

A Review of Trip and Parking Generation Rates in the Philippines

Jose Regin F. Regidor*

*Department of Civil Engineering
University of the Philippines Diliman
Quezon City 1101 PHILIPPINES*

ABSTRACT

The practice of transportation engineering and planning has employed trip and parking generation rates to determine the number of trips generated and attracted by developments, as well as the required number of parking spaces for facilities. Trip generation serves as an input to modeling transportation requirements and traffic flows influenced by the development. For example, a residential condominium may directly impact traffic within a 10 km radius. Meanwhile, a shopping mall can impact an area of over 50 km in radius. Thus, it is expected that most trips generated or attracted by the development would be captured within these influence areas. These trips generated and attracted are represented by standard rates for trip and parking generation. This paper reviews the trip and parking generation rates used in transportation practice and research in the Philippines. The review includes the ascertaining of various rates used in traffic analysis. An assessment of issues and concerns pertaining to local trip and parking rates are discussed, and recommendations for future research directions are made based on information derived for this review.

Keywords: trip generation, parking generation

1. BACKGROUND

A trip is defined as a one-way person movement by one or more modes of travel and having an origin and a destination. Trip generation refers to the production and attraction of trips by origins and destinations, respectively. Parking is a derivative of trip generation, wherein the term parking generation is used to refer as the parking spaces required as a resulting of trip attraction. The practice of transportation engineering and planning has employed trip and parking generation rates to determine the number of trips generated by developments, as well as the required number of parking spaces for facilities.

Trip generation serves as an input to modeling transportation requirements and traffic flows influenced by the development. For example, a residential condominium will directly impact traffic within a 10 km radius. Meanwhile, a shopping mall can impact an area of over 50 km in radius. Thus, it is expected that most trips generated or attracted by the development would be captured within these influence areas. These trips generated and attracted are represented by standard rates for trip and parking generation.

*Correspondence to: Department of Civil Engineering, University of the Philippines Diliman, Quezon City 1101 PHILIPPINES. email:jfregidor@up.edu.ph

This paper reviewed the trip and parking generation rates used in transportation practice and research in the Philippines. The review included the ascertaining of various rates used in traffic analysis. Issues and concerns pertaining to local trip and parking rates are discussed and recommendations for future research directions are made based on information derived for this review. Definitions of trip generation, parking generation, and other terms used in this paper are based on the universally accepted meaning that are found in most transportation engineering and planning texts.

2. TRIP GENERATION

Trip generation rates used in traffic studies are the fundamental inputs to determine the impacts of developments on the transportation and traffic along road network within their influence/impact areas. The trip rates are dependent on the intensity of development, where intensity is generally associated with density. As such, high-rise residential condominiums are expected to generally produce and attract significantly different larger number of trips as compared with a residential subdivision comprised of single-detached units.

The trip generation rates shown in Table I were derived from the Institute of Transportation Engineers (ITE) Trip Generation Manual (1997)[4]. Trip rates are stated in vehicle trip ends and given for different land uses for the peak periods including directional distributions and ranges. Peak hour trip rates are identified for the morning, afternoon and typical Saturdays. The ITE manual also contains trip rates stated in terms of typical weekdays, Saturdays, and Sundays. That is, trip generation rate are also given in terms of "trips per day."

What are actually seen in the ITE Trip Generation manual are figures for different land use types. The figures include ranges of values (minima and maxima), the applicable period for the trip rate (weekday, AM peak hour, PM peak hour, etc.), the independent variable (e.g., GFA, number of students or employees, etc.) used, the number of specimens used to establish the rates, and other pertinent information on the trip generation rates. An example of trip generation rates and regression model for a typical land use is shown in Figure 1.

Trip generation rates used in local studies are expressed in person trips. These are converted to equivalent vehicle trips using assumed vehicle occupancy rates. Person trips are first classified into private and public trips. Trips expected to use public transport are further distributed to the different public transport modes (e.g., bus, jeepneys, train) using estimated mode splits. Examples of local trip generation rates are provided in Table II.

In case of some local traffic studies, the trip rates may not be provided in the reports. Rather, only the estimated total trip production and attraction are given for the critical peak periods (i.e., AM and PM peak). Table III shows typical information on trips produced and attracted by a major traffic generator, in this case a large shopping mall.

3. PARKING GENERATION

There are a number of relevant laws pertaining to the provision of off-street parking for different types of development. Among these are the following:

- National Building Code (P.D. 1096) of the Republic of the Philippines - signed by Pres. Ferdinand E. Marcos in 1977 and subsequently revised by the DPWH in 2004;

Land Use	Peak Period	Average	Range		Standard Deviation	Unit	% In	% Out
			Min	Max				
Residential								
Low Density	AM	7.70	3.30	22.70	9.10	/Ha	25	75
	PM	10.20	4.20	29.80	10.50	/Ha	64	36
	Sat Peak	9.40	5.00	17.50	9.90	/Ha	54	46
Medium Density	AM	19.25	8.25	56.75	22.75	/Ha	25	75
	PM	25.50	10.50	74.50	26.25	/Ha	64	36
	Sat Peak	23.50	12.50	43.75	24.75	/Ha	54	46
High Density	AM	38.50	16.50	113.50	45.50	/Ha	25	75
	PM	51.00	21.00	149.00	52.50	/Ha	64	36
	Sat Peak	47.00	25.00	87.50	49.50	/Ha	54	46
Commercial								
Retail	AM	110.87	10.76	974.13	150.69	/Ha GLA	61	39
	PM	402.57	73.19	3150.60	293.85	/Ha GLA	48	52
	Sat Peak	534.97	157.15	1971.95	334.76	/Ha GLA	52	48
Supermarket	AM	349.83	107.64	837.43	334.76	/Ha GLA	50	50
	PM	1238.93	572.64	2184.00	480.07	/Ha GLA	51	49
	Sat Peak	1318.58	579.10	2432.64	498.37	/Ha GLA	51	49
Office/BPO								
	AM	167.92	64.58	643.68	150.69	/Ha GFA	88	12
	PM	160.38	52.74	687.81	147.47	/Ha GFA	17	83
	Sat Peak	44.13	17.22	168.99	73.19	/Ha GFA	54	46
Institutional								
College	AM	0.21	0.15	0.26	0.21	/Student	80	20
	PM	0.21	0.20	0.46	0.21	/Student	30	70
	Sat Peak	0.13	0.108	0.283	0	/Student	50	50
High School	AM	346.60	54.90	1061.32	270.17	/Ha GFA	72	28
	PM	109.79	29.06	230.35	122.71	/Ha GFA	0	0
	Sat Peak	86.11	8.61	223.89	117.33	/Ha GFA	74	26
Church	AM	77.50	8.61	711.49	202.36	/Ha GFA	54	46
	PM	71.04	22.60	226.04	108.72	/Ha GFA	54	46
	Sat Peak	349.83	43.06	2510.14	687.81	/Ha GFA	74	26
Village Center	AM	142.08	116.25	240.04	0.00	/Ha GFA	66	34
	PM	188.37	148.54	299.24	155.00	/Ha GFA	34	66
	Sat Peak	134.55	106.56	234.65	0.00	/Ha GFA	49	51

Table I. Peak period trip generation rates, in vehicle trips (ITE, 2000)

Table I Continued

Recreational								
Park	AM	8	-	-	-	/Ha	80	20
	PM	30	-	-	-	/Ha	41	59
	Sat Peak	16	-	-	-	/Ha	59	41
Golf Course	AM	2.22	1.06	4.52	1.48	/Hole	79	21
	PM	2.74	1.67	4.11	1.56	/Hole	44	56
	Sat Peak	4.59	1.61	7.17	2.03	/Hole	49	51
Industrial Park								
	AM	88.26	12.92	245.42	110.87	/Ha	86	14
	PM	92.57	13.99	317.54	117.33	/Ha	21	79
	Sat Peak	37.67	33.37	64.58	64.58	/Ha	32	68

Land Use	Trip Production	Trip Attraction	Units
Office	0.0027	0.0176	Trips/m ² of GFA
Commercial	0.0576	0.0735	Trips/m ² of GFA
Hotel	2.00	2.55	Trips/hotel room
Residential	2.42	1.52	Trips/dwelling unit
Mixed Use	0.0172	0.0243	Trips/m ² of GFA

Source: Asiadworld Transportation Planning Study, 1997 [12].

Table II. Example of local trip generation rates (in person trips)

Generated/ Attracted Trips	AM Peak		PM Peak	
	IN	OUT	IN	OUT
Person Trips				
Private Mode	2,099	1,042	2,352	2,952
Public Mode	4,898	2,431	5,488	6,887
Equivalent Private Car Trips (pcu/hr)	1,050	521	1,176	1,476

Source: Traffic Impact Study for SM San Lazaro, 2003 [10]

Table III. Example of local generated peak person and car trip rates

- The Subdivision and Condominium Buyer's Protective Decree (P.D. 957 and amended by P.D. 1216) - the latter P.D. was signed by Pres. Marcos in 1977 amending the former decree signed in 1976;
- The Condominium Act (R.A. 4726) - was signed into law in 1966

The National Building Code stipulate the minimum requirements in the number of parking slots per type of development. Developments are classified into groups and divisions, and

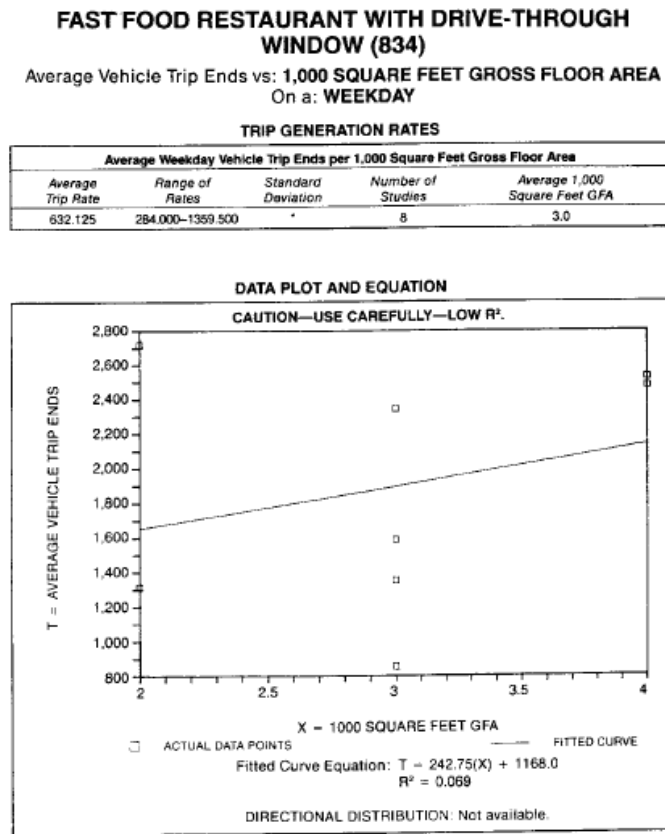


Figure 1. Example of trip generation rates and equation (ITE, 1987)

examples of these are provided below:

- Group A
 - Division A-1: Single family and multi-family dwelling units (single-detached)
 - Division A-1: Townhouse buildings regardless of number of storeys
 - Division A-2: Multi-family dwelling units located in residential condominium buildings regardless of number of storeys
- Group B
 - Division B-1: Hotels
 - Division B-1: Residential hotels and apartels (i.e., apartment-hotels)
 - Division B-1: Pension/boarding/lodging houses
- Group C
 - Division C-2: Churches and similar places of worship

- Division C-2: Public elementary, secondary, vocational and trade school
- Division C-2: Private elementary, secondary, vocational and trade school
- Division C-2: Public colleges and universities
- Division C-2: Private colleges and universities
- Group D
 - Division D-2: Public hospital
 - Division D-2: Private hospital
 - Division D-3: Nursing homes for ambulatory patients, school and home, for children over kindergarten age, orphanages and the like
- Group E
 - Division E-1: Terminals, inter-modals or multi-modals, depots, and the like
 - Division E-1: Transit stations and the like
 - Division E-2: Neighborhood shopping center/supermarket
 - Division E-2: Public markets
 - Division E-2: Restaurants, fast food centers, bars and beerhouses
 - Division E-2: Units located in office, commercial or mixed use condominium buildings/structures regardless of number of storeys
 - Division E-3: Aircraft hangars, open carports and garages, etc.
- Group F
 - Division F-1: Industrial buildings, mills, breweries, etc.
- Group G
 - Division G-1: Industrial buildings, factories, manufacturing establishments, mercantile buildings, warehouses, storage bins, power and water generation/distribution facilities
- Group H
 - Division H-1: Public recreational assembly buildings such as auditoria, theaters/cinemas, etc.
 - Division H-4: Covered amusement parks, amusement and entertainment complexes
- Group I
 - Division I-1: Recreational or similar public assembly buildings such as stadiums, sports complexes, convention centers, etc.
- Group J
 - Division J-1: Agriculture-related uses or occupancies
 - Division J-2: Other uses not classified in previous sections

