose is attained, the number of zones should be as small as possible. Figures 3.1 and 3.2 are examples adopted in JUMSUT for 64 and 74 zone systems.
- Zoning must be consistent with the road/railway network. A zone should not be created where no road passes. In other words, roads or railways must pass all the zones.

Figure 3.1
JUMSUT 64-Zoning System with Emphasis on the Distribution of Jeepney Terminals



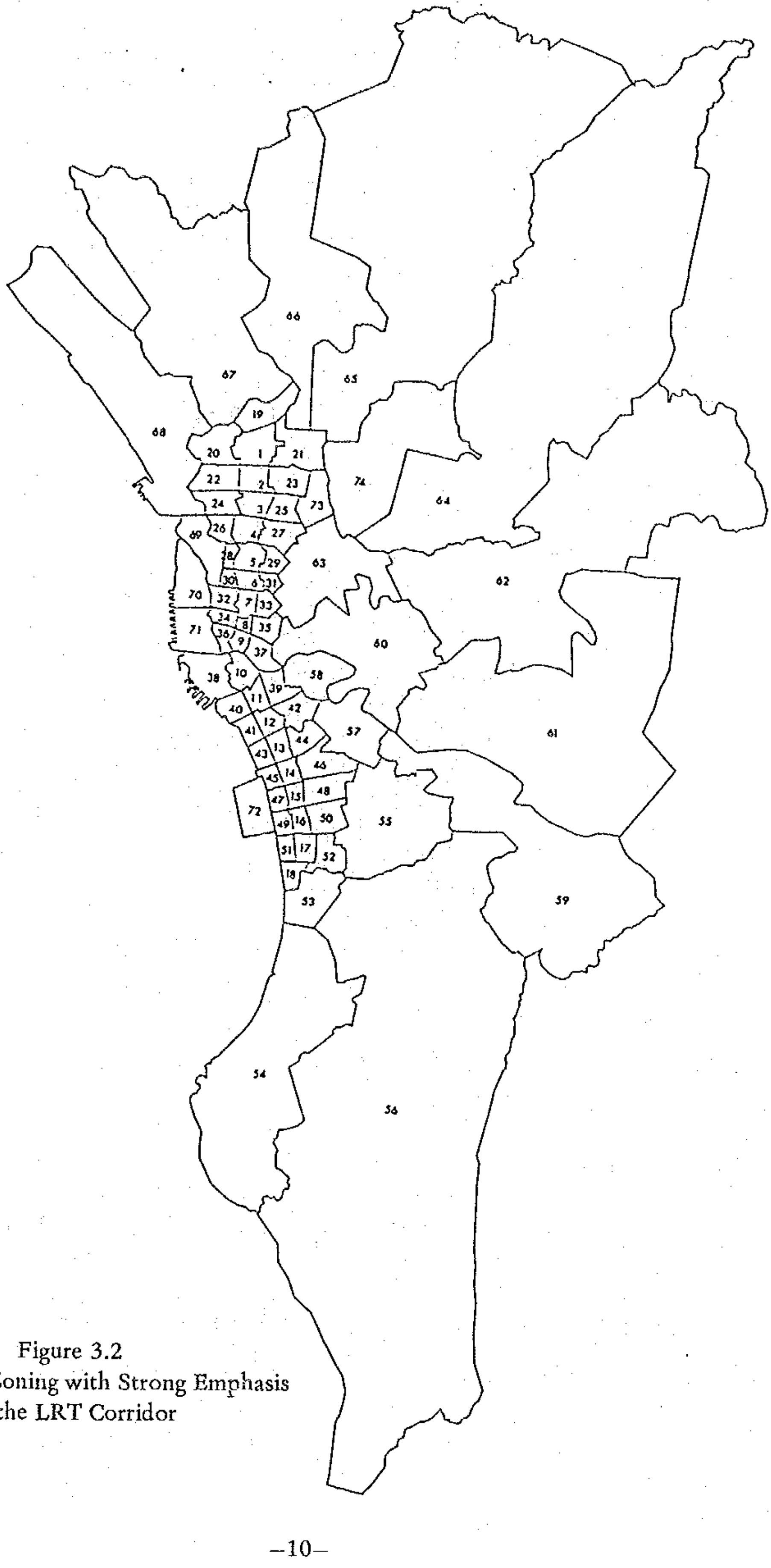


Figure 3.2
JUMSUT 74-Zoning with Strong Emphasis
on the LRT Corridor

3.3 ROAD/RAILWAY NETWORK

- The road/railway network explained here is a link-node system approximated from the actual network for the convenience of EDP. Therefore, the network is created as simple as possible to reduce the amount of EDP work as long as it can represent the actual network. The following aspects have been considered:
  - Whether all major public transport roads are covered
  - Whether all major thoroughfares are covered
  - Whether all zones are accessible
  - Whether there are links that can be integrated into other links, such as parallel one-way streets and roads connecting the same zone pairs with similar alignment.
- Figures 3.3 and 3.4 are actual examples used in JUMSUT for 64 and 74 zones.

- Once the approximated road railway network is created, it must be interpreted as link data and should be coded according to the format shown in Figure 3.5. Although there are 13 data items to be coded, five items are enough, as far as the four modules of public transport assignment are concerned. Other items will be used for other functions of TRANSTEP including the highway traffic assignment. These five items are described as follows:

  a) **Origin Node No.:** May be discrete. Usually, zone centroids are assigned the node numbers starting from one (1), followed by other junctions.
  b) **Destination Node No.:** Same as a) above.
  c) **Length** (kilometers x 100): Expressed in 10 meters, should represent the actual distance of the link. However, for the dummy links connecting the zone centroids with the road/railway network, the actual distance may not necessarily be coded depending on the characteristics of the public transport mode. For instance, 200 to 500 meters will be specified in Metro Manila for the dummy links of all zones regardless of the location of zone centroids, since jeepneys stop everywhere.
  d) **Transit Speed:** Sometimes called the link speed as against the line speed. It is one of the most important factors of the network calibration. Since PTPATH takes either link speed or line speed (whichever is lower), this becomes dominant if the value is set low compared to the line speed. Although it is desirable to take the actually observed speed of the link, there are cases when this value should be modified in order to obtain reasonable results. This occurs when the network is approximated to a considerable extent. In such a case, the transit speed should be considered as a parameter to calibrate the network.
  e) **Direction:** This is coded as 1 (one) when the link is one-way and as 2 (two) when two-way. However, it is rare to put 1 when the network is considerably approximated so that parallel one-way streets are integrated into a two-way road. Further, if a link is set one-way, line data must be carefully created for the routes that pass this one-way link.

