

Also due to the lack of employment information at the time, the area type categories were based solely on population densities obtained from the 1990 population census. It was thought this could serve as a proxy for the level of urban activity. Thus, 6 different area types were established and identified geographically:

<u>Area Type (initial scheme)</u>	<u>Sector</u>	<u>Population Density</u>
Rural	A	up to 10 residents/hectare
Suburban	B	10 to 30 residents/hectare
Urban Low	C	30 to 50 residents/hectare
Urban High	D	50 to 70 residents/hectare
CBD Low	E	70 to 100 residents/hectare
CBD High	F	100 and up residents/hectare

This economic activity and area type stratification was modified after the survey took place to reflect the actual information structure used by INEGI. Employment data from the 1994 economic census as well as population information from a 1995 count, both just recently published, were at last obtained. As a result, economic activities were rearranged as follows:

<u>Activity (final scheme)</u>	<u>Including</u>
1. Basic	Industry, manufacturing, construction, and wholesale.
2. Retail	Retail.
3. Services	Government, education, consulting, medical, real estate/finance, and restaurants.

As part of the changes, the education activity as a whole was included as part of the services category, and restaurants were moved from retail to services.

The area type stratification was also rearranged, but now based on the activity density¹ concept using the latest socioeconomic census information projected to 1996 (base year), and using a recently developed traffic analysis zone (TAZ) structure:

<u>Area Type (final scheme)</u>	<u>Activity density</u>
6. Rural	up to 26
5. Suburban	27 to 62
4. Urban Low	63 to 99
3. Urban High	100 to 135
2. CBD Low	136 to 200
1. CBD High	over 200

The ranges were selected such that minimized the standard error of the resulting activity density between the TAZs. It is important to underline that these ranges contrast with those conventionally obtained from most Texas cities, the difference being the considerable higher demographic densities found in Mexican cities. Resulting from this procedure, Figure 1 shows the geographic distribution of area types in Juarez, according to their activity density. This resulting distribution is in general consistent with the travel behavior observed in each sector.

Sample size

At the time of the workplace survey there was no data available on trip behavior for the region, or even from similar regions for that matter that could help determine an appropriate sample size. Due to time and budget constraints at the time, any pilot sampling was discarded. Thus arbitrarily it was decided to randomly select ten workplaces from the pool of sites, under each cross-classification category of economic activity and population density, so a total of 240 workplaces were originally chosen. Furthermore, it was decided that five employees and five non-employees from each workplace should be randomly selected and interviewed for the travel survey. In principle this would have provided a gross sample size of 50 employees and 50 non-employees under each cross-classification category.

¹ Activity Density = [Zone Population + (Zone Employment * Norm Factor)] / Zone Acres
 Norm Factor = Total study area Population / Total study area Employment

