PROCEDURE MANUAL FOR DETERMINING TRAFFIC PATTERNS FOR A SIMPLIFIED PROCEDURE FOR MAJOR THOROUGHFARE PLANNING IN SMALL URBAN AREAS

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BY

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JOINT HIGHWAY RESEARCH PROJECT

PURDUE UNIVERSITY AND

INDIANA STATE HIGHWAY COMMISSION

Interim Report

PROCEDURE MANUAL FOR DETERMINING TRAFFIC PATTERNS FOR A SIMPLIFIED PLANNING PROCEDURE FOR MAJOR THOROUGHFARE PLANNING IN SMALL URBAN AREAS

TO: J. F. McLaughlin, Director
Joint Highway Research Project

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

July 26, 1972

Project: C-36-69D

File: 3-7-4

The attached Interim Report is the final report on Part V "A Simplified Procedure for Thoroughfare Planning in Small Urban Areas" of the HPR Part I research study titled "An Investigation of Major Aspects of the Urban Transportation Planning Process". This Report is titled "Procedure Manual for Determining Traffic Patterns for A Simplified Planning Procedure for Major Thoroughfare Planning in Small Urban Areas". It has been prepared by Messrs. A. D. Jones and W. L. Grecco of our staff.

The Report outlines the procedure to be followed in application of the methods developed in this research study for determining traffic patterns for the simplified procedure for major thoroughfare planning. The Manual is provided to encourage the implementation of the procedure.

The Report is presented for acceptance as fulfilling the objectives of Part V of the Study and will be forwarded for review, comment and similar acceptance by ISHC and FHWA.

Respectfully submitted,

Harold L. Michael

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Purdue University
Lafayette, Indiana
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INTRODUCTION

The cities in the United States with population of 50,000 or more all have continuing, comprehensive, cooperative transportation studies underway. The studies result from the requirements established by the Federal Aid Highway Act of 1962, which were further interpreted and outlined in detail in subsequent procedural and instructional memorandums (PPM and IM) issued by the Federal Highway Administration. These studies are usually financed jointly by the Federal Highway Administration, the Department of Housing and Urban Development, the state, the county and the city or cities involved. The continuing aspect of the process requires that at least some staff be continually maintained for periodic updating and continual data collection.

The procedures to be followed while conducting these transportation studies, outlined in the PPM's and IM's, required the following studies:

1. Population study and forecast
2. Economic study and forecast
3. Land use study and forecast
4. Transportation facilities
5. Travel patterns
6. Terminal and transfer facilities
7. Traffic engineering features
8. Community controls
9. Financial recourses
10. Community value factors

To cite two examples, the cost for data collection, following the established procedures, varied from $0.22 per capita for Chicago, Illinois to $0.86 per capita for Tucson, Arizona (1)*. The total cost for the studies was considerably higher.

In addition to the cost in dollars, the personnel requirements were stringent, both as to number of peole and the required expertise in transportation planning. With this emphasis on transportation planning for the larger urban areas, transportation planning in the small urban areas was in an undesirable position due to several factors. The planning procedures established for the larger urban areas became extremely costly, burdensome and to a degree less valid when applied to the small urban areas. Personnel with the required expertise are not available to the smaller cities to carry out these comprehensive procedures. Finally, the process of transportation or major thoroughfare planning, though it is just as essential to viability of small urban areas, does not require the same level of sophistication as used in the large areas.

Research conducted at the Joint Highway Research Project at Purdue University, described in reports by French (2) and Jones (3), developed and tested a simplified procedure for determining traffic patterns for major thoroughfare planning in small urban areas.

The procedure for deriving traffic patterns (Item 5 in the list of studies on page 1) for planning in the large studies is composed of the following steps:

1. Determine existing traffic volumes.

2. Conduct a home interview origin-destination survey to determine the trip characteristics of the trip makers.

3. Conduct an external cordon survey to obtain trip characteristics of external traffic.

4. Develop trip generation models using computer techniques.

5. Develop trip distribution models using computer techniques.

6. Forecast future traffic volumes using forecasts of parameters used in trip generation models.

7. Assign forecasted traffic volumes to the thoroughfare system, using a computer to mathematically represent the major thoroughfares in a city.

8. Develop alternate solutions to problem areas identified through the assignment process.

Synthetic models have been used for providing trip data; however, a small sample home interview origin-destination survey is still required.