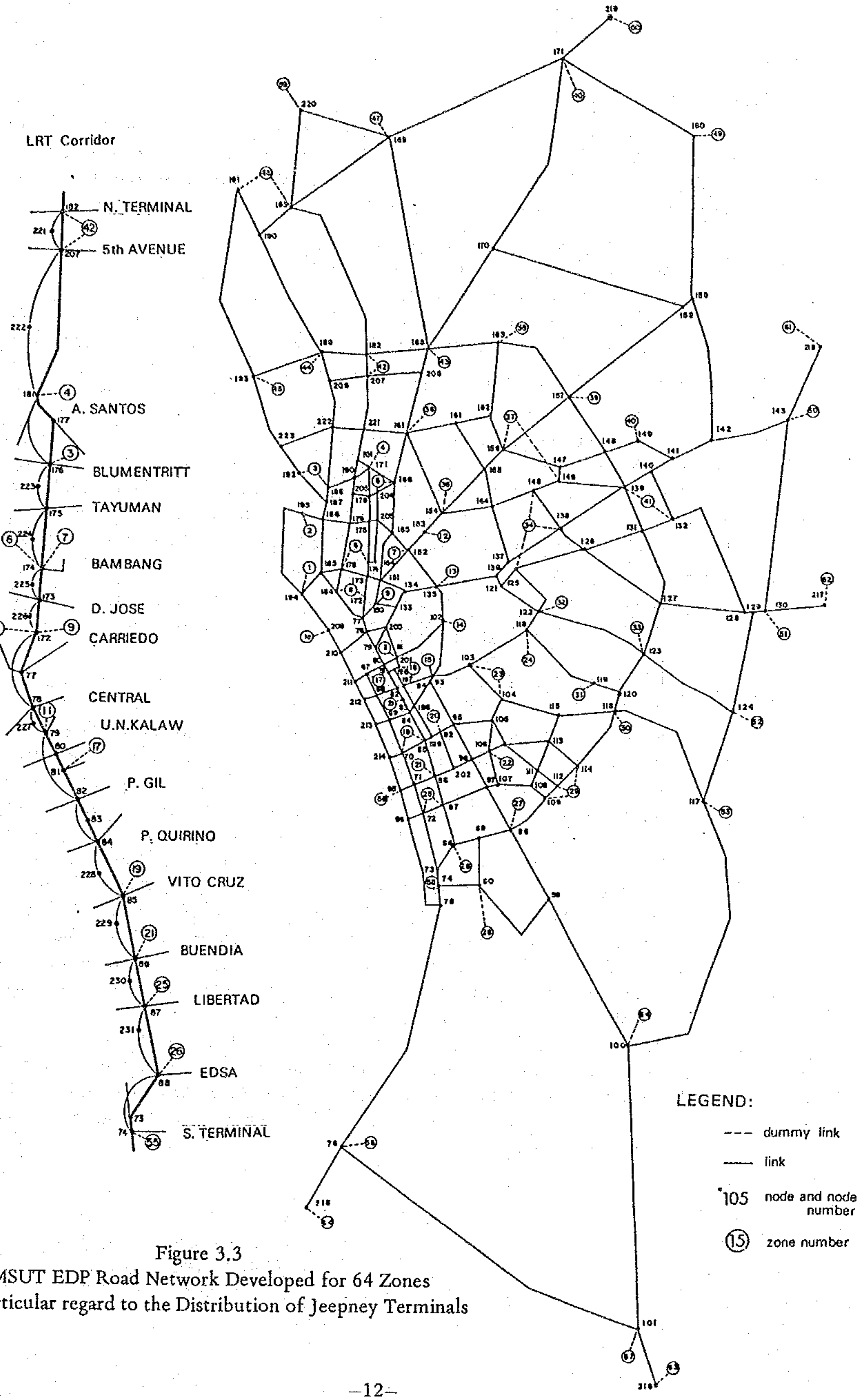


Figure 3.3
JUMSUT EDP Road Network Developed for 64 Zones
with particular regard to the Distribution of Jeepney Terminals

Figure 3.4
JUMSUT EDP Road Network Developed for 74 Zones with strong Emphasis on the LRT Corridor