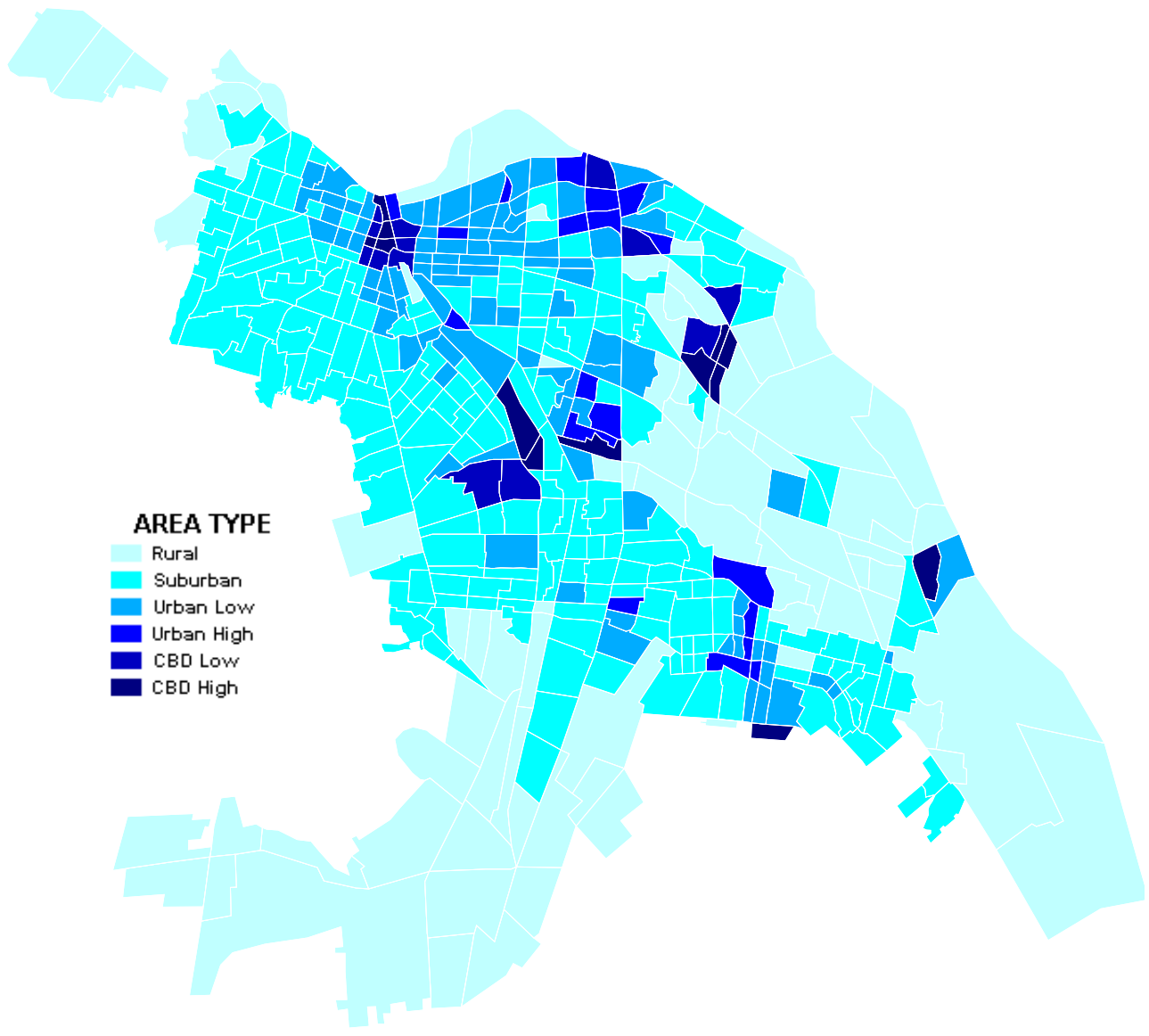
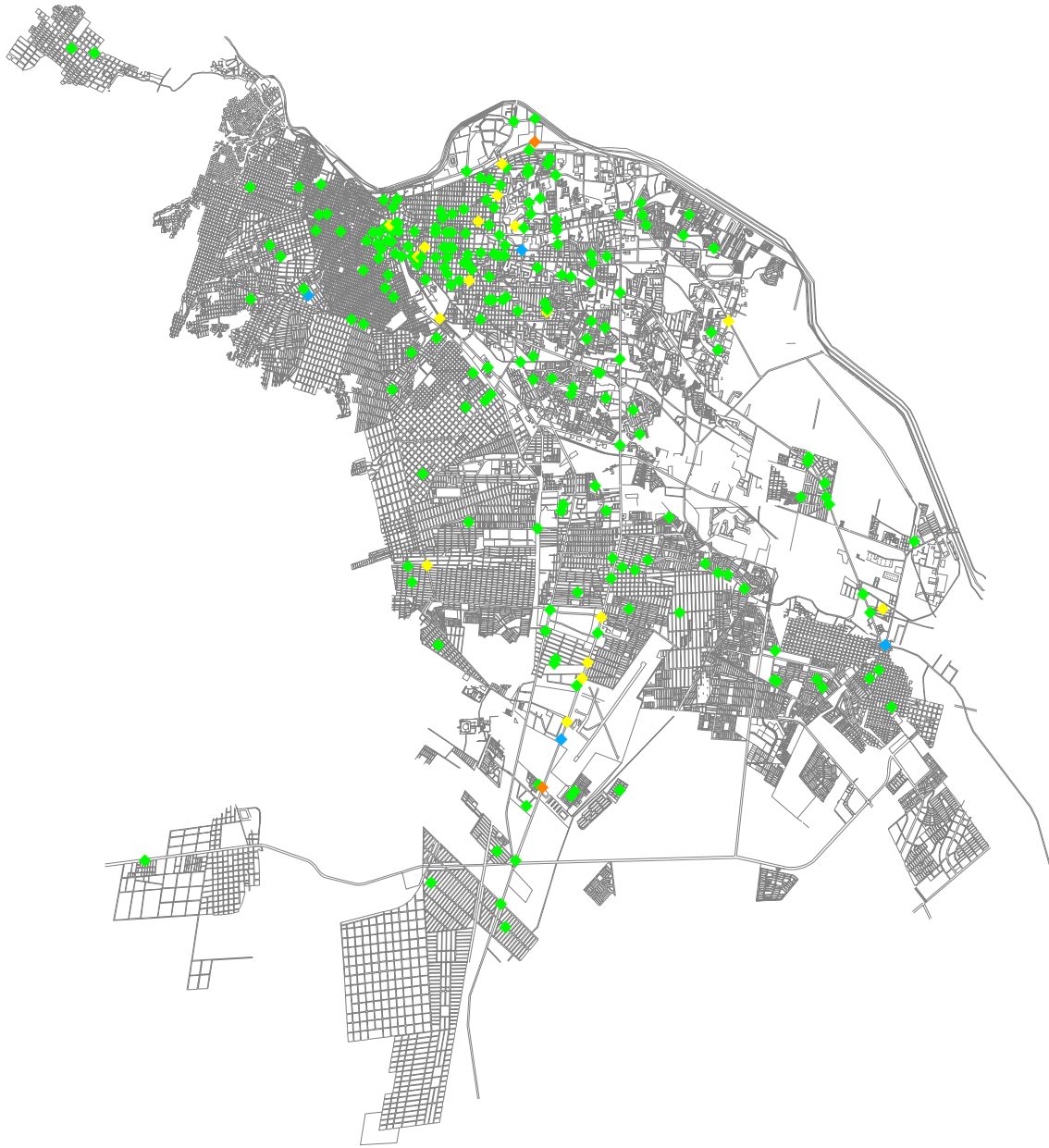


Figure 1. Area type geographic distribution of Juarez

Now, in practice there were those sites that had less than five employees, so in these cases additional sites were randomly selected until the quota of workers in the category was filled. In total 251 workplaces were selected for the survey. Their location referred to the nearest street intersection is shown in Figure 2.



WORKPLACE SURVEY LOCATION
(referred to nearest street intersection)

- ◆ 1
- ◆ 2
- ◆ 3
- ◆ 5

Figure 2. Location of workplace surveys

In addition to those workplaces to be sampled within the specified economic activity and original area type, the following ten sites were considered to have unique trip attraction patterns, and thus chosen for the special generator survey:

1. The University of Juarez/ Engineering and Architecture campus.
2. The University of Juarez/ Business and Social Studies campus.
3. Monterrey Tech, Juarez campus.
4. Juarez Bus station.
5. Juarez Rail station.
6. Zone 6 Hospital (IMSS).
7. Plaza de las Americas Mall.
8. State Government Building
9. Plaza Juarez Mall.
10. The Juarez market.

At each of these ten sites, it was decided to randomly select 20 employees and 20 visitors for the travel interview.

Survey instrument

The survey instrument is divided into 4 sections:

1. General information of the workplace. Includes person-trip attraction count.
2. Household information of employees.
3. Travel information of employees.
4. Travel information of non-employees.

During September and October of 1997, 261 surveys were entered (including trip geocoding) into the electronic database.

