

Trip Generation Rates for Las Vegas Area Hotel-Casinos

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The hotel-casinos of Las Vegas are known throughout the world. From the standpoint of size (number of rooms and casino square footage) and recreational attraction, this sort of development represents a unique land use for which trip generation rates have not been established or published. Thus, the evaluations of site traffic impacts for either new hotel-casinos or expansions to existing properties have been faced with the challenge of accurately predicting the number of vehicle trips that will be generated.

The goal of this study was to compile existing driveway count data obtained and documented in various traffic impact reports prepared within the Las Vegas area (Clark County, Nevada) and to use this information to prepare data plots and trip generation equations similar to those found in the ITE trip generation report.¹ To accomplish this task, the following independent variable characteristics were correlated to driveway count data from 1985 through 1990 for various hotel properties:

- Number of hotel rooms in the property
- Casino floor square footage
- Average number of employees

Data Collection

Manual driveway traffic counts and site characteristics shown in Table 1 were collected with the cooperation of the Clark County Department of Public Works, Traffic Management Division; the Uni-

versity of Nevada Las Vegas, Transportation Research Center; and from the records of SEA Consulting Engineers, as well as other traffic consultants in the Las Vegas area.²⁻²²

The compiled count data and property characteristics in Table 1 were divided into three groups. Properties were segregated into the following groups in an effort to identify any unique characteristics that may exist resulting from their location within the Las Vegas area.

Strip Hotels and Casinos (S). This category represents all properties located along the Las Vegas "strip," which is defined as that area along Las Vegas Boulevard (a total length of 5.2 miles or 8.4 km) between Sahara Avenue and Sunset Road. All of these properties are located within the unincorporated Las Vegas urban area. These properties are primarily an attraction for typical Las Vegas gaming tourists.

Outlying Areas (O). This category includes relatively small, rural hotel-casinos located outside of the Las Vegas metropolitan area, chiefly along Interstate 15, which links the Southern California area to Las Vegas.

Local Casinos (L). Off-strip hotel-

casinos with approximately 200 to 300 rooms are included in this group. These properties are generally located along arterial roadways within the Las Vegas urban area, and they primarily attract Las Vegas residents.

Data Evaluation

The data in Table 1 represent manual vehicle counts reported for access driveways to each hotel-casino property. The count observations were made during 15-minute intervals on weekdays during peak hour traffic (7 a.m. to 9 a.m. and 4 p.m. to 6 p.m.). The average weekday morning and afternoon peak hour used for these counts was that determined for the street traffic adjacent to each respective hotel-casino. Therefore, it is important to realize that the following evaluations do not necessarily reflect the peak-hour rates of the hotel-casino traffic generator.

In order to account for seasonal variations in the count data, the peak-hour volumes in Table 1 were adjusted to reflect a 100 percent room occupancy. This adjustment was made by dividing the driveway counts by the hotel occupancy rate on the day of the count. While these occupancy rates vary throughout holiday seasons, and especially during holiday periods, the average mid-week Las Vegas hotel occupancy rates have been relatively constant from year to year (81.4 percent for the 1988²³ calendar year and 81.6 percent for 1989²⁴).

Conversion Factors		
To convert from	to	multiply by
sq ft	m ²	0.0929
mi	km	1.609

The evaluated vehicle trip data in Table 1 represent 17 different hotel-casinos. However, in order to increase the number of data points for evaluation, counts from two properties (the Stardust and Riviera hotel-casinos) that have undergone major casino floor expansions or room additions were used. With this latter data included, a total of 21 afternoon peak-hour observations were available for comparison to the independent variables referred to previously (casino floor space, number of hotel rooms, and average number of employees).

The information contained in Table 1 was evaluated using a spreadsheet program to plot the data, determine directional distributions, and perform linear regression analysis. The linear regression analysis was calculated using the following three formulas found in ITE's *Trip Generation*¹:

$$T = C_1 X + C_2 \quad (1)$$

$$1/T = C_1 1/X + C_2 \quad (2)$$

$$\text{Ln}(T) = C_1 \text{Ln}(X) + C_2 \quad (3)$$

where:

T = Average vehicle trip ends (dependent variable),

X = Number of hotel rooms, aver-

age number of employees, or casino square footage (independent variables), and

C_1, C_2 = Coefficients (determined from regression analysis).