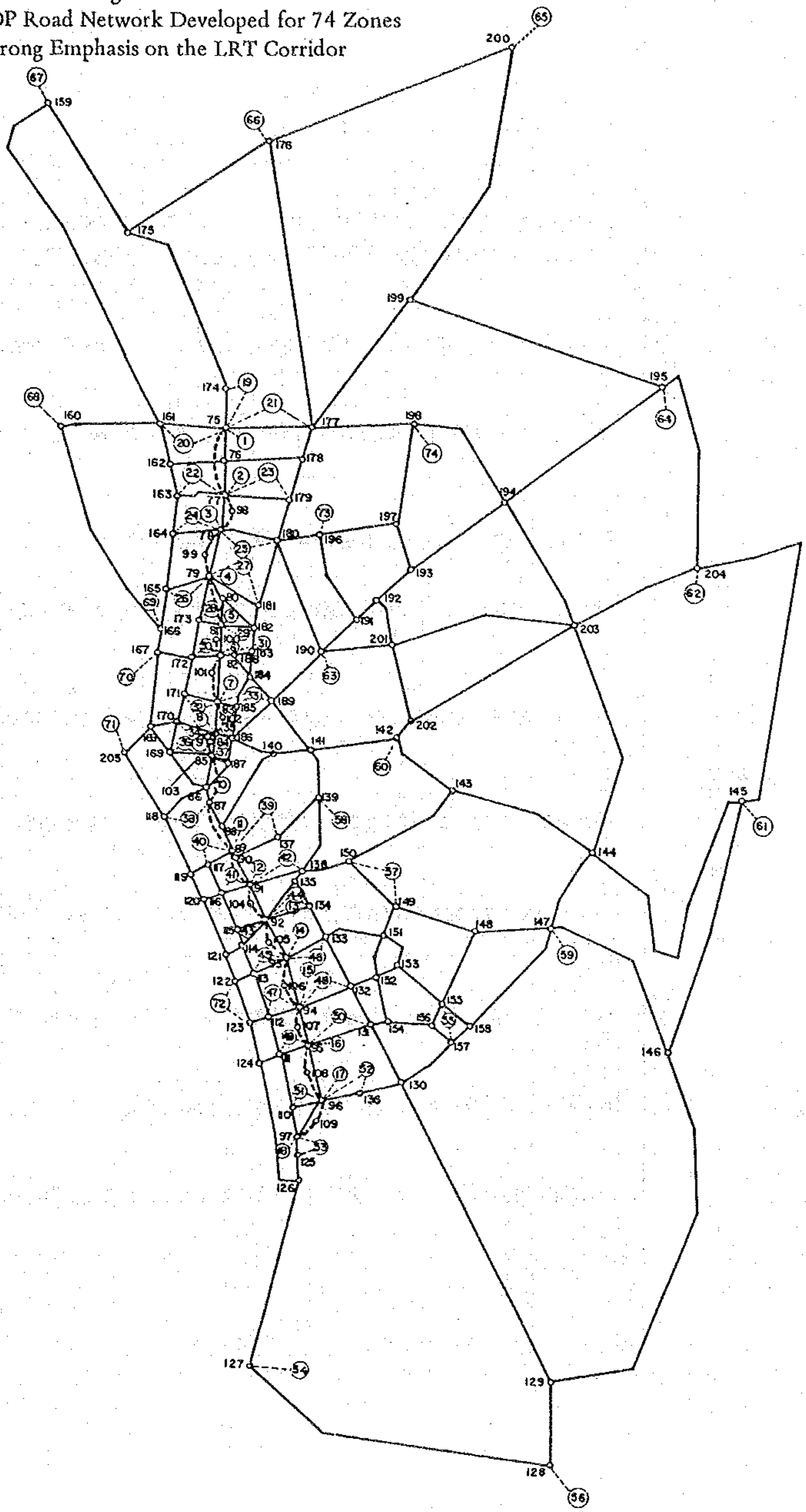
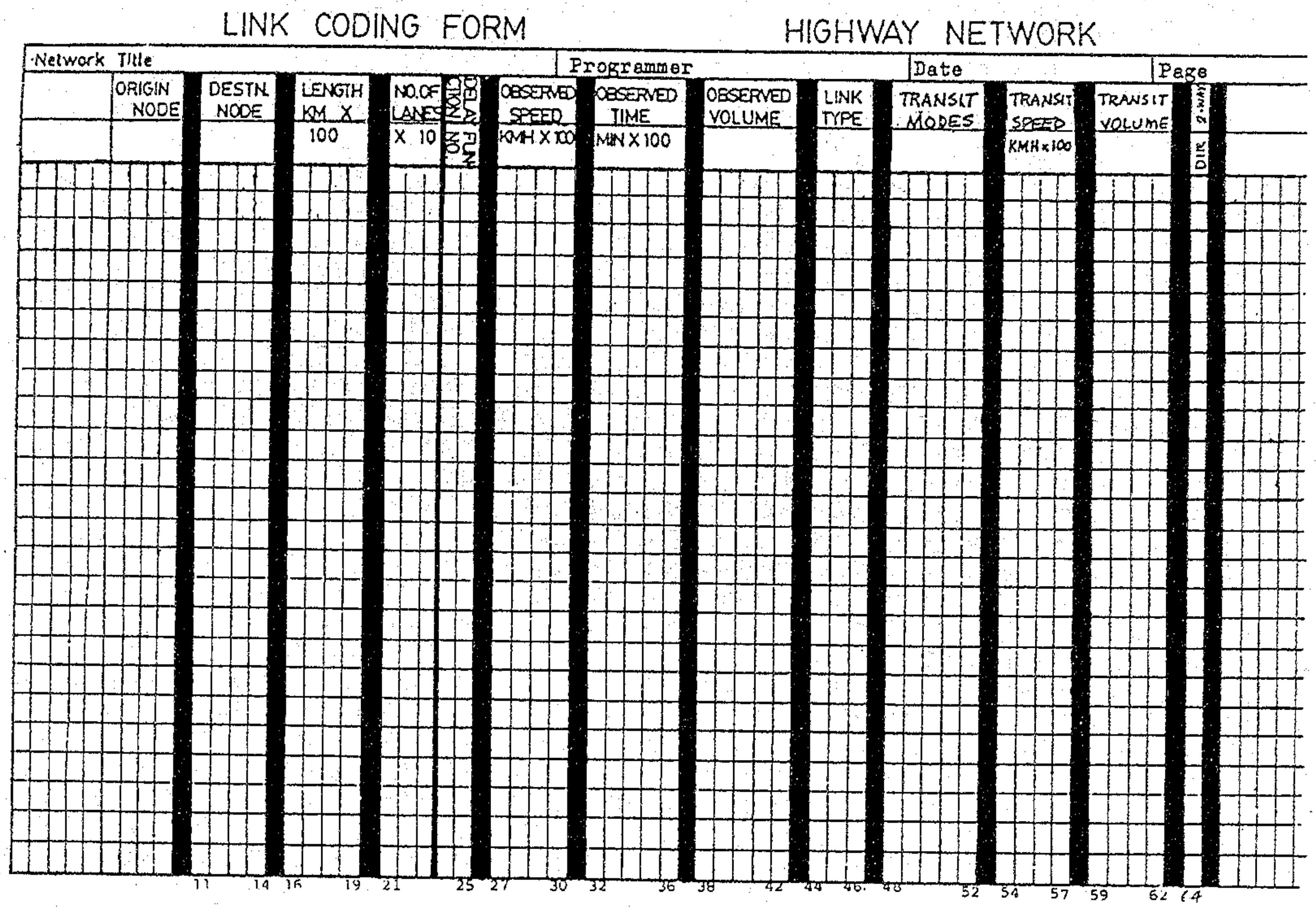


Figure 3.5
Link Coding Form for Highway Network



3.4 PUBLIC TRANSPORT ROUTE CONFIGURATION

- If the number of routes to be inputted is within the capacity of the computer, preparation of data will not be a problem. Usually, however, for large cities like Metro Manila where a large number of public transport routes exists, there is a need to integrate routes in order to meet the computer storage capacity.
- Route integration is normally done within the limitation that routes have the same origin zones, destination zones and "vias". In this case, the procedure is deemed logical. However, the number of routes is often not reduced enough to meet the computer capacity merely by means of logical integration. In this case, the routes may be further integrated as long as the overall route configuration is not distorted. Some sample methods to further integrate routes are shown in Table 3.1.

Table 3.1
Sample Methods for Further Route Integration

Type of Routes Combined in Further Integration	Conditions	Frequency of Combined Routes
A, B, C (parallel routes of differing length)	route length is not very much different	FA + FB + FC
A, B (consecutive routes)	frequencies of A and B routes are similar	FA or FB
A, B (consecutive routes), C (parallel to A and B)	frequencies of A and B route are similar	FA + FC or FB + FC

- Once routes are integrated to a reasonable extent, they must be coded using the form presented in Figure 3.6. Each data item is described as follows:
  a) **Line No.**: This should be sequential starting from 1 (one). Although the system accepts discrete numbers, it is not recommended considering subsequent data processing.
  b) **Mode No.**: This can be specified from 1 (one) to 6 (six). If the number of modes exceeds 6, integration of minor modes to a major mode of similar characteristics must be considered.
  c) **Direction**: 1(one) or 2 (two); same as the link data. When specifying this, the interaction with the link data, especially with one-way links, should be taken into account.
  d) **Headway**: This was replaced with service frequency in the JUMSUT version, as explained in Chapter 4 of this manual, should be coded in terms of 1/10 minutes. When the headway is so short that the traffic volume cannot be expressed in 1/10 minutes, the JUMSUT version will be used.

e) **Line Speed:** An important factor for calibrating the network as in the case of the link speed. Although it is desirable to use the actual operating speed of the route, it should be modified (in comparison with the link speed) if the network behavior is considered inappropriate.

f) **Node No.:** Route configuration is coded as a series of nodes. The process of creating an EDP network should be reviewed when the network is approximated considerably that it becomes difficult to code sometimes. In addition, it is worth noting that the intra-zonal traffic volume will not be assigned due to the logic of the system.