Database design

The base workplace/special generator survey database is composed of a principal table, and four detail tables:

	<u>Table name in english</u>
1. Table {Datos del Sitio de Empleo} :	{general workplace information} principal table
2. Table {Empleados del Sitio}:	{household information of employee}
3. Table {Vehiculos del Empleado}:	{employee's vehicle records}
4. Table {Informacion de viajes}:	{employee's trip records}.
5. Table {Usuarios del Sitio}:	{travel information of non-employee}

In addition a sixth table was included to provide details on geocode information:

6. Table {Interseccion}:	{intersection}
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A general layout of the database and its component tables and fields is shown in Figure 3. A description of each of the fields is given in Appendix A.

The survey information tables (No.1 to No.5) are related by the common fields **[tag]_Sitio** and **[tag]_Emp** which together form the survey unique code. Note that the prefix tag on the names of these two fields vary depending on the source table. The georeference information table (table No.6) is related to the principal table and to the trip records table through the field **int_int**

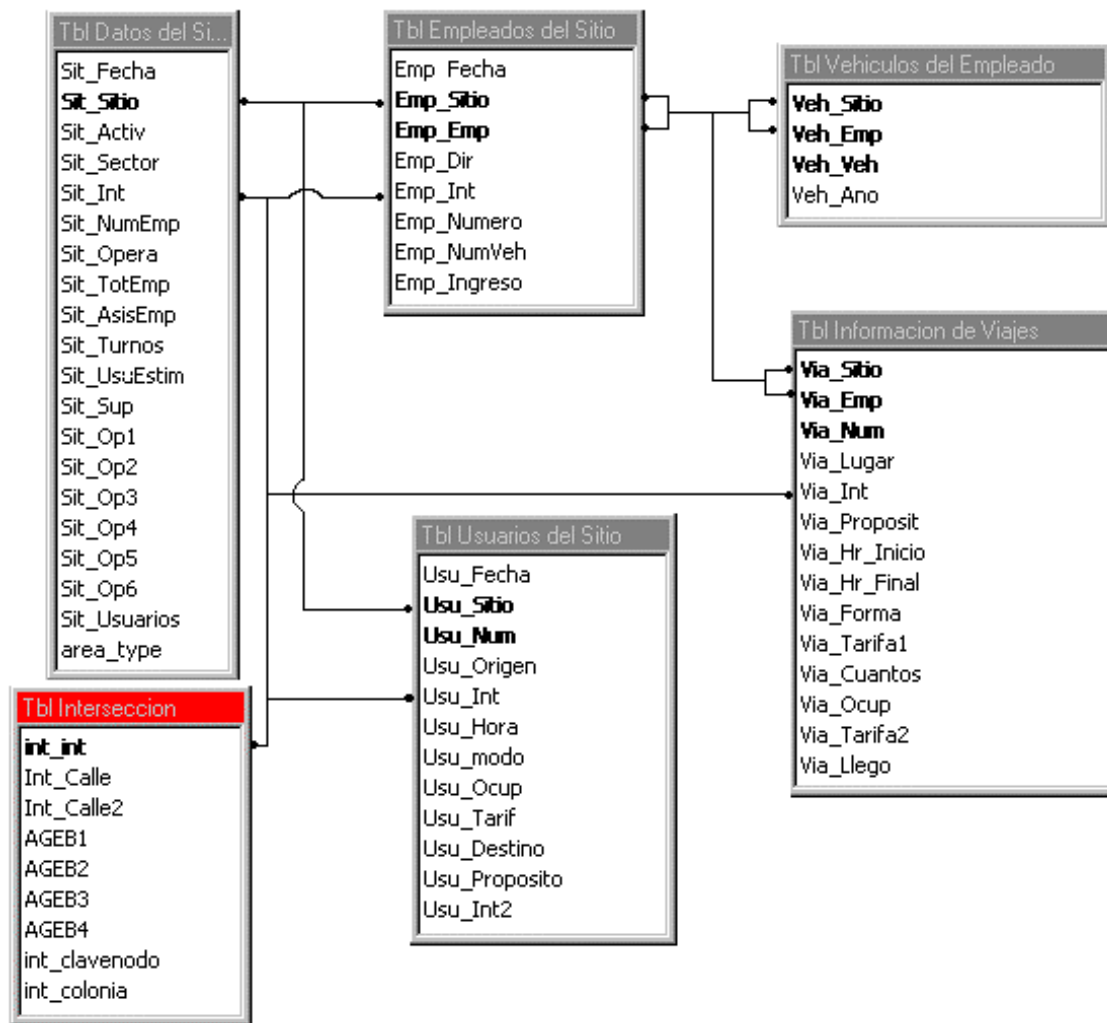


Figure 3. Workplace/special generator survey database layout

Edit checks

To identify logical or numerical errors or inconsistencies in the workplace/special generator survey database, fifty-two different checks were developed using the powerful query capabilities of MS-Access. Table 1 provides a description of these checks. The checks were designed to run in 4 separate groups or stages to avoid excessive repetition of error detection. Queries for one group at a time were programmed, and until the detected records were edited, the next group queries were generated.

Table 1. MS-Access queries developed for error checking

Group	Serial	Description	Records detected	Records modified	Surveys erased
1	WP-01	Surveys entered with invalid or unusual unique code	0	0	0
	WP-02	Surveys entered in {household information of employee} table, but not registered in {general workplace information} table.	2	2	0
	WP-03	Surveys entered in {general workplace information} table, but not registered in {household information of employee} table.	0	0	0
	WP-04	Surveys entered in {travel information of non-employees} table, but not registered in {general workplace information} table.	2	2	0

Table 1. (Continued)