Aside from the minimum requirements under the National Building Code, stricter regulations are implemented in urban areas. Examples of these are the guidelines for the Ayala

National Building Code	MACEA guidelines (Makati):	OCA guidelines (Ortigas):
• 1 pooled slot per 6 living units (units less than 50 m² GFA) • 1 pooled slot per 4 units (units 50-100 m² GFA) • 1 slot per unit (units >100m² GFA)	1 slot per 100 m ² GFA	1 slot per 90 m ² GFA

Table IV. Comparison of minimum parking space requirements

Variables	Indicators	Remarks
Building Size	Gross floor area (RGFA)	RGFA excludes commercial and/or offices spaces for rent or for sale within the building. Total number of residential units supplied.
	Gross saleable area (RGSA)	
	Number of units	
Development Density	Floor Area Ratio (RFAR)	RFAR = RGFA in m ² / Land Area in m ²
	Number of units per 1,000 m ² RGFA	
	Number of units per 1,000 m ² RGSA	
Development Mix	Number of unit types	Unit: Percentage
	Percentage of Studio units to total number of units	
	Percentage of 1-BR units to total number of units	
	Percentage of 2-BR units to total number of units	
	Percentage of 3-BR units to total number of units	
Policy Requirements	Number of slots required by NBC	Depends on the number and size of units
	Number of slots required by MACEA	Depends on the building's floor area
	Number of slots required by OCA	
Location	Distance from the nearest public transport stop	Measured in meters using map inserted in Autocad Release 14 program
	Distance from the heart of the CBD	
Cost	Parking slot cost	Cost of 1 slot in Philippine Peso

Table V. Parameters for parking (Orquina, 2003)

central business district (CBD) under the Makati Commercial Estates Authority (MACEA), and the Ortigas CBD under the Ortigas Center Association (OCA). Table IV shows a comparison of minimum parking requirements for the three guidelines in the case of residential condominiums.

Orquina (2003) examined the parking characteristics of residential condominiums in Metro Manila. The study identified several parameters for parking requirements for such developments and these are shown in the Table V. Similar parameters may be identified for other land use types. The identified parameters will aid in the derivation of suitable parking generation rates or models that would help in establishing the practical number parking spaces for particular land uses.

The ITE publishes Parking Generation, a manual similar to Trip Generation. This manual contains figures specifying ranges of values, applicable periods, number of specimens, and the appropriate independent variable for estimating parking generation. As in the case of trip generation, the fitted curve equation is provided together with the correlation coefficient. Low r^2 values elicit a note of caution for the use of the parking rates. An example of parking generation rates, equation and figure is shown in Figure 2.

FAST FOOD RESTAURANT WITH DRIVE-IN WINDOW (836)

Peak Parking Spaces Occupied vs: 1,000 GROSS SQUARE FEET
LEASABLE AREA

On a: WEEKDAY

PARKING GENERATION RATES

Average Rate	Range of Rates	Standard Deviation	Number of Studies	Average 1,000 GSF Leasable Area
9.95	3.55–15.92	3.41	18	3

DATA PLOT AND EQUATION

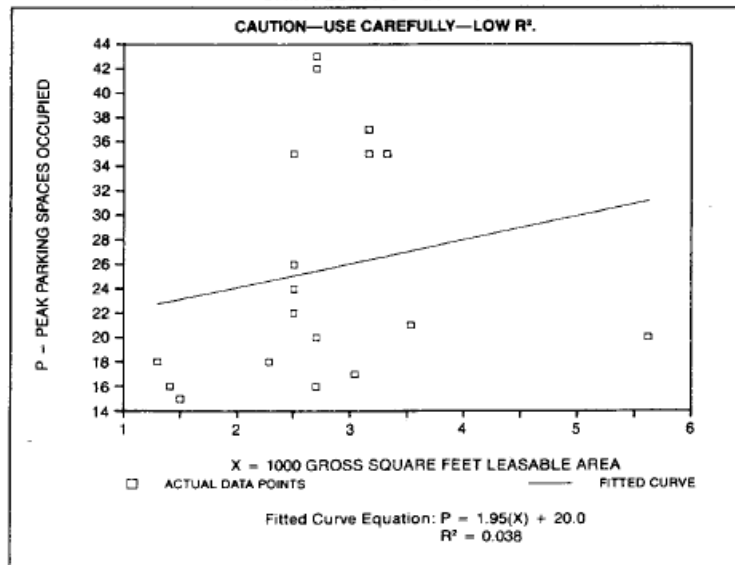


Figure 2. Example of parking generation rates and equation (ITE, 1987)

Parking indices have also been developed by other entities such as the Urban Land Institute in the U.K. and various local or federal governments but in cooperation with the ITE or using its guidelines for the development of such indices. Table VI lists parking rates developed by the ULI with data from the ITE and the Traffic Institute of Northwestern University. Such rates are ready to use for parking studies associated with traffic impact assessments. The indices are simply multiplied to the estimated magnitude of the independent variable to determine the recommended number of parking slots.

Land Use	Parking generation
Office	32.3 spaces per 1,000 m ² Gross Leasable Area
Retail	53.8 spaces per 1,000 m ² Gross Leasable Area*
	48.4 spaces per 1,000 m ² Gross Leasable Area**
	43.1 spaces per 1,000 m ² Gross Leasable Area***
	32.3 spaces per 1,000 m ² Gross Leasable Area****
Industrial	0.6 spaces per employee
Residential	2.0 spaces per single family dwelling unit
	2.0 spaces per multi-family dwelling unit with 3 or more bedrooms
	1.5 spaces per multi-family dwelling unit with 1 or 2 bedrooms
	1.0 space per multi-family efficiency dwelling unit
Restaurants	215.3 spaces per 1,000 m ² Gross Leasable Area
Cinemas	0.30 spaces per seat
Hotels	1.25 spaces per room

*Shopping centers over 55,742 m² (600,000 square feet)

**Shopping centers of 37,161 to 55,742 m² (400,000 to 600,000 square feet)

***Shopping centers of 2,323 to 37,161 m² (25,000 to 400,000 square feet)

****Convenience grocery stores

Source: Institute of Transportation Engineers, Transportation and Land Development, 1988 [11]

Table VI. Example of parking indices (converted from original English units)

4. OBSERVATIONS AND IMPLICATIONS

4.1. Issues and Concerns

The rates shown in this report are representative and illustrative of the trip and parking generation parameters employed by local transportation engineers and planners. These were culled from established references (i.e., ITE manuals) and consultants' study reports. In the former case, ITE publications are commercially available but not locally (in the Philippines). As such, ITE manuals are usually expensive to acquire, often only availed by the larger firms and university libraries. Few firms would have the latest edition; with some relying on editions published in the 1980's. It should be noted that newer editions have been heavily updated and would contain trip and parking rates that are significantly different from those in the old versions. The revisions were made following trends in the field of transportation as well as progress in design and analytical concepts and tools.

In the latter case of consultants' study reports, an observation of particular concern is the lack of proper referencing for parameters used in trip and parking generation. For parking, studies would usually point to the minimum requirements stipulated in the National Building Code and, if applicable, the guidelines of associations like MACEA. While following the code is only logical and may not be easily disputed, it has been established that minimum requirements are usually insufficient, especially for large trip generators (Shoup, [8]). Then there are also other situations that may be taken into consideration. Among these are instances of residential condominiums where although there are enough parking spaces provided (minimum or more), they are not occupied due to prohibitive cost of a slot.

Few reports refer to the ITE trip generation rates. Often, trip rates used in analysis are claimed to be locally developed values. Yet, there is no mention of their origin or basis. The client, reviewer or researcher is left in the dark as to who or what institution developed the rates. Again, such practice is problematic since there is no way to ascertain the validity of "local" parameters.

A comparison of local rates used in local traffic studies would be futile if the origins of these rates are not established. Note the tendencies of local consultants of borrowing or copying rates used by other consultants in their projects. Such practice perpetuates the possibility of using inappropriate trip generation rates as even clients including reputable firms or developers would even insist that the consultants they engaged use rates found in their archive of projects.

4.2. Availability of Trip and Parking Generation Data for Analysis

Government agencies like the Metro Manila Development Authority (MMDA) do not have copies of the traffic studies undertaken for major traffic generators. As such, they generally do not have information on trip rates, making it impossible for them to assess the validity of input parameters to traffic analysis undertaken to establish traffic management schemes for the traffic generators. The Environmental Management Bureau (EMB) may not necessarily be equipped with the capacity to evaluate trip rates although it is under the EIA that they require major developments that traffic impact studies are undertaken. Reports submitted to the EMB for evaluation are not generally made available to the public though they are technically for public consumption due to the nature of the reports (e.g., public interest).

Research on trip and parking generation would have to rely on the generosity and cooperation of consultants and similar entities for information on trip and parking generation parameters. This given, it is generally difficult to solicit such information especially if the trip and parking rates are to be derived from sensitive projects (e.g., large traffic generators).

5. CONCLUSIONS AND RECOMMENDATIONS

Local trip and parking rates may be too general for specific development projects. In the previous Table II, general land uses are mentioned and disregard possible variations in development density. Residential developments for example would have varying trip and parking generation characteristics that cannot be addressed by the rates in Table II. The inappropriateness of general trip generation rates is very evident from the perspective of undertaking traffic impact assessment (TIA) and where such trip rates fail to consider freight trip generation, as in the case of industrial and commercial land uses.

The ITE manuals and similar materials present more realistic and practical trip and parking generation rates for use in traffic analysis. These were developed with the thinking that the established rates might be expanded to take into consideration variations due to local traffic characteristics and conditions. More importantly, the ITE formulated the methodology for deriving and establishing local trip rates that would be consistent as well as supplementary to those that are already published. The methodology was developed in recognition of the fact that local traffic characteristics and conditions need to be factored in the formulation of suitable trip and parking generation rates for local use. It is obvious from the findings of this study that the next step would be to apply the established methodology to local conditions using local data and then compare and combine derived rates to established values. Such is a necessary step to confirm a valid set of trip and parking generation rates for Philippine use. However, it is also necessary to point out that trip generation field methodology must incorporate public transport trips and not be limited to "vehicle trips" that are interpreted as private trips. In retrospect, trip generation should be expressed in terms of person trips rather than vehicle trips.

ACKNOWLEDGMENT

This research was made possible through a Faculty Research Incentive Award (FRIA) by the U.P. Engineering Research and Development Foundation, Inc. (UPERDFI) and counterpart support from the University of the Philippines College of Engineering and the National Center for Transportation Studies.

REFERENCES

1. Institute of Transportation Engineers (1991) **Traffic Access and Impact Studies for Site Development, A Recommended Practice**, Prepared by the Transportation Planners Council Task Force on Traffic Access/Impact Studies, Brian S. Bochner, Chairperson, Washington, D.C.
2. Institute of Transportation Engineers (1999) **Transportation Planning Handbook**, 2nd Edition, John D. Edwards, Ed., Washington, D.C.
3. International Association of Traffic and Safety Sciences (2001) **Traffic Assessment Study**, Tokyo. (Original version in Japanese translated into English)
4. Institute of Transportation Engineers (1997) **Trip Generation**, 6th Edition, Washington, D.C.
5. Institute of Transportation Engineers (2004) **Trip Generation Handbook**, Second Edition, Washington, D.C.
6. National Center for Transportation Studies Foundation, Inc. (2001) **Formulation of Guidelines for the Traffic Impact Assessment of Urban and Regional Development Projects in the Philippines**, Research funded by the Japan International Cooperation Agency.
7. Salter, R.J. (1976) **Highway Traffic Analysis and Design**, Revised Edition, The Macmillan Press Ltd, London.
8. Shoup, D.C. (1999) "The Trouble With Minimum Parking Requirements," **Transportation Research**, Part A, Vol. 33, pp. 549-574.
9. SMDI Consultants, Inc. (2003) **Traffic Impact Study for SM City Dasmariñas**, Final Report.
10. SMDI Consultants, Inc. (2003) **Traffic Impact Study for SM City San Lazaro**, Final Report.
11. Stover, V.G. and Koepke, F.J. (1988) **Transportation and Land Development**, Institute of Transportation Engineers, Prentice Hall, Englewood Cliffs, New Jersey.
12. Transportation Systems Research, Inc. (1997) **Asiaworld Transportation Planning Study**, Final Report.