Figure 3.6
Public Transport Line Coding Form

PLAN TITLE CODER DATE PAGE OF

Line No.	Mode	2-way	Head-way Min. x 10	Speed KPH x 10	Node	Node	Node	Node	Node	Node	Node	Node	Node	Node	Node	Node	Cont.

3.5 PUBLIC TRANSPORT PASSENGER OD TABLE

- The OD tables are given in the public transport assignment modules of TRANSTEP. If the OD tables are not existing, they should be elaborated externally or by using the other modules of TRANSTEP. The OD tables used should be those of public transport passengers. Zoning and time period should also be consistent with other data.
- The file format of OD tables must be suitable for TRANSTEP operation. If the code or format is different from those of TRANSTEP standards, the data should be converted beforehand.

3.6 MODE COEFFICIENT

- Presumably, determining the values of the mode coefficients of PTPATH is the most controversial part in data preparation. The difficulties encountered are:
  - How to determine the values of mode coefficients initially
  - How to modify mode coefficients when the calibration is not well done.
- The meaning of each mode coefficient is useful when mode coefficients are initially determined. They are the weight to each generalized cost component, the total of which is used as a "distance" from one point to another in the minimum path search. Each cost component is defined as follows:

A. Walk Time per Passenger (both from origin and to destination)

Link Length (100 m.) x 1.2* x Walk MODECOEF

$$*: 1.2 = 100 \times \frac{60}{5000}$$

(assuming a walking speed of 5 kms/hr.)

B. Waiting Time per Passenger

$$\frac{30^*}{\text{Frequency}} \times \text{Wait MODECOEF}$$

$$*: \frac{30}{\text{Frequency}} = \frac{60}{\text{Frequency}} \times \frac{1}{2}$$

C. Loading Time per Passenger

0.3* × Load MODECOEF

*: 0.3 minutes per passenger loading is assumed

D. Travel Time per Passenger per Link

$$\frac{\text{Link Length (100 m.)}}{\text{Travel speed* (100 m/hr)}} \times 60 \times \text{Travel MODECOEF}$$

*: Travel speed is set at the lower value of either link speed or line speed.

E. Fare per Passenger per Ride in Terms of Minutes

$$\left\{ \begin{matrix}\text{Base} \\ \text{Fare} \\ \text{(cents)}\end{matrix} + \left(\begin{matrix}\text{Travel} \\ \text{Distance} \\ \text{(100 m.)}\end{matrix} - \begin{matrix}\text{Distance} \\ \text{Limit} \\ \text{(100 m.)}\end{matrix} \right) \times \frac{\begin{matrix}\text{Excess per} \\ \text{km. (cents)}\end{matrix}}{10} \right\} \times \text{Fare MODECOEF*}$$

$$*: \frac{\text{Fare}}{\text{MODECOEF}} = \frac{60 \text{ (minutes)}}{\text{Person Time Value (cents/hour)}}$$

F. Transfer Time per Passenger

$$\frac{30^*}{\text{Frequency}} \times \frac{\text{Transfer}}{\text{MODECOEF}}$$

$$*: \frac{30}{\text{Frequency}} = \frac{60}{\text{Frequency}} \times \frac{1}{2}$$

G. Discomfort (Capacity Restraint Factor used only in PTLOAD)

DSCOMF* × Travel Time** × Discomfort MODECOEF

*: DSCOMF = 5 × (VOLCAP RATIO) − 4
(VOLCAP RATIO ≥ 0.8)

**: Travel Time = 60 × Link Length/Travel Time

Note that this shows the Discomfort cost per passenger per link in terms of minutes.

- Therefore, with the exception of Discomfort, each mode coefficient can be theoretically determined if all necessary information is available. However, actual passenger loadings/unloadings cannot be simulated using theoretical values. The reasons are given as follows:
  - Due to the approximation of road/railway network, Walk Time, Waiting Time and Transfer Time are not well differentiated among public transport modes.
  - Time cost perceived by passengers is different from that calculated on a theoretical basis. Especially, when converting fare into time, Fare MODECOEF should be determined carefully so that the results will reflect the perceived cost. This is because the share of Fare in the total generalized cost is generally larger compared to other cost items. If the time cost of passengers is calculated from their income, it will probably be underestimated.
- Mode coefficients must be modified if the network is not well calibrated and passenger movement is not well simulated. Modifications, however, are usually done empirically. The following may be pointed out:

1) If passenger loadings onto similar routes of different modes are different from the actual situation and the same tendency is seen all over the network, this can be attributed to incorrect mode coefficients. They must be modified towards the direction that passenger loadings will be balanced among modes, considering the relative importance of each cost component.
2) If passenger loadings are different from the actual situation by area, it might be an influence of the link and line speeds. After checking mode coefficients, the link and line speeds must be reviewed.
3) Usually, the above is sufficient for calibrating the data/coefficients for operating the models, although iteration of the operation might be needed. However, since the

data/coefficients cannot be manipulated arbitrarily, the user has to look for another possibility to modify the conditions of the operation, if reasonable results cannot be obtained. Empirically, this situation is caused by improper integration of routes, for example, imbalance of number of lines among modes, unnatural line configuration, etc.

3.7 OTHER PARAMETERS

- In addition to the above-mentioned data/coefficients, the following parameters have to be specified:

  a) Cost Limit
  b) Maximum Number of Paths
  c) Maximum Number of Transfers

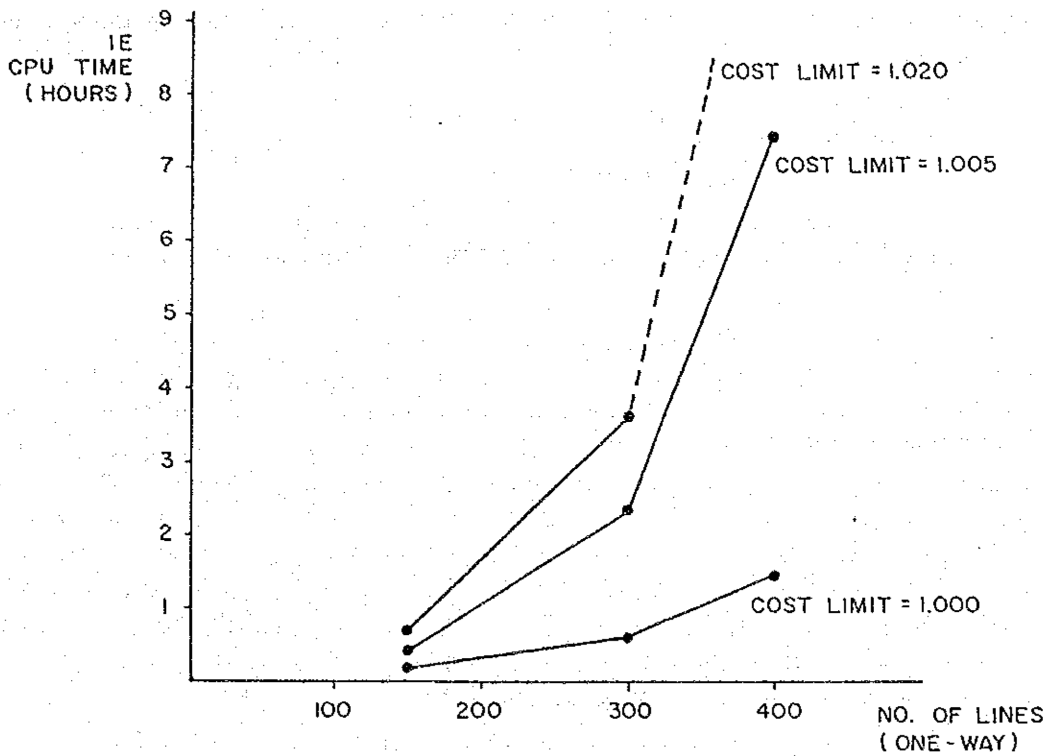
  For other parameters used, actual values can be easily specified. (e.g. number of zones, fare by mode, vehicle capacity by mode, etc.). Use default options/values otherwise.

- The Cost Limit (CSTLIM) is extremely influential on the computation time. The default value, which is 1.2, is too large for the operation of a large city like Metro Manila. If the number of routes is large and major roads are covered by routes of different modes, 1.05 is presumably sufficient.Even 1.02 or 1.01 may be selected if the computation time becomes enormous. Since this parameter determines the range of feasible paths to be taken up in terms of the ratio of the generalized cost of one path to that of the minimum path, it is theoretically desirable to set this value as high as possible. However, for the EDP network of Metro Manila, the selected paths actually pass the same road with a difference only in route or in transfer point. This is true especially when the Maximum Number of Paths (MAXPTH) is set low. Therefore, from a practical point of view, a value range of 1.01 to 1.05 is recommended. (Refer to Figure 3.7.)

- The Maximum Number of Paths literally determines the maximum number of feasible paths to be listed up by PTPATH within the limitation of CSTLIM. The value of this parameter can be selected within a range from 1 to 20. This affects the computation time when set high in a similar manner to CSTLIM,but to a lesser extent. Usually, a range between 5 to 10 is selected. However, 5 is enough for a dense public transport route network from a practical point of view.

- The Maximum Number of Transfers, which can be set within a range of 0 to 3, literally determines the maximum number of transfers allowed to a passenger on the EDP network. The value of this parameter is usually set at the maximum value, i.e., 3, because if set lower, several trips may not be assigned onto the network due to the small number of transfers allowed. Moreover, even if a path is found, it is often unrealistic because of a large detour, etc.

Figure 3.7
Interrelationship between Computation Time
and Number of Lines1/



1/ Based on 77-zone system and PT lines adopted in the LRT Line No. 1 Study of MMUTIP.

4. TRANSTEP PUBLIC TRANSPORT ASSIGNMENT MODULE IMPROVEMENTS

4.1 IMPROVEMENTS DONE BY JUMSUT

- The improved version of TRANSTEP is readily available on the disk of the TTC computer although the original TRANSTEP is also stored in a magnetic tape.
- The improvement done by JUMSUT is summarized in Table 4.1.

4.2 CHANGE IN PTEDIT

- The input data of this module was changed from headway to frequency. This was done considering the extremely short headway of jeepney routes (especially when integrated).
- The revised coding form is shown in Figure 4.1. Except for columns 8 to 11, the form remains the same.

Table 4.1
TRANSTEP Improvements by JUMSUT

Module	Improvement
PTEDIT	• Change in the form of input data (from headway to frequency)
PTPATH	• Change in memory allocation • Change in the form of data (from headway to frequency) • Change of the specification of "COST LIMIT" (from F 4.2 to F 5.3)
PTLOAD	• Change in the form of data (from headway to frequency) • Improvements in output forms • Addition of the NSECT option

4.3 CHANGE IN PTPATH

- Although changes were made in memory allocation, data form (from headway to frequency) and "COST LIMIT" specification, the usage of the module remains the same. The only point that the user has to be aware of is that he can specify the "COST LIMIT" up to three (3) decimal places. This was done because the computation time of PTPATH is sensitive to "COST LIMIT".

4.4 CHANGE IN PTLOAD

- The program was modified according to the change in data form from headway to frequency. However, the usage of this module also remains the same.
- Moreover, the output forms of PTLOAD were considerably improved, as shown in Figures 4.2 to 4.5. These improvements have been done by adding totals/subtotals and other related information. As a result, comparison between cases became easier and much faster.
- In public transport route planning, the need to know the origin and destination of passengers passing specific corridors/road sections sometimes arises. In view of this, an option has been added to PTLOAD so that the above requirement can be satisfied. This option program will function when the following statement is added to the end of the job control cards of PTLOAD:

    NSECT = A,
  where, A: No. of sections to be broken down

  When the above statement is added, the node numbers must be provided in the form of cards right after the job control cards. The format of the data cards are:

  From Columns 1 to 5: Sequential No. (from 1)
  From Columns 6 to 10: A Node No.
  From Columns 11 to 15: Another Node No.

The option program outputs to a magnetic tape the following data in binary form:

- Sequential Number of Specified Section
- Link Number (internally produced)
- Origin Node
- Destination Node
- Route Number
- Mode Number
- Origin Zone Number
- Destination Zone Number
- Number of Trips (Passengers)

Figure 4.1
Public Transport Line Coding Form

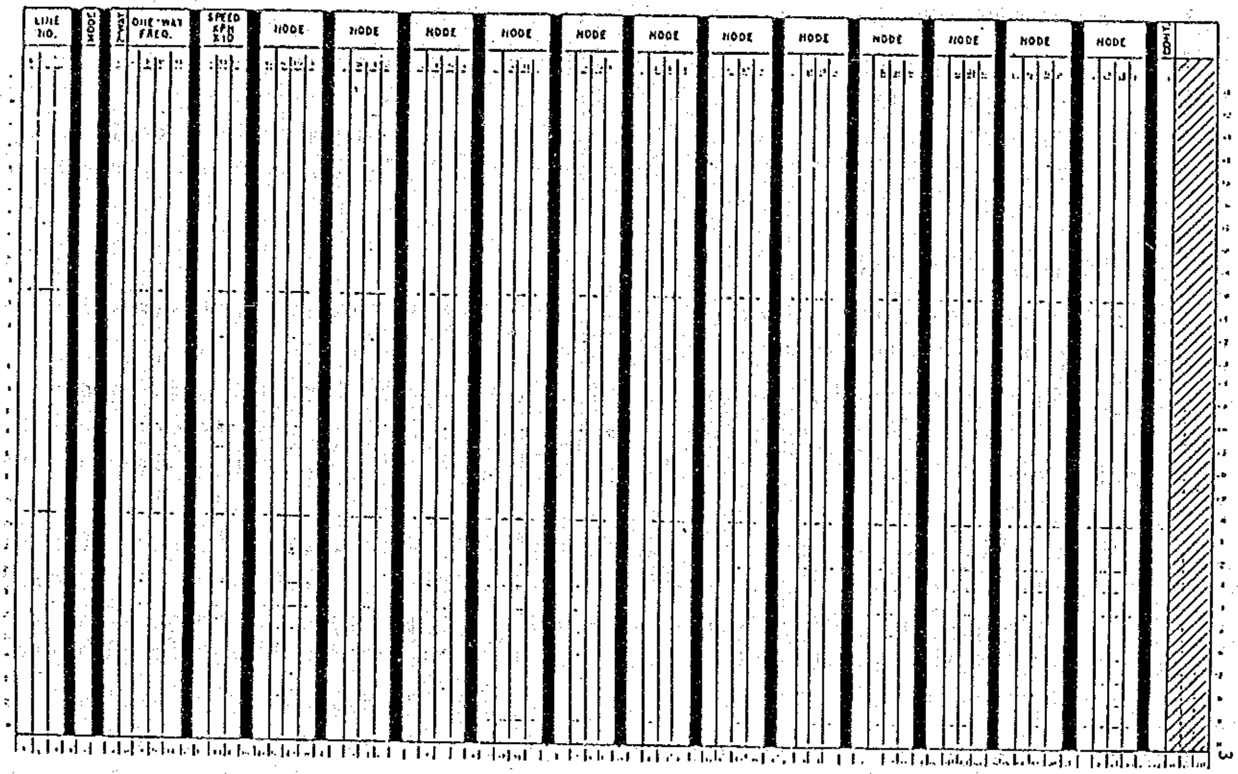


Figure 4.2
Output Improvement of PTLOAD (Mode Report)

BEFORE IMPROVEMENT :

MODE	ROUTE HOURS	ROUTE KMS.	NO. OF PASS.	PASS. HOUR	PASS. KMS.	TOTAL PERCEIVED COMPONENTS						
						1 WALK HOURS	2 WAIT HOURS	3 LOAD HOURS	4 FARE ₱	5 TRAVEL HOURS	6 TRANSFER HOURS	7 DISCOMFORT HOURS

AFTER IMPROVEMENT :

MODE	TOTAL ROUTE LENGTH	VEHICLES		AVERAGE VOLUME CAPACITY RATIO	PASSENGER			AVERAGE TRIP LENGTH		TOTAL PERCEIVED COMPONENTS					
		HOURS	KMS.		NUMBER	HOURS	KMS.		1 WAIT HOURS	2 WAIT HOURS	3 LOAD HOURS	4 FARE ₱	5 TRAVEL HOURS	6 TRANSFER HOURS	7 DISCOMFORT HOURS

Figure 4.3
Output Improvement of PTLOAD (Mode Report)

BEFORE IMPROVEMENT :

TRANSFER BETWEEN MODES

TO / FROM	1	2	3	4	5
1					
2					
3					
4					
5					

TRANSFERS BY FREQUENCY OF TRANSFER

NUMBER OF TRIPS	TRIPS	PERCENT-AGE OF TOTAL
0		
1		
2		

AFTER IMPROVEMENT :

TRANSFER BETWEEN MODES

TO / FROM	1	2	3	4	5	TOTAL
1						
2						
3						
4						
5						
TOTAL						

TRANSFERS BY FREQUENCY OF TRANSFER

NUMBER OF TRIPS	TRIPS	PERCENT-AGE OF TOTAL
0		
1		
2		
TOTAL		

Figure 4.4
Output Improvement of PTLOAD (Link Report)

BEFORE IMPROVEMENT :

ORIGIN	DESTINATION	VOLUME CARRIED BY MODE				
		1	2	3	4	5

AFTER IMPROVEMENT :

ORIGIN	DESTINATION	VOLUME CARRIED BY MODE						
		TWO-WAY TOTAL	TOTAL	1	2	3	4	5

Figure 4.5
Output Improvement of PTLOAD (Route Report)

BEFORE IMPROVEMENT :

LINE NUMBER	DIRECTION	MODE	FREQUENCY	FINAL HEAD WAY	MAXIMUM VOLUME CAPACITY	ROUTE HOURS	ROUTE KMS.	NO. OF PASSENGERS	PASS. HOURS	PASS. KMS.

AFTER IMPROVEMENT :

LINE NO.	DIRECTION	MODE	ROUTE LENGTH	INITIAL		FINAL		VOL/CAPACITY		VEHICLE		PASSENGER			AVE. TRIP LENGTH	AVE. FARE PAID
				FREQ.	HEAD WAY	FREQ.	HEAD WAY	AVE.	MAX.	HOURS	KMS.	NO.	HOURS	KMS.		

An example of the JCL is presented below:

```
* ¥¥JOB JNM=JUMSUT,CLASS=1,TIME=0.0,LIST=0
// RUN MOTC,JUMSUT
// ASSGN SYS001,X'142',SHR
// FD UOUT,FLID=TRFILE64,FLORG=SD,
      VOL=(SYS029,SPACE=(1440,370,CONTIG))
// ASSGN SYS029,SYS001,SHR
// EXEC CLRDK
// UCL B=(K=0,D=1440,X'00'
// END
// FD FT11F01,FLORG=SD,VOL=SYS011,DISP=(SHR),FLID=PTNET11
// ASSGN SYS011,SYS001,SHR
// FD FT20F01,FLORG=SD,VOL=SYS020,FLID=PATHS02
// ASSGN SYS020,SYS001,SHR
// FD FT24F01,FLORG=SD,VOL=SYS024,DISP=(SHR),FLID=ROUTES11
// ASSGN SYS024,SYS001,SHR
// FD FT14F01,FLORG=SD,VOL=SYS014,FLID=TSTP8364,DISP=(SHR)
// ASSGN SYS014,SYS001,SHR
// FD FT29F01,FLID=TRFILE64,FLORG=SD,VOL=SYS029,DISP=(,DELETE)
// ASSGN SYS029,SYS001,SHR
// ASSGN SYS010,X'014'
// FD    FT10F01
// ASSGN SYS015,X'292'
// FD FT15F01,VOL=SYS015,LABEL=(FSEQ=1,SL)
// FD IJSYSCL,FLID=TRANSTEP.CIL,DISP=(SHR)
// ASSGN SYSCLB,X'142',SHR,PERM
// EXEC PTLOAD
$LOAD PUBLIC TRANSPORT
$HEADER
    REROUTING JEEPNEY & BUS
    CASE NO. 53
    SAME CO-EFF. (CASE 47)
$END
&OPTION
PSKIM=F,
&END
&PARAMS
NZONES=64,NMODES=5,TRTABL=1,UCOEF1=1.00000000,1.00000000,1.00000000,
1.00000000,1.00000000,1.00000000,1.00000000,UCOEF2=1.00000000,
1.00000000,1.00000000,1.00000000,1.00000000,1.00000000,1.00000000,
MCOEF1=1.00000000,1.0000000,0.399999976,0.350000024,1.00000000,
1.00000000,2.00000000,MCOEF2=1.50000000,1.00000000,0.500000000,
0.350000024,1.19999981,1.19999981,1.50000000,MCOEF3=2.39999962,
1.19999981,0.899999976,0.350000024,1.19999981,1.80000019,3.00000000,
MCOEF4=1.50000000,1.0000000,0.500000000,0.350000024,1.19999981,
1,30000019,5,00000000,MCOEF5=2.00000000,10.0000000,0.300000012,
0.350000024,1.00000000,10.0000000,1.00000000,MCOEF6=1.00000000,
1.00000000,1.00000000,1.00000000,1.00000000,1.00000000,1.00000000,
REVIEW=0.0,BASEF=65,65,450,65,100,50,LIMIT=5.00000000,5,00000000,
40.0000000,5.00000000,40.0000000,5.00000000,EXCESS=13,13,0,13,0,1,
MODCAP=15,60,60,35,1125,20,SKTABL=3,ABSTRP=10,STEPS=0.500000000'
0.500000000,0.199999988,0.0,0.0,MAXHED=12.0000000,6.00000000,
1.00000000,1.00000000,0.500000000,1.00000000,MINHED=0.100000016E-01,
0.100000016E-01,0.100000016E-01,0.100000016E-01,0.100000016E-01,
1.00000000,DETAIL=3,FREEXF=F,F,F,F,F,F,NSECT=25,
&END
```

```
(Data above mentioned)
 .
 :
 .
/*
/&
* ¥¥EOJ
```

Since this option program creates a data file on a magnetic tape, no printout will be produced even after running PTLOAD. In order to get a compiled table showing the number of passengers for each specified section, the following two steps are still needed:

1) Sorting of data using the "Sequential Number of Specified Section" as a key.
2) Tabulation, using a newly developed program "ODPATTERN".

- The data sorting is needed in order to modify the sequence of data for the subsequent usage of "ODPATTERN". This sorting is done by using the "Sequential Number of Specified Section" as a key. In addition, this sorting program is provided as a system utility of TTC. The following is an example of the JCL to use this utility program:

```
* ¥¥JOB,JNM=TAPTOTAP,CLASS=1,Time=0.0
// RUN MOTC,TAPTOTAP
// FD FT1F01,VOL=SYS010,LABEL=(FSEQ=1,SL)
// ASSGN SYS010,X'292'
// FD FT15F01,VOL=SYS15,LABEL=(FSEQ=1,SL)
// ASSGN SYS015,X'290'
// FORTCLG
      INTEGER A(9)
      NUM=0
      CALL FILES(15,1,3600,36)
      CALL FILES(10,1,3600,36)
   10 READ (15,END=20) A
      NUM=NUM+1
      WRITE(10,1000) A
      GO TO 10
   20 ENDFILE 10
      REWIND  10
      WRITE(6,2000) NUM
      STOP
 1000 FORMAT(9I4)
 2000 FORMAT(1H1//1H 10X,'NO. OF RECORDS',I6)
      END
/*
// FD SORTOUT,VOL=SYS001,LABEL=(FSEQ=1,SL)
// ASSGN SYS001,X'290'
// FD SORTIN1,VOL=SYS002,LABEL=(FSEC=1,SL)
// ASSGN SYS002,X'292'
// ASSGN SYS003,X'160'
// ASSGN SYS004,X'160'
// FD SORTWK1,FLID=SORT1,VOL=(SYS003,SPACE=(TRK,500,50,CONTIG)),
      FLORG=SD,DISP=(,DELETE,DELETE)
// FD SORTWK2,FLID=SORT2,VOL=(SYS004,SPACE=(TRK,500,50,CONTIG)),
      FLORG=SD,DISP=(,DELETE,DELETE)
// EXEC SORT
```

```
SORT FIELDS=(1,4,CH,A),WORK=2
RECORD TYPE=F,LENGTH=36
INPFIL BLKSIZE=3600
OUTFIL BLKSIZE=3600
END
// RESET SYS001
// FD FT1F01,VOL=SYS010,LABEL=(FSEQ=1,SL)
// ASSGN SYS010,X'292'
// FD FT15F01,VOL=SYS015,LABEL=(FSEQ=1,SL)
// ASSGN SYS015,X'290'
// FORTCLG
      INTEGER A(9)
      NUM-0
      CALL FILES(15,1,3600,36)
      CALL FILES(10,1,3600,36)
   10 READ (15,1000,END=20) A
      NUM=NUM+1
      WRITE(10) A
      GO TO 10
   20 ENDFILE 10
      REWIND  10
      REWIND  15
      WRITE(6,2000) NUM
      STOP
 1000 FORMAT(9I4)
 2000 FORMAT(1H1//1H 10X,'NO. OF RECORDS',I6)
      END
/*
/&
* ¥¥EOJ
```

- After sorting the data, "ODPATTERN" is used for tabulation. This program is provided in the form of cards (Refer to the Appendix). This requires input data of the following format:

  From Columns 1 to 5: Sequential Number (form 1)
  From Columns 6 to 10: A Node Number
  From Columns 11 to 15: Another Node Number
  From Columns 16 to 43: Section Name

  The number of cards must coincide with the value of NSECT mentioned previously. The following is an example of the JCL to use "ODPATTERN":

```
* ¥¥JOB,JNM=ODPATTERN CLASS=1,TIME=0.0,LIST=0
// RUN MOTC,ODPATTERN
// FD FT10F01,VOL=SYS010,LABEL=(FSEQ=1,SL)
// ASSGN SYS010,X'293'
// FORTCLG
// F2COMP    CLG=CLG,PGM=FFORTRAN
// FD        IJSYSSC,FLID=PRV.SYSSOC,VOL=SYSSOC,LBLINF=USRLABEL
```

```
// FORTCLG
  .
  .
 (Program of ODPATTERN)
  .
  .
  .
/*
  .
  .
  .
 (Data above mentioned)
  .
  .
/*
/&
* ¥¥EOJ
```

The following is an output example:

Figure 4.6
Output Example of "ODPATTERN"

SUBJECT NO.22 FROM 102 TO 135
NAME P.QUIRINO AVE.

NO.	O – D	UP 1	102 ---> 135 2	3	4	TOTAL	DOWN 1	135 ---> 102 2	3	4	TOTAL	BOTH 1	2	3	4	TOTAL
101	15-36	0	1	0	0	1	0	15	0	0	15	0	16	0	0	16
102	14-31	13	0	0	0	13	0	0	0	0	0	13	0	0	0	13
103	15-46	13	0	0	0	13	0	0	0	0	0	13	0	0	0	13
104	16-40	1	0	0	0	1	11	0	0	0	11	12	0	0	0	12
105	16-61	0	0	0	0	0	12	0	0	0	12	12	0	0	0	12
106	14-17	0	0	0	0	0	11	0	0	0	11	11	0	0	0	11
107	16-54	0	0	0	0	0	11	0	0	0	11	11	0	0	0	11
108	5-39	0	0	0	0	0	0	10	0	0	10	0	10	0	0	11
109	13-35	0	0	0	0	9	0	0	0	0	0	0	7	0	0	9
		0	0	0	0	0	8	9	0	0	1	8	0	0	0	8
111		6	0	0	0	6	0	1	0	0	1	6	1	0	0	7
116	10-34		0	0	0	8	0	0	0	0	0	5	0	0	0	5
117	14-49	2			0	5	0	0	0	0	0	5	0	0	0	5
118	19-50	3	0			5	0	0	0	0	0	0	5	0	0	5
119	13-29	3	0	0			0	0	0	0	0	4	0	0	0	4
120	4-16	2	0	0	0			0	0	0	0	4	0	0	0	4
121	35-53	0	0	0	0	0	0		0	0	3	0	3	0	0	3
122	12-23	0	0	0	Q	0	2	0		0	0	3	0	0	0	3
123	16-37	2	0	0	0	2	0	0	0		0	3	0	0	0	3
124	14-61	1	0	0	0	1	0	0	0	0			0	0	0	2
125	14-15	1	0	0	0	1	0	0	0	0	0			0	0	2
126	15-39	1	0	0	0	1	0	0	0	0	0	1	0		0	2
127	15-43	0	1	0	0	1	0	0	0	0	0	0	1	0		2
128	16-43	1	0	0	0	1	0	0	0	0	0	1	0	0	0	
129	2-21	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1
130	15-41	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1
131	3-16	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1
132	15-61	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1

TOTAL 15123

Appendix I
Program of "ODPATTERN"

```
C     OD PATTERN FOR TRANSTEP
C
      IMPLICIT INTEGER (A-Z)
      DIMENSION OD(2100,5,3),SK(2100),IA(2100),TL(20),ST(3),NAM(7)
      DATA  ST  / 4H UP , 4HDOWN, 4HBOTH /
C
      CALL FILES(10,1,3600,36)
C
      READ (5,1000) TL
      WRITE(6,2000) TL
      READ (5,1100) NZ,NMD
      WRITE(6,2000) NZ,NMD
C
      NZZ=NZ*(NZ-1)/2
      NMD1=NMD+1
      TSW=0
      LF=1
      NUM=0
      GO TO 260
C
  100 READ (10,END=140) SUBL,LNKN,LNKO,LNKD,RN,MODE,O,D,TRIPS
      NUM=NUM+1
C
      LF=(SUBL+1)/2
      UD=2-MOD(SUBL,2)
C
      IF(SLF-LF) 150,110,150
C
  110 IF(O-D) 112,100,114
  112 IND=(D-2)*(D-1)/2+O
      GO TO 116
  114 IND=(O-D)*(O-1)/2+D
  116 OD(IND,MODE,UD)=OD(IND,MODE,UD)+TRIPS
      IF(UD-1) 120,120,100
  120 LO=LNKO
      LD=LNKD
      GO TO 100
C
  140 REWIND 10
      TSW=1
C
  150 TOT=0
      DO 180 IND=1,NZZ
      DO 170 K=1,NMD
      DO 160 L=1,2
      OD(IND,NMD1,L)=OD(IND,NMD1,L)+OD(IND,K,L)
  160 OD(IND,K   ,3)=OD(IND,K   ,3)+OD(IND,K,L)
  170 OD(IND,NMD1,3)=OD(IND,NMD1,3)+OD(IND,K,3)
      SK(IND)=OD(IND,NMD1,3)
      TOT=TOT+OD(IND,NMD1,3)
  180 CONTINUE
C
```

```
      CALL BSORT(NZZ,SK,IA)
C
  190 READ (5,1200) KR,NODEA,NODEB,(NAM(M),M=1,7)
      IF(KR-SLF) 195,197,197
  195 WRITE(6,2000) TL
      WRITE(6,2150) KR,NODEA,NODEB,(NAM(M),M=1,7)
      ZERO=0
      WRITE(6,2500) ZERO
      GO TO 190
  197 CONTINUE
      NO=0
  200 BN=NZZ-NO
      NO=NO+1
      II=IA(BN)
      IF(SK(II)) 250,250,210
  210 J=(SQRT(FLOAT(8*II+1))+3.)/2
      I=II-(J-2)*(J-1)/2
      IF(I) 212,212,214
  212 J=J-1
      I=I+J-1
  214 CONTINUE
      IF(MOD(NO,50)-1) 230,220,230
  220 WRITE(6,2000) TL
      WRITE(6,2150) KR,NODEA,NODEB,(NAM(M),M=1,7)
      WRITE(6,2200) ST(1),LO,LD,ST(2),LD,LO,ST(3)
      WRITE(6,2300)((K,K=1,NMD),L=1,3)
  230 WRITE(6,2400) NO,I,J,((OD(II,K,L),K=1,NMD1),L=1,3)
      GO TO 200
C
  250 WRITE(6,2500) TOT
      IF(TSW.NE.0)GO TO 300
C
  260 DO 270 IND=1,NZZ
      DO 270 K=1,NMD1
      DO 270 L=1,3
  270 OD(IND,K,L)=0
      SLF=LF
      LO=0
      LD=0
      IF(NUM) 100,100,110
C
  300 WRITE(6,2600) NUM
      STOP
C
 1000 FORMAT(20A4)
 1100 FORMAT(16I5)
 1200 FORMAT(3I5,5X,7A4)
 2000 FORMAT(1H1//1H ,20X,20A4//)
 2100 FORMAT(1H ,10X,'NO. OF ZONES',I5/1H ,10X,"NO. OF MODES',15)
 2150 FORMAT(1H ,20X,'SUBJECT NO.',I2,5X,'FROM',I4'   TO',I4/
     1       1H ,38X,'NAME ',7A4//)
 2200 FORMAT(1H , 9X,'NO.    O-D',3X,3(A4,8X,I3,'-- '.I3,9X) )
 2300 FORMAT(1H ,21X,3(4I6,' TOTAL')/)
 2400 FORMAT(1H , 9X,I3,2X,I2,'-',I2,2X,15I6)
 2500 FORMAT(/   1H ,99X,'TOTAL',I7)
 2600 FORMAT(////1H ,110X,'** FINISH **'/1H ,110X,'NO. OF RECORDS',I6)
C
      END
```

JICA