Group	Serial	Description	Records detected	Records modified	Surveys erased
1	WP-05	Surveys entered in {general workplace information} table, but not registered in {travel information of non-employees} table.	0	0	0
	WP-06	Surveys entered in {employee's trip records} table, but not registered in {general workplace information} table.	0	0	0
	WP-07	Surveys entered in {general workplace information} table, but not registered in {employee's trip records} table.	0	0	0
	WP-08	Surveys entered in {general workplace information} table, but not registered in {employee's vehicle records} table.	0	0	0
	WP-09	Surveys entered in {employee's vehicle records} table, but not registered in {general workplace information} table.	2	2	0
	WP-10	Surveys with invalid or unusual site activity code.	10	0	0
	WP-11	Surveys with invalid or unusual site sector code.	10	0	0
	WP-12	Surveys with invalid geocode for site location.	3	3	0
	WP-13	Surveys with missing information on site working hours.	20	20	0
	WP-14	Surveys with missing information on roofed space.	10	3	0
2	WP-15	Surveys with invalid geocode for employee household.	9	9	0
	WP-16	Surveys where reported number of vehicles in {general workplace information} table differs from number of records in {employee's vehicles records} table.	1,057	1,053	0
	WP-17	Surveys with invalid family income code.	28	6	0
	WP-18	Surveys entered in {employee's vehicle records} table, but not registered in {household information of employee} table.	0	0	0
	WP-19	Surveys with vehicles reported in {household information of employee} table, but not registered in {employee's vehicle records} table.	0	0	0
	WP-20	Surveys with less than 5 employees interviewed.	0	0	0
	WP-21	Surveys with more than 5 employees interviewed.	10	0	0
3	WP-22	Surveys with invalid or unusual vehicle year.	39	10	0
	WP-23	Surveys with invalid or unusual vehicle number.	18	0	0
	WP-24	Surveys with invalid or unusual code for non-employee trip destiny.	37	37	0
	WP-25	Surveys with invalid intersection geocode for non-employee trip origin.	70	67	0
	WP-26	Surveys with invalid intersecion geocode for non-employee trip destiny.	56	52	0
	WP-27	Surveys with invalid or unusual code for non-employee trip origin.	12	12	0
	WP-28	Surveys with invalid or unusual code for non-employee travel mode.	8	8	0

Table 1. (Continued)

Group	Serial	Description	Records detected	Records modified	Surveys erased
3	WP-29	Surveys with invalid or unusual code for non-employee trip purpose.	12	12	0
	WP-30	Surveys with invalid or unusual number of occupants for non-employee trip.	6	1	0
	WP-31	Surveys with invalid or unusual bus fare for non-employee trip.	18	7	0
	WP-32	Surveys with less than 5 non-employees interviewed.	13	7	0
	WP-33	Surveys with non-existent intersection geocode for employee trip destiny.	55	55	0
	WP-34	Surveys entered in {household information of employee} table, but not registered in {employee's trip records} table.	0	0	0
	WP-35	Surveys with invalid or unusual number of occupants for employee trip.	39	20	0
	WP-36	Surveys with invalid or unusual code for employee trip purpose.	11	11	0
4	WP-37	Surveys with invalid or unusual code for employee travel mode.	8	7	0
	WP-38	Surveys with invalid or unusual number of buses boarded for employee trip.	4	4	0
	WP-39	Surveys with trip 0 missing for employee.	0	0	0
	WP-40	Surveys with invalid or unusual parking fee for employee vehicle trip.	28	12	0
	WP-41	Surveys with an employee reporting less than 2 trips per day.	13	12	0
	WP-42	Surveys with invalid or unusual bus fare for employee trip.	260	260	0
	WP-43	Surveys with invalid or unusual code for employee travel mode to the bus stop.	1,104	640	0
	WP-44	Surveys with invalid or unusual travel times for employee's trips.	71	43	0
	WP-45	Surveys where employee trip purpose is work but trip-end geocode differs from that of workplace.	0	0	0
	WP-46	Surveys where employee's trips were made by private vehicle, but no number of occupants were reported.	12	12	0
	WP-47	Surveys with missing travel date in {travel information of non-employee} table.	0	0	0
	WP-48	Surveys with missing interview date in {household information of employee} table.	4	4	0
4	WP-49	Surveys with missing interview date in {general workplace information} table.	0	0	0
	WP-50	Surveys with illogical trip sequence for employee.	12	12	0
	WP-51	Surveys where employee's trip finish time is greater than the starting time of the next trip.	37	36	0
	WP-52	Surveys where employee's trip-end place is home, but trip purpose code is not returning home.	84	84	0

Using these queries, the errors and inconsistencies detected were corrected. Quite similar to the household survey, many of the errors were originated at the time of electronic data entry (input typos) where

the system did not have a validation rule from its design. However, for this survey very few of the errors detected were inconsistencies registered in the field; this was probably the result of having a team of trained personnel conducting the travel interviews, instead of school children.

As summary, Table 2 presents the resulting surveys obtained under each cross-classification cell of economic activity (or employment type) and area type. As previously explained, the recent modification on the area type stratification, resulted in a variation of the survey distribution in the matrix from that originally conceived. In addition, the table shows only three economic activities instead of the original four, the result of including the education activity within the services category for sample expansion purposes.

Table 2. Sample distribution of workplace survey

Economic Activity	Data from sample		Area Type						Totals
			1 CBD High	2 CBD Low	3 Urban High	4 Urban Low	5 Suburban	6 Rural	
Basic	Sampled sites	number	4	1	2	13	11	9	40
		% of total	1.6%	0.4%	0.8%	5.2%	4.4%	3.6%	15.9%
	Site employment	number	1840	2	10	976	3077	706	6611
		% of total	18.5%	0.0%	0.1%	9.8%	30.9%	7.1%	66.5%
Retail	Sampled sites	number	6	4	3	21	17	4	55
		% of total	2.4%	1.6%	1.2%	8.4%	6.8%	1.6%	21.9%
	Site employment	number	28	19	73	129	86	26	361
		% of total	0.3%	0.2%	0.7%	1.3%	0.9%	0.3%	3.6%
Services	Sampled sites	number	4	8	15	65	46	18	156
		% of total	1.6%	3.2%	6.0%	25.9%	18.3%	7.2%	62.2%
	Site employment	number	58	57	120	710	932	1094	2971
		% of total	0.6%	0.6%	1.2%	7.1%	9.4%	11.0%	29.9%
Totals	Sampled sites	number	14	13	20	99	74	31	251
		% of total	5.6%	5.2%	8.0%	39.4%	29.5%	12.4%	100.0%
	Site employment	number	1926	78	203	1815	4095	1826	9943
		% of total	19.4%	0.8%	2.0%	18.3%	41.2%	18.4%	100.0%

As reference, Table 3 shows the actual distribution of workplaces in the city.