Because of the limited number of hotel-casino counts available for the local and outlying hotel-casino categories, the data were evaluated for either "all hotels" or "strip hotels." The best-fit relationship was found for each independent variable by comparing the coefficients of determination, R^2 . As the value of R^2 approaches 1.0, the relationship between the number of trips and the independent variable(s) becomes more favorable. The resulting best-fit relationships are given in Table 2 for the single-variant relationships. The single-variant equations, directional distribution, and data plots for all hotels are presented in Figures 1 through 6 in a format similar to that found in the ITE trip generation report.¹ In addition, multi-variant regression analysis was performed on the data set for various combinations of independent variables. The best-fit relationship was found for the four combinations of the three independent

variables. These equations and associated R^2 values are presented in Table 3 for the multi-variant relationships.

To further supplement the single-variant regression analysis, an average trip rate was determined for the three independent variables. For comparison purposes, the rate equation was also plotted on Figures 1 through 6.

Conclusions

Based upon the available hotel-casino vehicle trip data, the analyses of the vehicle volumes, and the resulting single-variant and multi-variant trip generation equations, the following conclusions can be drawn concerning the trip generation rates for Las Vegas area hotel-casinos.

The single-variant relationships of the form $T = C_1 X + C_2$ had the best correlations. The variable incorporating the average number of employees was found to have the strongest correlation between the three independent variables evaluated. For general planning purposes, when the number of employees is known from social and economic projections for a given hotel-casino land use

Table 1. Hotel-casino trip and site characteristics.

Type	Hotel	Hotel Occupancy ^a (%)	Count	AM Peak Hour ^b			PM Peak Hour			Number of Hotel Rooms	Casino Floor Sq Ft	Avg. No. of Emp.
				In	Out	Total	In	Out	Total			
S	Caesars Palace ²	95	1989	724	361	1,085	876	857	1,733	1,500	93,000	3,000
S	Circus-Circus ³	100	1988	568	599	1,167	883	915	1,798	3,154	110,979	3,500
S	El Rancho ⁴	79	1987	—	—	—	171	154	325	438	31,794	250
S	Excalibur ^{5,c}	96	1990	—	—	—	859	1,527	2,386	4,032	105,540	4,000
S	Frontier ⁶	93	1989	225	160	385	263	230	493	176	53,825	1,500
L	Gold Coast ⁷	93	1988	404	227	631	961	716	1,677	297	71,000	2,030
O	Goldstrike ⁸	79	1990	—	—	—	157	126	283	300	27,608	500
S	Hacienda ⁹	91	1990	142	125	267	280	253	533	780	17,500	800
S	Imperial Palace ¹⁰	92	1985	231	173	404	257	362	619	1,492	35,788	1,400
L	King 8 ¹¹	61	1988	107	92	199	134	125	259	298	4,138	300
O	Nevada Landing ¹²	79	1990	—	—	—	161	139	300	300	35,700	600
S	Riviera ¹³	100	1985	—	—	—	275	223	498	1,196	40,000	1,615
S	Riviera ¹⁴	100	1986	—	—	—	229	241	470	1,196	75,350	1,100
S	Riviera ¹⁵	100	1988	508	322	830	495	437	932	2,136	75,350	2,000
S	Riviera ¹⁶	98	1990	427	213	640	491	512	1,003	2,136	75,350	2,000
S	Sahara ¹⁷	82	1990	—	—	—	403	325	728	1,500	26,956	1,600
L	Sam's Town ¹⁸	80	1987	—	—	—	704	699	1,403	204	62,884	1,150
S	Sands ¹⁹	92	1989	238	144	382	274	324	598	720	26,000	1,500
S	Stardust ²⁰	90	1986	355	299	654	448	524	972	1,365	18,500	1,900
S	Stardust ²¹	97	1989	392	344	736	533	578	1,111	1,302	49,993	2,000
S	Westward Ho ²²	99	1987	140	164	304	172	203	375	780	34,457	900

S = Strip Hotel & Casino; O = Outlying Area Hotel & Casino; L = Local Hotel & Casino.

Note: Numbers appearing after hotel name refer to reference citations.