The simplified procedure described herein replaces steps 2, 3, 4, 5 and 7 and utilizes much simpler techniques for steps 1, 6 and 8. The entire procedure is directed toward providing an adequate, simple, economical method for thoroughfare planning with the explicit intent of using local government personnel.

The procedure should enhance the probability of initiation and establishment of a true continuing planning process in an urban area.

Figure 1 pictorially presents the complete transportation planning procedure. The only portion to be discussed in this manual are those specific to the procedure for determining travel patterns for planning future major thoroughfares.

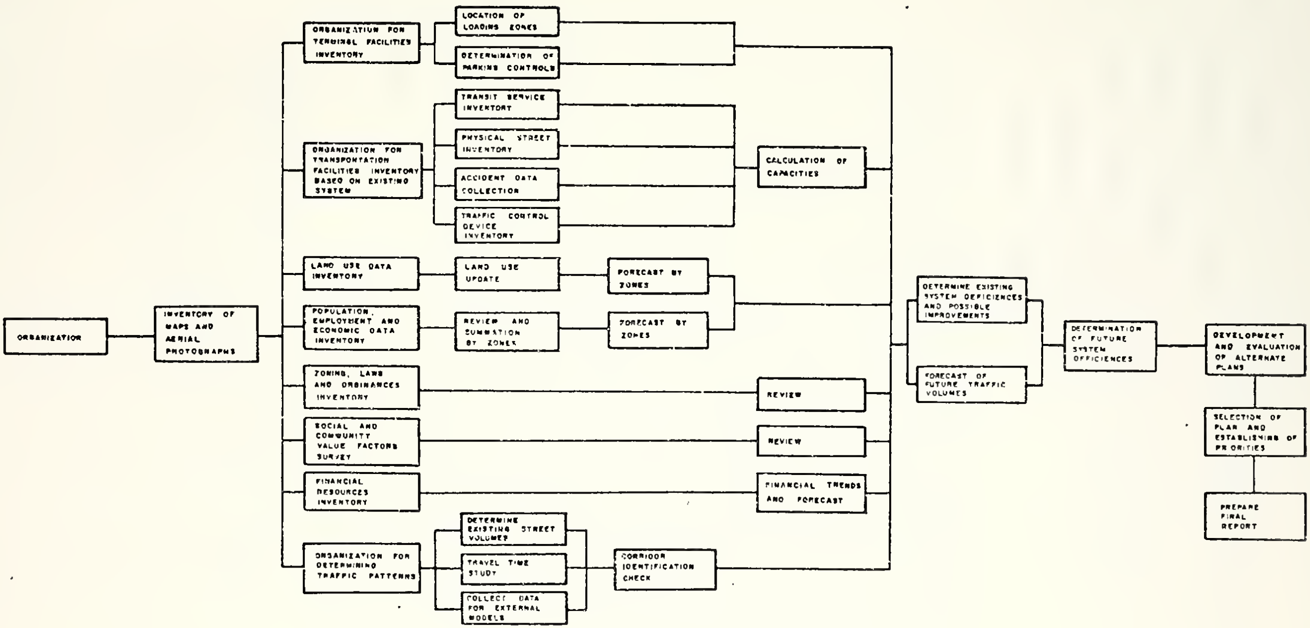

FIGURE I. PROJECT FLOWCHART

There are three basic parts to the procedure which will be discussed separately as follows:

1. Corridor and external cordon identification.
2. Traffic volumes.
3. Travel patterns and traffic forecasts
   A. Internal traffic
   B. External Traffic

Corridor and External Cordon Identification

The identification of traffic corridors is an integral and basic part of the simplified procedure for major thoroughfare planning herein described. The procedure for establishment of the corridors requires data collection for two points in time to permit calibration or fitting to local conditions. The time span for this "calibration" should be approximately five to ten years with the date of the study then being used to provide the base year information for future forecasts. In general, only those years with aerial photographs and traffic volumes available should be selected for analysis.

The information needed for corridor identification is as follows:

1. A street classification map indicating the major thoroughfares.
2. Traffic flow map prepared using current volumes on all major thoroughfares.
3. Existing land use map.

A corridor may be defined as an area between traffic "divides" and representing the area producing trips served by the one or more basically parallel major streets in the area. The orientation of the corridor in small urban areas would be basically oriented toward the central area because of its predominance as a generator. With a knowledge of the local travel habits, supplemented by aerial photographs, street classifications, land use maps, and a traffic volume map, the corridor limits may be determined. The corridor boundary should be equidistant between arterials unless physical constraints dictate otherwise. Corridors may overlap with separate corridors identified on circumferential or cross routes.

To select corridors first requires delineation of the central area. This central area would include the Central Business District (CBD) or core and would generally include the "frame" of the CBD. Specifically, the central area would begin at the point where radial corridors and the arterial streets serving the corridors merge and lose their individual identify. Usually the merging movement would be served by cross routes bordering the CBD providing for disbursement of traffic to the scattered destinations.

The procedure for corridor identification begins by evenly dividing the distance between radial thoroughfares. If a physical barrier better establishes the dividing line, or some aspect of a particular thoroughfare gives it a higher attractiveness than the adjacent facility, then the line would be moved further toward the adjacent thoroughfare.

The "divide" is similar to the divide between drainage areas, with this devide representing the point where vehicles move in opposite directions to reach a thoroughfare destined to the central area.

Circumferential corridors would be reviewed similarly. The corridor boundary would be at the point between the route and a similar alternate route, probably through the central area, where traffic would be attracted to the route to travel across town. Equal time instead of equal distance will be the controlling variable on this line.

The external cordon line should be located at a point that includes all urban development within the study area for the present and forecast period.

The data collection for the parameters for calculation of corridor growth factors is then completed by corridors for the two times being used. The growth factors computed are applied to the base year corridor traffic volumes and then compared to the existing volumes. Minor adjustment in corridor boundaries may be necessary to provide an adequate comparison of volumes. It should be remembered that the procedure is designed to provide data sufficiently accurate for design, though not absolutely precise.

Traffic Volumes

The existing traffic volumes should be obtained at all arterial streets or highway cordon crossings and at the central area screenline crossings. Volumes on the arterials at the approximate mid-point between the central area and the outer cordon should also be obtained. Counts not available from city or state may necessitate use of automatic traffic counting recorders by study personnel. Counts should be taken on Monday through Friday, for forty-eight hour periods, when schools are in session. If there is any unusual event that would affect the normality of the counts they should not be taken during that period. An example would be a holiday, a major strike, etc.

The existing volumes will be utilized for comparison to the computed capacities for thoroughfare system to determine the available excess capacity, and to check street usage.

National Committee on Urban Transportation Procedure Manual 3A describes procedure for measuring traffic volumes.

Travel Patterns and Traffic Forecasts

Using the simplified procedures developed by the Joint Highway Research Project at Purdue University, future traffic volumes can be forecasted for the major thoroughfares in small urban areas (2), (3). The traffic volumes existing on each major thoroughfare will be divided into two components, one representing the external traffic and one representing the internal traffic. Forecasts will be made for each component separately and then summed for the design volumes. The forecasted volumes will be determined by application of growth factors, based on the increase in dwelling units, total employees and retail employees, from the base year to the target year, in each corridor and applied to the internal traffic component. The growth factors will be developed as follows:

A. Internal Traffic:

1. The total dwelling units existing and forecasted for each corridor and for the entire study area are to be determined. Aerial photography (uncontrolled) may be used supplemented by field checks.

2. The total number of employees and number of retail employees (those employed in businesses with a SIC classification code between 5250 and 5460 or 5540 to 5990) are to be determined for each corridor and for the entire area for the base year and target year. The code format should correspond to the information available from the State Employment Division; however, for forecasting the code should be summarized as one digit classifications.

3. The percentage of the total trips to be represented by each parameter can be varied based upon available information. If local information is not available, the following percentages may be used; fifty percent for dwelling units, thirty-five percent for total employees and fifteen percent for retail employees.

4. A trip generation rate is calculated as follows:

$$\frac{\text{(Percent of trips represented by parameter)}}{\text{Total units of parameter in study area}}$$

Example: Assume there are ten thousand dwelling units, five thousand total employees and one thousand retail employees in an area in the base year.

For dwelling units: $\frac{.50}{10,000} = 5.0 \times 10^{-5}$

For total employees: $\frac{.35}{5,000} = 7.0 \times 10^{-5}$

For retail employees: $\frac{.15}{1,000} = 15.0 \times 10^{-5}$

For further calculations the 10^{-5} may be discarded from the factors.

5. A total trip generation rate is calculated for each corridor for the base year and the target year as follows:

   Example: Assume for the above study area, there are one thousand swelling units in the corridor for the base year, one thousand two hundred dwelling units in the corridor for the target year; five hundred total employees in the corridor for the base year and seven hundred total employees in the corridor for the target year; one hundred retail employees in the corridor for the base year and one hundred-twenty retail employees in the corridor for the target year. Calculation of growth factor:

   Base Year

1,000 dwelling units X 5.0	=	5,000
500 total employees X 7.0	=	3,500
100 retail employees X 15.0	=	1,500
		10,000

   Target Year

1,200 dwelling units X 5.0	=	6,000
700 total employees X 7.0	=	4,900
120 retail employees X 15.0	=	1,800
		12,700

   The growth factor for the corridor is the total for the target year divided by the total for the base year.

   Example: $\text{Growth Factor} = \frac{12{,}700}{10{,}000} = 1.27$

6. The growth factor is applied to the existing internal traffic volume in the corridor near the screenline adjacent to the central area to determine the forecasted volume for that point for the target year. The same procedure should be followed for a point in the corridor near the midpoint between the central area and the external cordon or outside boundary of the study area. The same growth is applied to the existing traffic volume, because the existing traffic volume represents total vehicle movement and is not directional.

7. The same procedure should be followed for a circumferential route after determination of the corridor boundaries for the route. These corridors will naturally overlap the radial corridors. This does not affect the procedure and valid results can be obtained.

The calibration of the procedure to fit local conditions is briefly discussed in the corridor identification section. This calibration will require developing growth factors for the period from some earlier year to the study year. Applying these growth factors to the earlier year traffic volumes will provide volumes which can be checked against study year volume counts as a test of corridor delineation. The final step in the forecasting technique is to forecast dwelling units, total employment and retail employment for each corridor to the target or forecast year, by five year steps. Computation and application of the growth factors to the study year traffic volumes give the design traffic volumes for each interim period.

The five year incremental forecasts provide check points for the continuing aspect of the procedure.

B. External Traffic:

Traffic entering small cities is composed of varying percentages of external-internal and external-external traffic.

There are two separate possible procedures which can be followed for determining the total external traffic and the components of external-external and external-internal traffic necessary for the simplified procedure for major thoroughfare planning. The procedure to follow will be determined by the availability of information as follows:

1. An external cordon survey study report for the area from a past year is available, or
2. Traffic volumes from a past year at the cordon stations are the only available information.

With an external survey report available the procedure should be greatly simplified. A growth factor based on the increase in vehicle registration in the region should be adequate for forecasting to the future. A calibration period using a growth factor based on five to ten years should provide a check on the accuracy of the procedure.

The percentage split between external-external and external-internal traffic at the cordon given by the previous report (item one above) is the best estimate of the present split. Also, the percentages of total external-internal cordon crossings at each station given in the previous report is the best estimate of the present percentage. In addition, the percentage of total external volume at a cordon crossing, as given by the report, is the best estimate of the percentage for the study and forecast year.

External traffic volumes are to be expanded separately from internal traffic volumes and the two forecasts combined for the total volume to be used for design.

When an earlier report is not available (item two above), the following procedure will be used to determine the external-external trips, those passing through the area, and the external-internal trips, those with origins or destinations in the area, crossing at each external station on a major thoroughfare in a corridor.

The total number of vehicles presently crossing the external cordon on a major thoroughfare in an average twenty-four hour period are determined using an automatic traffic counter. The percent that the volumes at each cordon location represents of the total volume of such crossings is then determined.

An external growth factor developed by dividing the total vehicle registration for the study year by the total vehicle registration for an earlier year is applied to the total external traffic volumes for the earlier year and the result compared to existing study year volumes. If the comparison substantiates that the accuracy of the procedure is satisfactory, an external growth factor for the forecast period is developed by forecasting county vehicle registration based on the historical trend.

The required accuracy will be determined by review of the forecasted volume at the central area screenline. If the error in the forecasted volume at the screenline is sufficient to require a design change then an alternate forecast procedure should be used, such as the regression model given below:

$$Y = 4.28 + 0.035(X1) + 0.066(X2) - 0.064(X3)$$

where:

Y = The total external-external cordon crossings for the city.

$X1$ = Population of cities larger than subject city within 25 miles radius of center of city, expressed in thousands.

$X2$ = County population density, expressed as persons per square mile.

X3 = Population of cities smaller than subject city within 25 mile radius of center of city, expressed in thousands.

This volume is distributed among the cordon stations using the same percentage ratio for each station as exists. Subtracting this volume from the total external volume determined above gives the external-internal component.

Regardless of the method of arriving at the external traffic volumes, the next step is to determine the percentage of the external-internal traffic destined to the central area. This percentage is calculated by setting the ratio of all employment in the central area to the total study area employment equal to the ratio of the external-internal traffic destined to the central area to the total external-internal traffic and solving for the external-internal traffic destined to the central area. The external-external volume is added to the external-internal traffic volume destined to the central area to give the total traffic to be expanded using the external growth factor, except as discussed below.

In areas where a bypass route exists, the external-external component is assigned to this route instead of through the central area. An example follows:

Assume: External cordon station with ten percent of the total external traffic crossing at that point; total external-internal traffic for the study area is ten thousand external crossings; central area total employment is five thousand with total study area employment ten thousand. To find the component of the external-internal traffic crossing the central area screenline, compute as follows:

10 percent of 10,000=1,000 external-internal trips crossing at the external crodon station.

$$\frac{5,000}{10,000} = \frac{X}{1,000} \quad ; \quad X = 500$$ external-internal trips crossing the central area screen-line

A sample calculation of the forecasted volume on a major thoroughfare (corridor) at the central area cordon is as follows:

Example: Existing observed total traffic volume at the central area screeline is ten thousand vehicles per day. External-external volume at the external station on the corridor is one thousand vehicles per day.

1. Utilizing the above procedure for determining the external-internal component to the central area, the figure is determined to be five hundred vehicles per day. The external-external volume is added to the above to give the total traffic to be expanded using the external growth factor. This gives a total of fifteen hundred vehicles per day.

2. 10,000 - 1,500 leaves 8,500 vehicles per day as the internal-internal traffic to be expanded using the corridor growth factor.

A sample calculation sheet from a Columbus, Indiana, area procedure check is included (Table 1) for informational purposes.

Table I. Radial Corridors - Columbus - Near Central Area

Corridor	Street	1960 Volume	Internal Volume	Internal Growth Factor	External Volume	External Growth Factor	Estimated 1970 Volume	Actual 1970 Volume	Corridor Error
1	U.S. 31 Alternate (S)	7,400	5,170	1.63	2,230	1.64	12,084	10,240	1,844
2	S. 46 (W)	4,793	2,193	2.98	2,600	1.64	10,799	12,861	-2,062
3	U.S. 31 (N)	5,220	0	2.38	5,220	1.64	8,561	6,200	2,361
4	Central Ave.	10,000	10,000	1.31	-	-	13,100	14,495	-1,395
5	Tenth Street	4,100	4,100	1.34	-	-	5,494	5,400	94
6	S. R. 7	14,608	11,898	1.21	2,710	1.64	18,841	16,708	2,133
7	Washington	10,800	8,435	1.54	2,365	1.64	16,869	15,974	
	Franklin	2,500	2,500	1.54	-	-	3,850	3,800	
	Lafayette	1,500	1,500	1.54	-	-	2,310	1,700	
	California	2,300	2,300	1.54	-	-	3,542	2,900	
	Chestnut	1,300	1,300	1.54	-	-	2,002	2,500	
		18,400	16,035	1.54	2,365	1.64	28,573	26,874	1,699
	Circumferential Route								
	U.S. 31 Bypass at Twentyfifth	*7,700	6,770	1.46	930	1.64	11,025	12,317	-1,292

* Reduced volume by 30% (Arterial Plan for Columbus, Indiana)

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1. Creighton, Hamburg, "Data Requirements for Metropolitan Transportation Planning", National Cooperative Highway Research Program - Report 120, Highway Research Board, 1971.

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3. Jones, A. D., "A Simplified Procedure for Major Thoroughfare Planning in Small Urban Areas", Joint Highway Research Project, Report No. , July 1972.