Table 3. General workplace distribution in Juarez (1996 projection)

Economic Activity	Data from urban area		Area Type						Totals
			1 CBD High	2 CBD Low	3 Urban High	4 Urban Low	5 Suburban	6 Rural	
Basic	Total sites	number	132	223	106	681	934	133	2209
		% of total	0.5%	0.8%	0.4%	2.5%	3.4%	0.5%	8.1%
	Total employment	number	42329	24239	13858	27864	18264	4371	130925
		% of total	18.0%	10.3%	5.9%	11.8%	7.7%	1.9%	55.5%
Retail	Total sites	number	1717	1634	841	3028	6383	802	14404
		% of total	6.3%	6.0%	3.1%	11.1%	23.3%	2.9%	52.6%
	Total employment	number	6060	4346	3747	13458	17650	2809	48070
		% of total	2.6%	1.8%	1.6%	5.7%	7.5%	1.2%	20.4%
Services	Total sites	number	1767	1417	683	3119	3293	468	10747
		% of total	6.5%	5.2%	2.5%	11.4%	12.0%	1.7%	39.3%
	Total employment	number	7336	8182	5134	19633	13395	3026	56706
		% of total	3.1%	3.5%	2.2%	8.3%	5.7%	1.3%	24.1%
Totals	Total sites	number	3616	3273	1630	6828	10610	1403	27360
		% of total	13.2%	12.0%	6.0%	25.0%	38.8%	5.1%	100.0%
	Total employment	number	55725	36767	22739	60955	49309	10206	235701
		% of total	23.6%	15.6%	9.6%	25.9%	20.9%	4.3%	100.0%

Table B1 in Appendix B, shows additional workplace survey information, aggregated under each of these stratification levels.

Workplace trip attraction rates: initial model

Having finished the database cleaning process, the next two major goals were to develop attraction rates for use in estimating travel demand, better known as weighted model attraction rates, and computing the variability of these rates as well. Only the data from the 251 surveyed workplaces was used, thus, leaving out the information from the 10 special generators.

In order to achieve these two objectives, several macros were programmed to compute overall trip attractions of each workplace surveyed. An initial step was to link serve passenger trips on the employee survey, and to establish trip purpose under the common categories of home-based-work (HBW), home-based-non-work (HBN), non-home-based (NHB), and truck-taxi (TT); this last one was considered to be any NHB trip using a commercial vehicle. The procedure was followed for all trips reported by employees regardless if the trips were to or from the workplace. A subsequent step identified which of these trips were productions or attractions of the surveyed workplace. Similarly, trips from the non-employee survey were categorized by the described trip purposes and characterized as productions or attractions. On both employee and non-employee procedures, external trips were identified and removed.

In order to expand the data, both employee and non-employee expansion factors were obtained for each workplace. The employee expansion factors ϵ_i (for workplace “ i ”) were computed simply by dividing the number of employees at work (on the day of the survey) by the number of employees surveyed. Similarly, non-employee or visitor expansion factors ν_i (for workplace “ i ”) were computed by dividing the number of daily visitors counted at each workplace by the number of non-employees surveyed. Finally, the daily person-trips reported in the survey under each purpose category were then multiplied by these factors to obtain the total employee person-trips, as well as non-employee person-trips generated by each workplace.

Weighted model attraction rates

For modeling purposes, weighted model attraction rates needed to be developed. In order to accomplish this, the expanded attractions at each workplace (employee and non-employee) were summed under each stratification level, differentiating by trip purpose as well. The results of this step are shown in Table 4. No trip productions were included.

Table 4. Workplace person trip attraction by trip purpose

Economic Activity	Trip Purpose	Area Type						Totals
		1 CBD High	2 CBD Low	3 Urban High	4 Urban Low	5 Suburban	6 Rural	
Basic	No. Sites	4	1	2	13	11	9	40
	HBW	3680	4	24	1809	5945	1057	12519
	HBN	56	0	22	61	110	138	387
	NHB	109	5	58	440	334	443	1390
	TT	4	0	0	0	35	61	101
	All purposes	3850	9	104	2311	6424	1699	14397
Retail	No. Sites	6	4	3	21	17	4	55
	HBW	46	27	130	547	153	42	945
	HBN	883	171	381	2906	1727	89	6157
	NHB	515	164	516	934	231	273	2632
	TT	0	0	0	26	47	12	86
	All purposes	1443	362	1028	4413	2158	416	9820
Services	No. Sites	4	8	15	65	46	18	156
	HBW	114	104	308	2142	1889	2297	6855
	HBN	1072	3155	3001	20821	27454	3152	58655
	NHB	30	17	462	2500	4543	2947	10499
	TT	0	0	0	0	95	30	125
	All purposes	1216	3277	3771	25463	33981	8426	76133
Totals	No. Sites	14	13	20	99	74	31	251
	HBW	3840	136	462	4499	7986	3396	20319
	HBN	2011	3326	3404	23789	29292	3378	65199
	NHB	654	186	1036	3874	5108	3663	14520
	TT	4	0	0	26	177	104	312
	All purposes	6509	3648	4902	32187	42563	10541	100350

Finally, weighted model attraction rates were obtained dividing these expanded survey attractions by the total employment corresponding to the stratification level; this represents a weighted average trip attraction rate. Total employment was used instead of the stratification’s sum of employees at work, since the former will

normally be more easily available information and thus is better for forecasting purposes. Table 5 shows the result of this final step.

Table 5. Person trip attraction per employee (weighted model person trip rates)

Economic Activity	Trip Purpose	Area Type						Totals
		1 CBD High	2 CBD Low	3 Urban High	4 Urban Low	5 Suburban	6 Rural	
Basic	No. Sites	4	1	2	13	11	9	40
	HBW	2.000	2.000	2.400	1.854	1.932	1.497	1.894
	HBN	0.031	0.000	2.180	0.063	0.036	0.195	0.059
	NHB	0.059	2.500	5.800	0.451	0.109	0.627	0.210
	TT	0.002	0.000	0.000	0.000	0.012	0.087	0.015
	All purposes	2.092	4.500	10.380	2.368	2.088	2.407	2.178
Retail	No. Sites	6	4	3	21	17	4	55
	HBW	1.643	1.432	1.781	4.240	1.777	1.615	2.618
	HBN	31.521	9.000	5.222	22.529	20.086	3.423	17.057
	NHB	18.379	8.632	7.074	7.238	2.681	10.485	7.291
	TT	0.000	0.000	0.000	0.202	0.549	0.477	0.237
	All purposes	51.543	19.063	14.077	34.209	25.093	16.000	27.202
Services	No. Sites	4	8	15	65	46	18	156
	HBW	1.966	1.832	2.568	3.017	2.027	2.099	2.307
	HBN	18.479	55.358	25.008	29.325	29.457	2.881	19.743
	NHB	0.514	0.302	3.848	3.521	4.875	2.694	3.534
	TT	0.000	0.000	0.000	0.000	0.102	0.028	0.042
	All purposes	20.959	57.491	31.425	35.863	36.460	7.702	25.625
Totals	No. Sites	14	13	20	99	74	31	251
	HBW	1.994	1.738	2.277	2.479	1.950	1.860	2.044
	HBN	1.044	42.646	16.768	13.107	7.153	1.850	6.557
	NHB	0.339	2.387	5.104	2.134	1.247	2.006	1.460
	TT	0.002	0.000	0.000	0.014	0.043	0.057	0.031
	All purposes	3.379	46.772	24.150	17.734	10.394	5.773	10.093

Trip rate variability

Variability of trip rates under each stratification level was established through each cell's coefficient of variation. These are shown in Table 6, for each stratification cell.

Table 6. Coefficients of variation for weighted model person trip rates

Economic Activity	Trip Purpose	Area Type						Totals
		1 CBD High	2 CBD Low	3 Urban High	4 Urban Low	5 Suburban	6 Rural	
Basic	No. Sites	4	1	2	13	11	9	40
	HBW	0.000	NA	0.236	0.778	0.122	0.292	0.461
	HBN	13.388	NA	1.233	4.750	55.546	10.853	27.360
	NHB	9.210	NA	1.073	2.242	4.782	1.413	8.201
	TT	7.931	NA	NA	NA	1.237	9.471	26.837
	All purposes	0.454	NA	0.913	1.012	1.140	1.333	1.501
Retail	No. Sites	6	4	3	21	17	4	55
	HBW	0.500	0.471	0.297	2.526	0.261	0.549	2.581
	HBN	1.696	0.720	1.916	1.628	1.647	11.600	2.103
	NHB	1.034	0.598	3.407	2.018	1.757	1.991	1.893
	TT	NA	NA	NA	7.038	5.978	1.858	8.617
	All purposes	1.137	0.559	2.382	1.548	1.411	3.685	1.697
Services	No. Sites	4	8	15	65	46	18	156
	HBW	0.565	0.266	0.800	1.019	0.571	1.891	1.112
	HBN	0.544	2.516	1.400	1.255	1.415	8.852	2.387
	NHB	2.754	1.975	1.367	2.358	2.210	5.690	2.803
	TT	NA	NA	NA	NA	15.268	42.976	22.157
	All purposes	0.409	2.422	1.109	1.086	1.195	4.290	1.904
Totals	No. Sites	14	13	20	99	74	31	251
	HBW	0.420	0.315	0.794	2.240	0.485	1.658	1.840
	HBN	39.251	2.561	1.854	2.661	5.399	13.295	6.384
	NHB	42.265	1.839	1.939	4.524	7.232	7.186	7.098
	TT	4.437	NA	NA	45.604	46.235	18.167	39.005
	All purposes	14.259	2.323	1.340	2.295	3.958	5.947	4.514

To compute these coefficients of variation, the following steps were taken.

1. For each workplace, the expanded employee and non-employee attracted person-trips were added under each trip purpose, thus obtaining the total workplace attracted person-trips (by trip purpose).
2. For each workplace, an average person-trip attraction rate by trip purpose was computed, dividing the total workplace attracted person-trips (by trip purpose) by the total employment of the workplace.
3. These workplace rates (by trip purpose) were aggregated at each stratification level and cell, and a cell average and standard deviation were obtained. Tables B2 and B3 in Appendix B show the resulting values for each cell.
4. The coefficient of variation for the weighted model attraction rate under each cell is obtained by dividing the standard deviation previously obtained for each cell (step 3), by the respective weighted model attraction rate of the cell (Table 5).

Workplace trip attraction rates: a second model

Taking a closer look at the number of sites aggregated at each stratification level, it is easy to identify several that have a very small number. Such is the case for area types 2 and 3, under basic and retail economic activities, where there is even a stratification level with only one site surveyed; as a result not even the standard deviation can be computed for the cells in this stratification level (at least two observations are required for this computation). In an attempt to provide a more robust sample for these stratification groups, area types 1 and 2 were joined as one, as well as area types 3 and 4. Thus for this second model the area types were labeled as follows:

<u>Code</u>	<u>Area Type</u>	<u>Activity density</u>
6	Rural	up to 26
5	Suburban	27 to 62
4 & 3	Urban	63 to 135
2 & 1	CBD	over 136

As a result, the geographic distribution of area types under this reduced number of categories got a more clustered appearance, as shown in Figure 4.

Following the previously described procedures to develop weighted model attraction rates, and to compute the coefficients of variation, Tables 7 and 8 show the corresponding values under the second model. In Appendix C, Table C1 shows the aggregated workplace information under the second area type array, as well as complementary tables that resulted from the computation process.

Concluding remarks

A couple of quick observations can be made from the two attraction models. Several cells show high variability in their trip rates. A notorious example is that of the basic activity HBN trips in the suburban area type. Yet, closer look of the sites in the basic economic activity shows that the number of employees doesn't seem to have much impact in the number of non-work related daily attractions. This is even more evident in the suburban area type, where the sample show sites with 1,800 and 5 employees at the extremes, but similar HBN attractions. Both retail and services do seem to have an over all correlation in their HBN and NHB attractions with the number of employees.

As expected, the joining of area types and thus data aggregation on the second model increases the rate variability in some of the cells. This is quite notorious for basic activity NHB trips in the CBD and Urban area types. Yet, this seemed to be a necessary step to improve the significance level of the resulting rates, and appears to yield better defined trends in some trip rates, as one moves between the new area types.

This is an area though were only an experienced eye can detect inconsistencies in the results, and thus the IMIP team looks forward to have TxDOT and TTI evaluate the findings in this document. Therefore, in addition to the present tech memo, IMIP will send a copy of the clean-edited workplace survey database just in case further information might be required. In the mean time, the trip rates in the second layout will be used as input to the trip generation modeling process with Tripcal5.

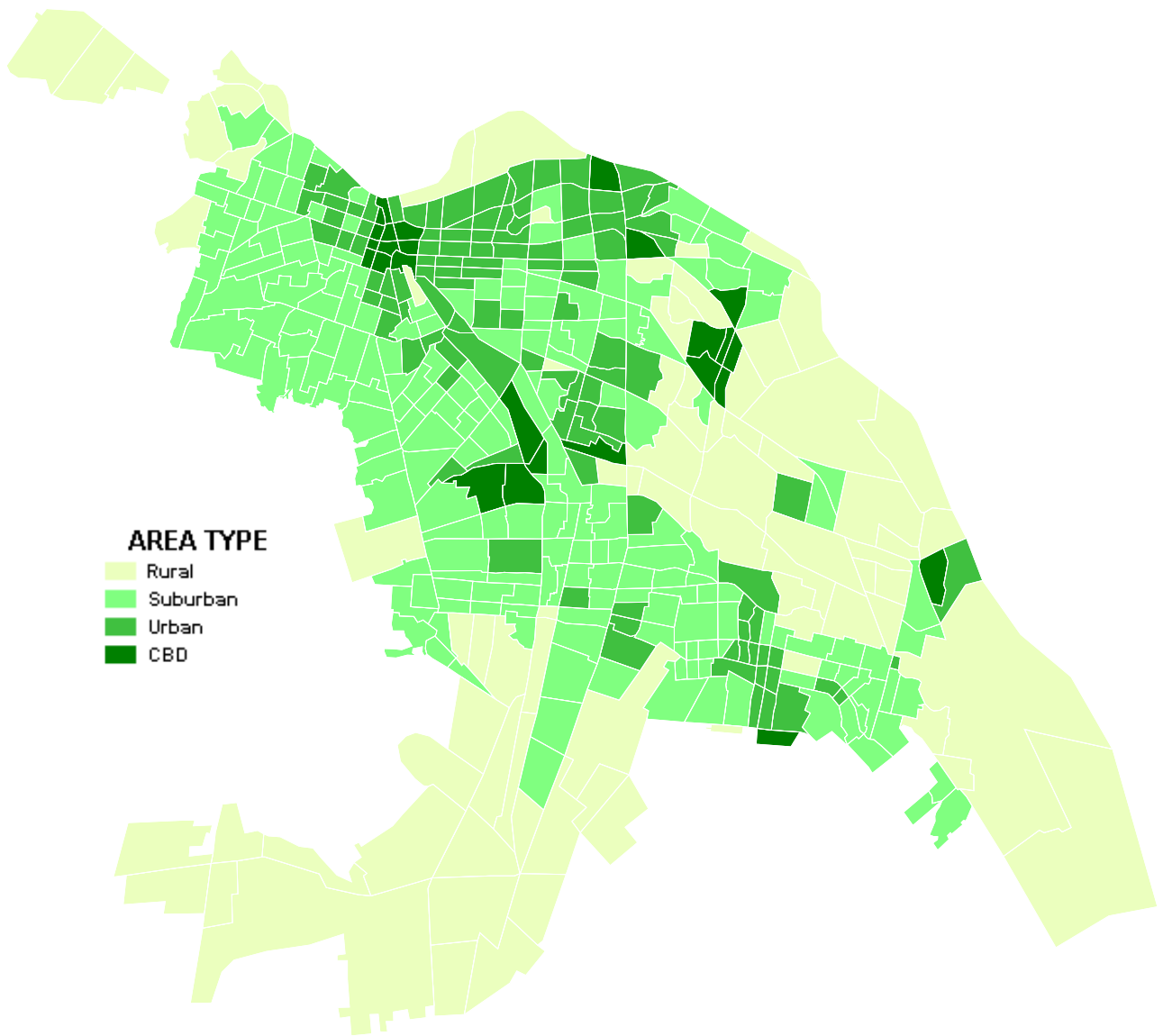


Figure 4. Area type geographic distribution under second model

Table 5. Person trip attraction per employee (second model)

Economic Activity	Trip Purpose	Area Type				Totals
		1 & 2 CBD	3 & 4 Urban	5 Suburban	6 Rural	
Basic	No. Sites	5	15	11	9	40
	HBW	2.000	1.859	1.932	1.497	1.894
	HBN	0.031	0.084	0.036	0.195	0.059
	NHB	0.062	0.505	0.109	0.627	0.210
	TT	0.002	0.000	0.012	0.087	0.015
	All purposes	2.095	2.449	2.088	2.407	2.178
Retail	No. Sites	10	24	17	4	55
	HBW	1.557	3.351	1.777	1.615	2.618
	HBN	22.417	16.275	20.086	3.423	17.057
	NHB	14.438	7.179	2.681	10.485	7.291
	TT	0.000	0.129	0.549	0.477	0.237
	All purposes	38.413	26.933	25.093	16.000	27.202
Services	No. Sites	12	80	46	18	156
	HBW	1.899	2.953	2.027	2.099	2.307
	HBN	36.758	28.701	29.457	2.881	19.743
	NHB	0.409	3.568	4.875	2.694	3.534
	TT	0.000	0.000	0.102	0.028	0.042
	All purposes	39.066	35.222	36.460	7.702	25.625
Totals	No. Sites	27	119	74	31	251
	HBW	1.984	2.458	1.950	1.860	2.044
	HBN	2.663	13.475	7.153	1.850	6.557
	NHB	0.419	2.433	1.247	2.006	1.460
	TT	0.002	0.013	0.043	0.057	0.031
	All purposes	5.068	18.379	10.394	5.773	10.093

Table 6. Coefficients of variation for weighted model person trip rates (second model)

Economic Activity	Trip Purpose	Area Type				Totals
		1 & 2 CBD	3 & 4 Urban	5 Suburban	6 Rural	
Basic	No. Sites	5	15	11	9	40
	HBW	0.000	0.723	0.122	0.292	0.461
	HBN	12.164	12.283	55.546	10.853	27.360
	NHB	17.442	5.222	4.782	1.413	8.201
	TT	7.101	NA	1.237	9.471	26.837
	All purposes	0.567	1.725	1.140	1.333	1.501
Retail	No. Sites	10	24	17	4	55
	HBW	0.466	3.004	0.261	0.549	2.581
	HBN	2.018	2.123	1.647	11.600	2.103
	NHB	1.052	2.160	1.757	1.991	1.893
	TT	NA	10.308	5.978	1.858	8.617
	All purposes	1.328	1.873	1.411	3.685	1.697
Services	No. Sites	12	80	46	18	156
	HBW	0.385	0.985	0.571	1.891	1.112
	HBN	3.090	1.263	1.415	8.852	2.387
	NHB	2.501	2.184	2.210	5.690	2.803
	TT	NA	NA	15.268	42.976	22.157
	All purposes	2.903	1.079	1.195	4.290	1.904
Totals	No. Sites	27	119	74	31	251
	HBW	0.353	2.086	0.485	1.658	1.840
	HBN	30.011	2.534	5.399	13.295	6.384
	NHB	25.893	3.972	7.232	7.186	7.098
	TT	3.325	46.247	46.235	18.167	39.005
	All purposes	16.064	2.138	3.958	5.947	4.514

Appendix A

Workplace/Special generator Survey database.
Component tables and description of fields.

INSTITUTO MUNICIPAL DE INVESTIGACION Y PLANEACION
Estudio Integral de Transporte para Ciudad Juárez
Component tables for Workplace/Special generator Survey database

TABLE NO.	TABLE NAME	FIELD NAME	DESCRIPTION	RELATION
1	Datos del Sitio de Empleo	Sit_Fecha	Date on which the survey was conducted	
		Sit_Sitio	Survey unique code	Emp_Sitio (Tbl Empleados del Sitio); Veh_Sitio (Tbl Vehículos del Empleado); Via_Sitio (Tbl Información de Viajes); Usu_Sitio (Tbl Usuario del Sitio)
	(General information of Workplace)	Sit_Activ	Economic activity	
		Sit_Sector	Sector code (based on population density)	
		Sit_Int	Intersection geocode	
		Sit_NumEmp	This field was not used (completely blank)	
		Sit_Opera	Working hours	
		Sit_AsisEmp	Employees that went to work the day of the survey	
		Sit_TotEmp	Total employment of the site	
		Sit_Turnos	Number of work shifts	
		Sit_UsuEstim	Estimated number of visitors per day	
		Sit_Sup	Roofed surface	
		Sit_Op1*	"Delayed Employee" Option	
		Sit_Op2*	"Employee Non-attendance" Option	
		Sit_Op3*	"Clients deficit access" Option	
		Sit_Op4*	"Employee accident" Option	
		Sit_Op5*	"Special trips hiring" Option	
		Sit_Op6*	"Others" Option	
		Sit_Usuarios	Visitor count per day	
		area_type	New field. Area type category according to activity density value	
		* Options for the question about how the public transportation system now in use has affected your company.		
2	Empleados del Sitio	Emp_Fecha	Trip day	
		Emp_Sitio	Survey unique code	Sit_Sit (Tbl Datos del Sitio); Veh_Sitio (Vehículos del Empleado); Via_Sitio (Información de viajes); Usu_Sitio (Usuarios del Sitio)
	(Household information of employee)	Emp_Emp	Employee Number	Veh_Emp (Tbl Vehículos del Empleado); Via_Emp (Información de viajes)
		Emp_Dir	Employee Address	
		Emp_int	Intersection geocode for employee's address	
		Emp_N	Number of people that live at employee's address	
		Emp_NumVeh	Motorized vehicles available at address	
Emp_Ingreso	Total household income			
3	Vehículos del Empleado (Employee's vehicle records)	Veh_Sitio	Survey unique code	Sit_Sitio(Tbl Datos del Sitio); Emp_Sitio (Tbl Empleados del Sitio); Via_Sitio (Tbl Información de viajes); Usu_Sitio (Tbl Usuarios del Sitio).
		Veh_Emp	Employee Number	Emp_Emp (Tbl Empleados del Sitio)
		Veh_Veh	Vehicle number	
		Veh_Año	Vehicle year	
4	Información de viajes	Via_Sitio	Survey unique code	Sit_Sitio (Tbl Datos del Sitio); Emp_Sitio (Tbl Empleados del Sitio); Veh_Sitio (Tbl Información de Viajes); Usu_Sitio (Tbl Usuarios del Sitio)
		Via_Emp	Employee Number	Emp_Emp (Tbl Empleados del Sitio)
	(Trip records)	Via_Num	Trip number	
		Via_Lugar	Place of destination	
		Via_Int	Destination intersection geocode	
		Via_proposito	Trip purpose code	
		Via_Hr_Inicio	Trip starting time	
		Via_Hr_Final	Trip ending time	
		Via_Forma	Trip mode of transportation code	
		Via_Tarifa1	Bus fare (only if this mode was used)	
		Via_Cuantos	Number of buses required for the trip	
		Via_Ocup	Number of passengers (only if the person drove)	
Via_Tarifa2	Parking fare (only if person paid for parking)			
Via_Llego	Mode by which the person got to the bus stop.			
5	Usuarios del Sitio	Usu_Fecha	Date of the survey	
		Usu_Sitio	Survey unique code	Sit_Sitio (Tbl Datos del Sitio); