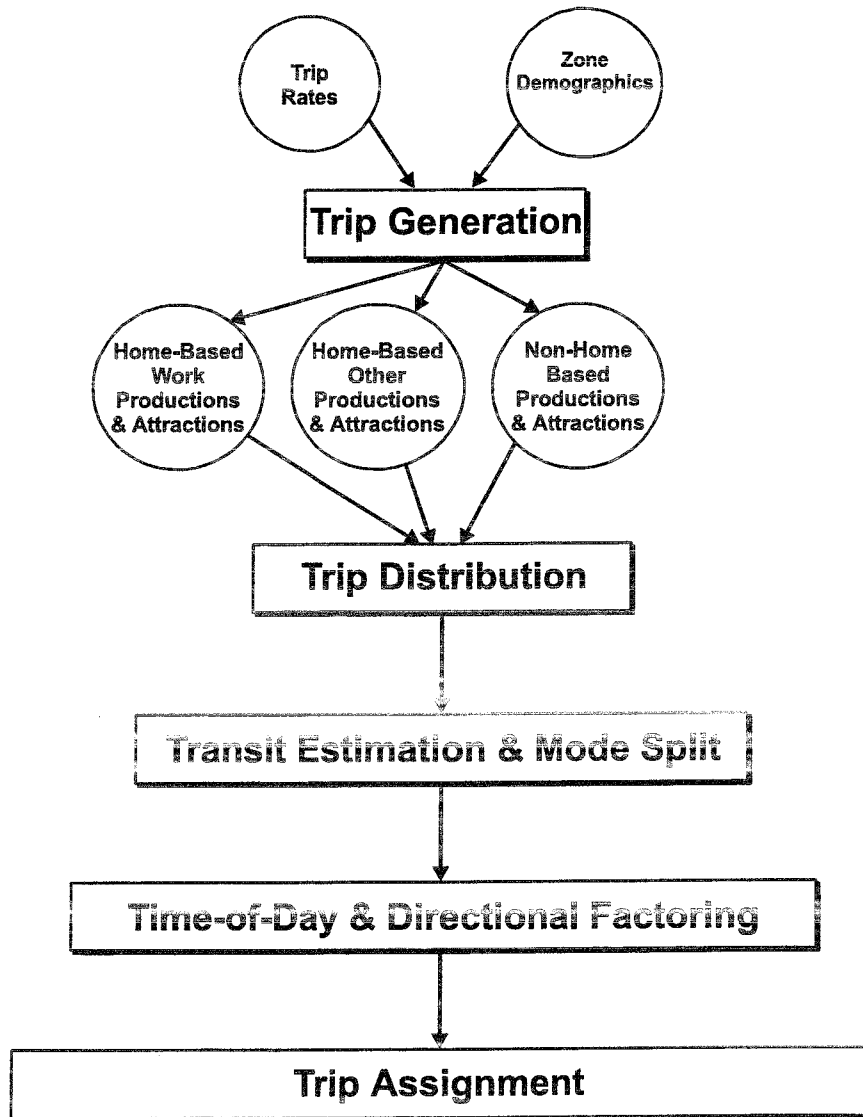


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# Session 5: Trip Generation

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# Session 5: Trip Generation

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## Objectives:

- Define productions and attractions by trip purpose
- Identify typical inputs to a trip production model
- Identify the outputs from a trip production model
- Identify typical inputs to a trip attraction model
- Identify typical outputs from a trip attraction model
- Explain the logic for balancing productions and attractions
- Explain the logic for balancing productions and attractions by TAZ for NHB trips

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# Session 5: Trip Generation

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## Session Outline

- Terminology
- Key concepts
- Inputs and outputs
- Error checking, calibration, and validation

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# Session 5: Trip Generation

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## SESSION OUTLINE

This session covers trip generation, the first step in the traditional TDF process. The session includes a discussion of trip purposes, a discussion of how the number of trip ends are calculated for each TAZ using zonal household and employment data. The session also includes a discussion on trip rate information developed from the travel surveys. The inputs and outputs to the trip generation step, the treatment of special generators, the balancing of attractions to productions, and error checking are also discussed.

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Notes:

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# Terminology

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- Trip generation
- Person trip
- Vehicle trip
- Trip end
- Trip production
- Trip attraction
- Home-based (HB) trip
- Non-home based (NHB) trip
- Special generator

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# Terminology

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**Trip generation** is the estimation of the number of trips (by purpose) produced by or attracted to a TAZ, as a function of demographic and employment of the TAZ and the trip rate.

**Person trip** is a trip made by a person or persons.

**Vehicle trip** is person trips divided by vehicle occupancy equals vehicle trips.

**Trip end** is the beginning or ending of a trip. For example, a trip from home to work has two trip ends.

**Trip production** is the home end of a HB trip and the beginning of a NHB trip.

**Trip attraction** is the non-home end of any HB trip or the destination of any NHB trip.

**Home-based (HB) trip** occurs when the home of the trip maker is one end of the trip.

**Non-home based (NHB) trip** occurs when neither end of the trip is the home of the trip maker.

**Special generator** is a land use with unusually high or low generation characteristics. Examples of special generators are large shopping malls, hospitals, commercial service airports, universities, and military bases.

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Notes:

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# Key Concepts

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## Trip Generation Model

- Estimates person trip ends for each TAZ
- Equations predict trips based on attributes
- Dependent variables are trip rates calculated from household and work place surveys, and the TAZ household and employment attributes developed using demographic and employment estimation methodologies

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# Key Concepts

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## **TRIP GENERATION MODEL**

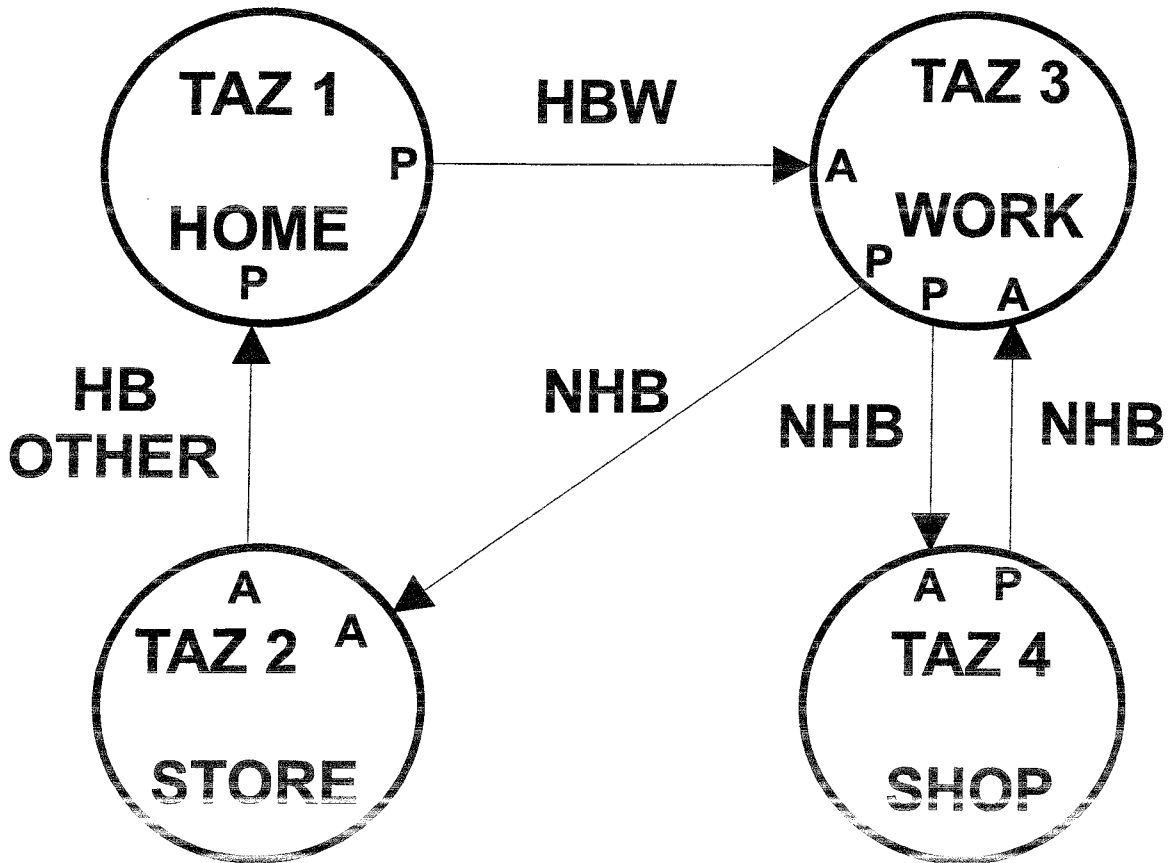
Trip generation is the first step in the traditional four-step TDF process. The trip generation model estimates the number of person trip ends for each TAZ. These trips are calculated on a household, person, or employee basis and then aggregated to TAZ level. Therefore, trip generation uses disaggregate data and a disaggregate model to perform aggregate estimation or forecasting.

The trip generation model consists of equations that are established to predict the number of trips generated based on TAZ household and employment data and regional trip rates developed from household and work place travel surveys.

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**Notes:**

# Trip Purposes



**P = Production**  
**A = Attraction**  
**HBW = Home-based work**  
**NHB = Non-home based**  
**HBO = Home-based other**

TAZ	HBO		HBW		NHB	
	P	A	P	A	P	A
1	1		1			
2		1				1
3				1	2	1
4					1	1
Total	1	1	1	1	3	3

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# Trip Purposes

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Practice has shown that better travel forecasting models are obtained if trips by different purposes are identified and modeled separately. The most common trip purposes are:

- HBW
- HBO
- NHB

In TDF, trip productions and attractions are used to represent the ends of a trip. A production is the home end of a HB trip and the beginning of a NHB trip. An attraction is the non-home end of a HB trip and the end of a NHB trip.

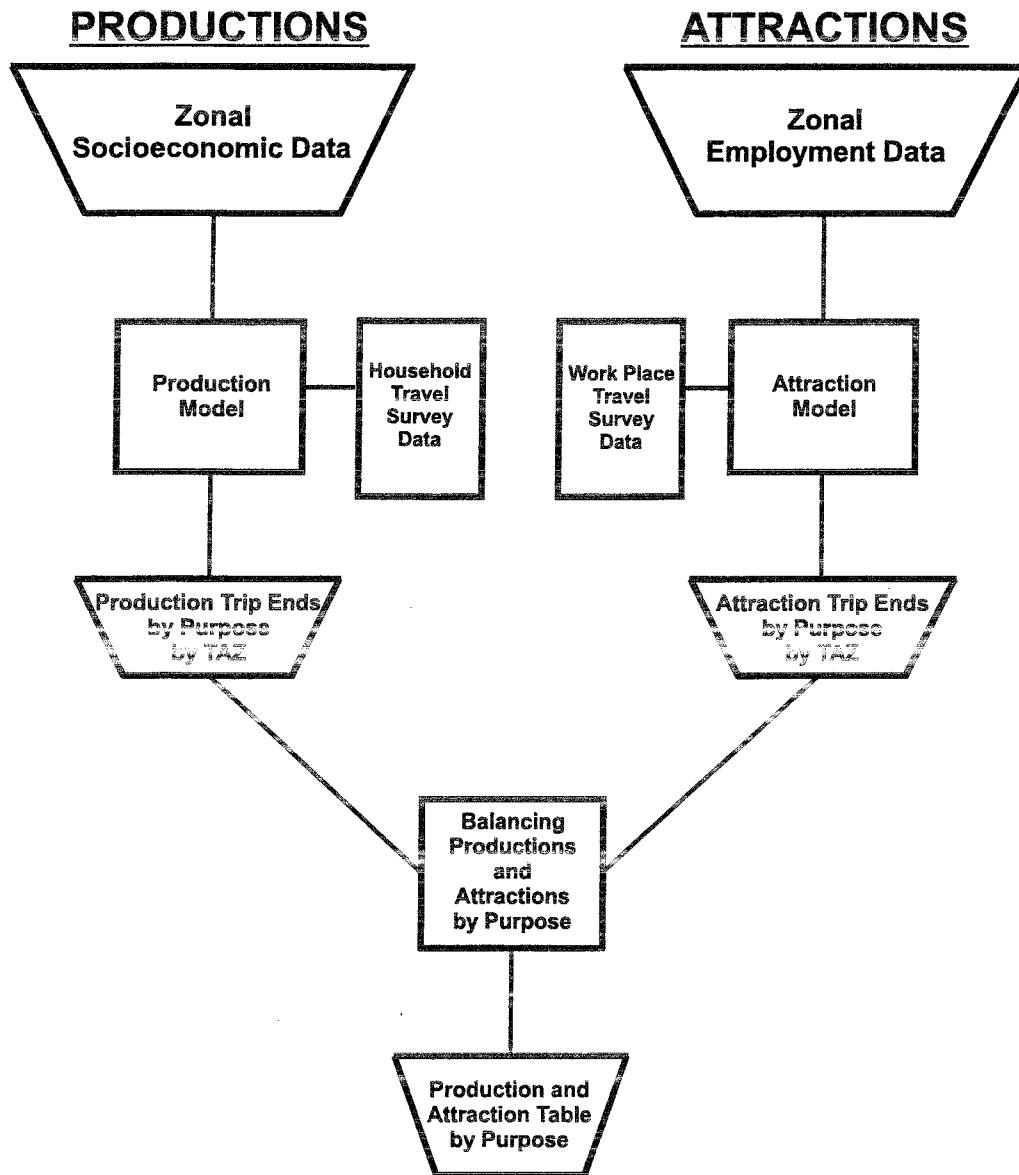
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Notes:

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# Trip Generation Process

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# Trip Generation Process

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## **Information Needs for Trip Productions**

Socioeconomic disaggregate data are required to develop trip production models. Typical socioeconomic data elements include: income, automobile availability, household size, and number of workers. Socioeconomic data from the Census and household activity data from travel surveys are used to develop trip production models.

## **Information Needs for Trip Attractions**

It is difficult to obtain adequate information to develop trip attraction models. For trip attractions, the most important data element is employment. Employment is broken down into categories. The most common categories are basic employment, retail employment, and service employment. Trip attraction rate information is developed from work place and household surveys.

## **Special Generator Information Needs**

To obtain trip rates and trip estimates for special generators, specific information relating to each type of generator needs to be obtained. For example, in the case of a hospital, the number of beds is important. For a large shopping mall, the gross leaseable area is used.

## **Trip Rates From Travel Surveys**

Travel surveys include household, work place, external station, special generator, truck, and transit on-board surveys. The data obtained from travel surveys are used to develop trip production and trip attraction rates for each trip purpose.

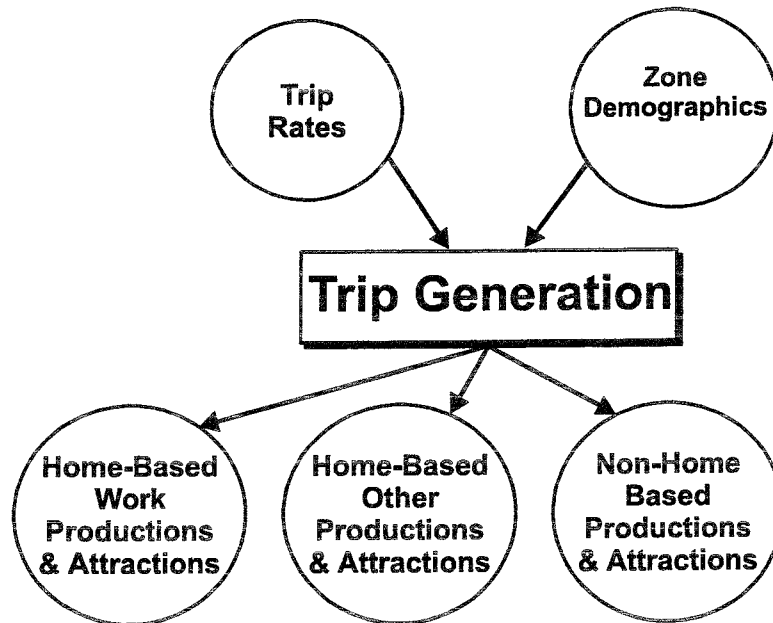
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**Notes:**

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# Trip Generation Models

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## Trip Generation Model Components

- Trip production models
- Trip attraction models
- Estimation of special generator trip generation
- Balancing productions and attractions

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# Trip Generation Models

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Trips generally are stratified by purpose, which typically include: HBW, HBO, and NHB trips. HBO trips can be stratified further (HB school, HB shopping, etc.) depending on regional travel characteristics and data availability. In addition to this stratification, the TAZs can also be divided into various levels of residential densities, called area types. Area types include the CBD, CBD fringe, urban residential, suburban residential, and rural. HB trips in urban areas are about 70% of total person trip making.

The trip generation rates typically includes trip production models, trip attraction models, estimation of special generator trips, and a procedure for balancing trip productions and attractions. The models are mathematical functions used to estimate trip ends. The outputs from the trip generation step are productions and attractions by trip purpose for each TAZ.

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**Notes:**

# Production Model

## Cross-Classification Model

HBW

1990 Household Income Range	Person Trips Per Household				
	Household Size				
	1	2	3	4	5+
\$0 - \$4,999	0.33	0.67	0.84	0.90	1.05
\$5,000 - \$9,999	0.49	0.96	1.27	1.37	1.59
\$10,000 - \$19,999	0.76	1.32	1.73	1.85	2.13
\$20,000 - \$34,999	1.09	1.84	2.40	2.57	2.94
\$35,000 plus	1.33	2.17	2.82	3.02	3.43

NHB

1990 Household Income Range	Person Trips Per Household				
	Household Size				
	1	2	3	4	5+
\$0 - \$4,999	1.07	1.40	1.59	1.83	2.08
\$5,000 - \$9,999	1.31	2.03	2.36	2.85	3.56
\$10,000 - \$19,999	1.60	2.64	3.10	3.88	4.86
\$20,000 - \$34,999	1.81	3.12	3.67	4.70	5.89
\$35,000 plus	2.49	3.87	4.58	5.95	7.46

Example trip production rates developed from the 1990 Amarillo, Texas, household travel survey

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# Production Model

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## CROSS-CLASSIFICATION MODEL

A cross-classification model is one type of model used to determine trip productions. Regression models are also used for trip productions but are not illustrated here. This model is based on estimating the response (e.g., the number of trip productions per household for a given purpose) as a function of household attributes. The model assumes that trip production rates are stable over time for households. Trip rates are derived empirically from travel surveys with the same household characteristics. Cross classification is based on grouping the households in different strata; for example, a specific cell is based on household size and household income. The trip production rate for that specific cell then is the total number of trips in that cell divided by the number of households in that cell. This relationship can be stated as follows:

$$t^p(h) = T^p(h) / H(h)$$

Where:

h	=	Households with a particular combination of characteristics (for example a two-person family in income group 1)
$t^p(h)$	=	Trip rate for purpose p made by members of households of type h
$T^p(h)$	=	Total number of trips by purpose p made by households in cell h
H(h)	=	Number of households in cell h

Following are some advantages of the cross-classification model:

- Groupings are independent of the TAZ system of the study area.
- No prior assumptions of the shape of the relationship are required and can easily accommodate non-linear relationships.
- It can also be employed for mode split.
- It is simple to use and to understand.

Following are some disadvantages of the cross-classification model:

- It does not permit extrapolation beyond its calibration strata.
- There are no statistical goodness-of-fit measures for the model.
- It requires large sample sizes (25 households per cell); otherwise cell values will vary in reliability.

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# Attraction Model

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- **Cross-Classification Models**

HBW

<b>Person Trips</b>			
<b>Attractions per Employee</b>			<b>Attractions per Household</b>
<b>Basic</b>	<b>Retail</b>	<b>Service</b>	
1.60	1.35	1.39	0.082

NHB

<b>Person Trips</b>			
<b>Attractions per Employee</b>			<b>Attractions per Household</b>
<b>Basic</b>	<b>Retail</b>	<b>Service</b>	
0.99	4.53	1.63	0.361

Example trip attraction rates developed from the 1998 Austin, Texas, household travel survey

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# Attraction Model

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## CROSS-CLASSIFICATION MODELS

HB trip attraction models usually are aggregate models for predicting trip ends that are associated with the non-home end of the trip. A lack of data is a major problem with trip attraction models. Household surveys provide excellent data for production models but much less information for attraction models. The same trip purposes used for the trip production models are used for the trip attraction models.

Trip attraction models have received less attention than production models. Typically, cross-classification models are used, or regression models that relate trips to the various land use types to which they are attracted are used.

In cross-classification, the most commonly used classification is employment type, which is divided into groups such as basic, retail, and service employment. Trips also are attracted to households. Household trip rates are developed from household travel surveys.

The examples provided are trip rates developed from the 1998 Austin, Texas, travel surveys.

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Notes:

# Balancing Attractions to Productions

## Example: HBW

<b>Computed Productions and Attractions</b>		
<b>TAZ</b>	<b>Productions</b>	<b>Attractions</b>
1	25	1,000
2	125	350
3	350	500
4	800	100
5	600	250
<b>Total</b>	<b>1,900</b>	<b>2,200</b>

<b>Adjusted Attractions</b>		
<b>TAZ</b>	<b>Productions</b>	<b>Attractions x 0.8636</b>
1	25	864
2	125	302
3	350	432
4	800	86
5	600	216
<b>Total</b>	<b>1,900</b>	<b>1,900</b>

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# Balancing Attractions to Productions

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The final step in trip generation modeling is balancing productions and attractions. The estimated number of trips produced by households should be equal to the number of trips attracted to activity centers. Each trip has a production and an attraction end. In practice, the estimation of productions and attractions will not be equal.

Trip production totals normally are used as control totals, and attractions are scaled to productions because there is a greater degree of confidence in the production models than in the attraction models.

Rule of Thumb - Best practice suggests that production/attraction factors should be between 0.9 and 1.1.
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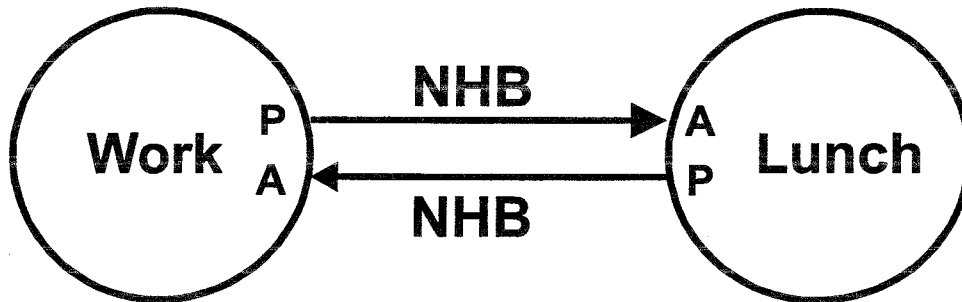
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Notes:

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# Balancing Non-Home Based Trips

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- NHB productions and attractions balance by zone

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# Balancing Non-Home Based Trips

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NHB trip production rates were developed for the “home” zone or travelers, but by definition, for NHB trips neither end is at home. Therefore, we discard the NHB productions generated in the “home” TAZ and substitute them with the NHB attraction for that TAZ, assuming that people attracted to that TAZ will be produced out of that TAZ.

This procedure means that NHB trips must balance by TAZ; for example, if TAZ 1 has 100 NHB attractions, it must also have 100 NHB productions.

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**Notes:**

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# **Error Checking, Calibration, and Validation**

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- Compare trip percentages by purpose
- Compare person trips per household by purpose
- Check treatment of special generators

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# Error Checking, Calibration, and Validation

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Error checking of the trip generation step includes comparing the results to other models and to state or federal averages for consistency and reasonableness. Application of the trip generation model for a previous year for which survey data are available may provide a test for the model's stability. Carefully scrutinize the following:

- Compare trip percentages by purpose to percentages from other surveys, other urban areas, or typical values.

Typical Values	
HBW	20%
HBO	57%
NHB	23%

Source: NCHRP Report 365, *Travel Estimation Techniques for Urban Planning*, 1998

- Compare person trips per household to other surveys, other urban areas, or typical values.

NBW	1.70 - 2.30 trips per household
HBO	3.40 - 4.80 trips per household
NHB	1.90 - 3.00 trips per household

Source: *Model Validation and Reasonableness Checking Manual*, TMIP, 2001.

- Ensure that facilities such as shopping malls, military installations, universities, and airports, which have high or low trip attraction rates per employee, are represented correctly in the trip generation model.

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