^aHotel room occupancy at time of driveway counts as reported by owner.

^bAdjusted counts to 100 percent room occupancy.

^cPM peak hour from Monday, Labor Day 1990.

area, Figures 3 and 4 may be used in a manner similar to the methods applied in *Trip Generation* to determine the anticipated number of vehicle trip ends. In using Figures 3 and 4 it is important to recognize that the results are based upon 100 percent room occupancy and should therefore be adjusted to reflect the average room occupancy rate for the hotel-casino land use area being evaluated.

The evaluation of directional split data shows that the morning peak hour has a greater number of vehicles arriving than departing (58 percent enter, 42 percent exit), while during the afternoon peak hour the directional split is almost equal (49 percent enter, 51 percent exit).

Multi-variant relationships, including all three independent variables, resulted in the strongest correlations. The strip hotel data had the best overall relationships, with R^2 values of 0.949 (morning peak hour) and 0.929 (afternoon peak hour) for the three independent variables. Of all the relationships analyzed, those incorporating the independent variable of the average number of employees demonstrated the strongest correlations with respect to the anticipated number of vehicle trip ends. However, it is important to recognize that even though the average number of employees will result in the best single-variant and multi-variant correlations to the number of vehicle trip ends, this variable may be difficult to precisely determine from an owner during the early development stages of a hotel-casino project when a site impact report needs to be

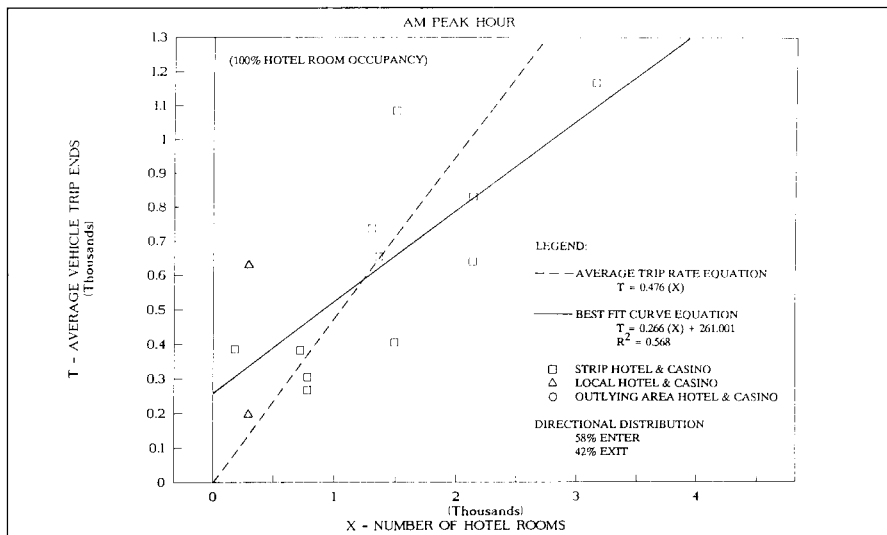


Figure 1. Average vehicle trip ends per hotel room, morning peak hour.

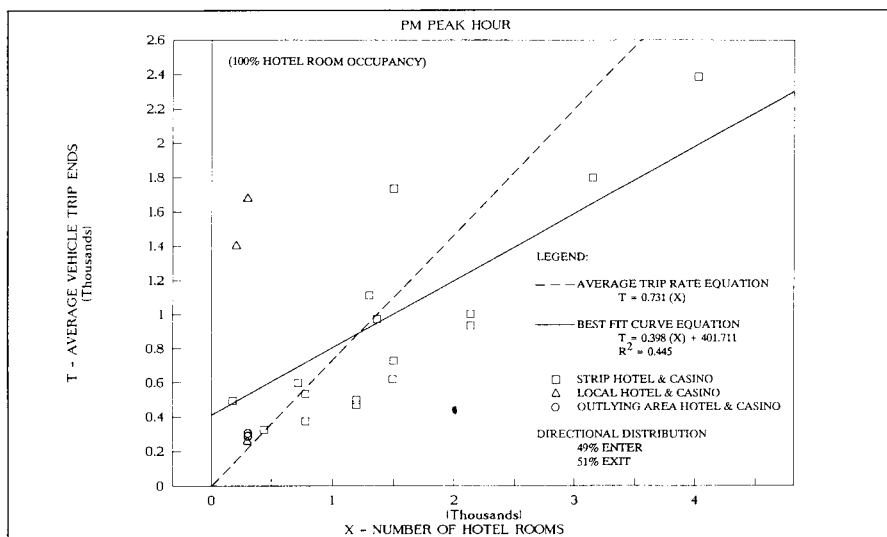


Figure 2. Average vehicle trip ends per hotel room, afternoon peak hour.

Table 2. Trip generation equations single variant relationships (100 percent hotel room occupancy).

Independent Variable	All Hotel-Casinos Average Vehicle Trip Ends (T)		Strip Hotel/Casinos Average Vehicle Trip Ends (T)	
	AM	PM	AM	PM
Trips Per Hotel Room (X)				
Rate Equation	$T = 0.476 (X)$	$T = 0.731 (X)$	$T = 0.441 (X)$	$T = 0.610 (X)$
Fitted Curve Equation	$T = 0.266 (X) + 261.001$	$T = 0.398 (X) + 401.711$	$T = 0.290 (X) + 213.221$	$T = 0.514 (X) + 143.206$
Coefficient of Determination (R^2)	0.568	0.445	0.608	0.745
Trips Per Employees (X)				
Rate Equation	$T = 0.337 (X)$	$T = 0.550 (X)$	$T = 0.334 (X)$	$T = 0.501 (X)$
Fitted Curve Equation	$T = 0.342 (X) - 10.334$	$T = 0.545 (X) + 9.205$	$T = 0.369 (X) - 64.984$	$T = 0.578 (X) - 139.629$
Coefficient of Determination (R^2)	0.927	0.799	0.935	0.923
Trips Per 1,000 square feet of Casino (X)				
Rate Equation	$T = 11.540 (X)$	$T = 17.258 (X)$	$T = 11.602 (X)$	$T = 16.744 (X)$
Fitted Curve Equation	$T = 8.216 (X) + 170.239$	$T = 15.905 (X) + 69.054$	$T = 8.406 (X) + 171.646$	$T = 14.727 (X) + 109.757$
Coefficient of Determination (R^2)	0.748	0.631	0.722	0.595

T = Trip ends at 100 percent room occupancy

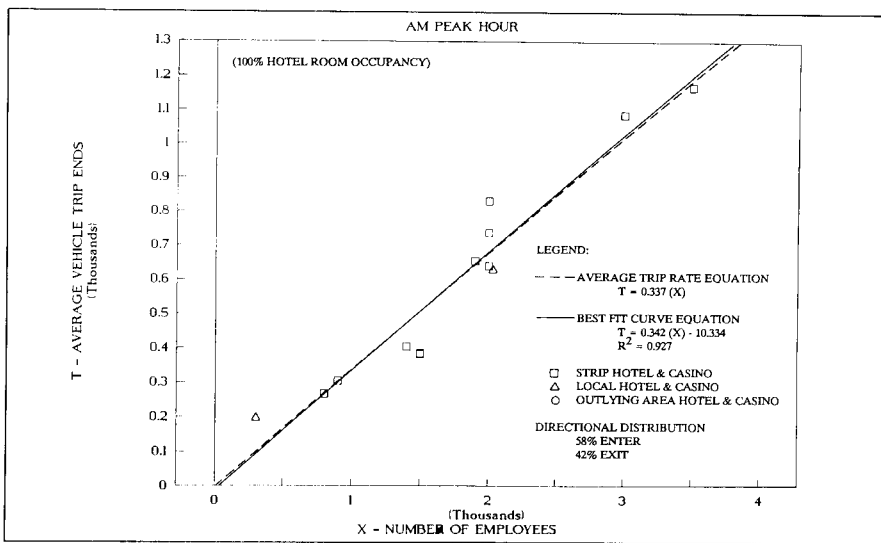


Figure 3. Average vehicle trip ends per hotel employee, morning peak hour.

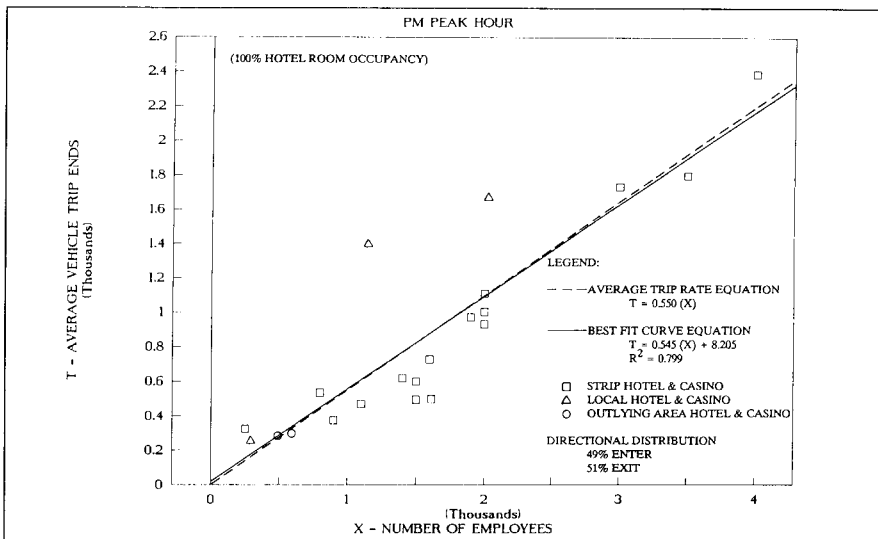


Figure 4. Average vehicle trip ends per hotel employee, afternoon peak hour.

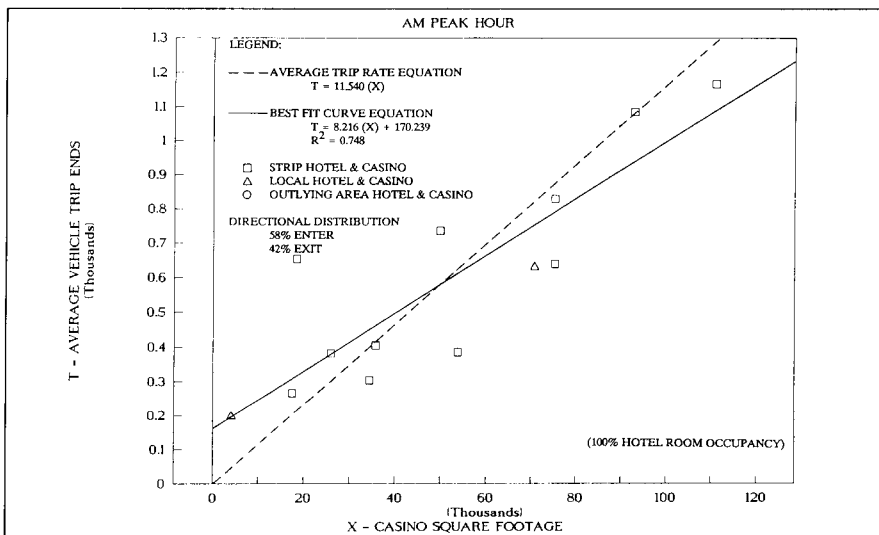


Figure 5. Average vehicle trip ends per 1,000 sq ft of casino floor area, a.m. peak hour.

prepared. Since the number of proposed hotel rooms and the casino floor space is more precisely known during the planning stages of either a new project or property expansion, it is recommended that vehicle trip-end projections for site impact reports be made based on these two more readily known variables, as given in Table 3. In using the equations contained in Table 3, it is important to recognize that the results are based on 100 percent room occupancy for the facility and must be adjusted to reflect the appropriate room occupancy rate for the project being evaluated.

Since the number of employees correlates so well with the number of trip ends for individual hotel-casinos, further study of this relationship is recommended as it relates to seasonal variations, hotel occupancy rates, and regional hotel-casino land use zones.

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Table 3. Trip generation equations Multi-variant Relationships (100 percent hotel room occupancy).

Independent Variables	All Hotel/Casinos Average Vehicle Trip Ends (T)		Strip Hotel/Casinos Average Vehicle Trip Ends (T)	
	AM	PM	AM	PM
Trips Per Hotel Rooms (X), 1,000 square feet of Casino (Y)				
Fitted Curve Equation	$T = 0.115 (X) + 6.181 (Y)$	$T = 0.147 (X) + 12.607 (Y)$	$T = 0.128 (X) + 5.937 (Y)$	$T = 0.386 (X) + 5.529 (Y)$
Coefficient of Determination (R ²)	+ 131.216 0.809	+ 60.405 0.665	+ 123.909 0.778	+ 33.990 0.782
Trips Per Hotel Rooms (X), Employees (Y)				
Fitted Curve Equation	$T = 0.047 (X) + 0.308 (Y)$	$T = -0.160 (X) + 0.681 (Y)$	$\ln(T) = 0.131 \ln(X) + 0.966$	$T = 0.087 (X) + 0.503 (Y)$
Coefficient of Determination (R ²)	-9.282 0.936	-18.313 0.820	$\ln(Y) - 1.791$ 0.948	-432.538 0.929
Trips Per Employees (X), 1,000 square feet of Casino (Y)				
Fitted Curve Equation	$T = 0.325 (X) + 0.529 (Y)$	$T = 0.439 (X) + 4.326 (Y)$	$T = 0.346 (X) + 0.707 (Y)$	$T = 0.562 (X) + 0.656 (Y)$
Coefficient of Determination (R ²)	-6.618 0.928	-43.152 0.815	-59.229 0.936	-145.676 0.924
Trips Per Hotel Rooms (X), Employees (Y), 1,000 square feet of Casino (Z)				
Fitted Curve Equation	$T = 0.047 (X) + 0.296 (Y)$	$T = 0.158 (X) + 0.576 (Y)$	$\ln(T) = 0.132 \ln(X) + 0.913$	$T = 0.085 (X) + 0.500 (Y)$
Coefficient of Determination (R ²)	+ 0.396 (Z) - 6.511 0.937	+ 4.271 (Z) - 68.771 0.836	$\ln(Y) + 0.048 \ln(Z) - 1.591$ 0.949	+ 0.175 (Z) - 134.264 0.929

T = Trip ends at 100 percent room occupancy.

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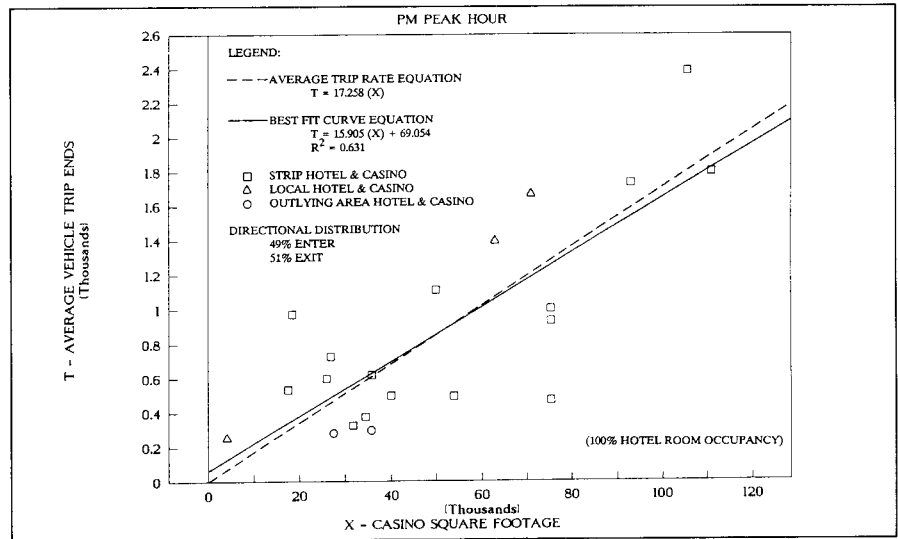
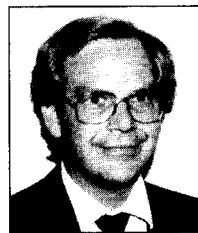
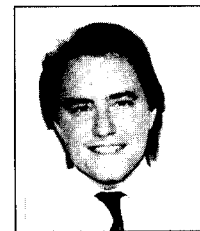


Figure 6. Average vehicle trip ends per 1,000 sq ft of casino floor area, afternoon peak hour.



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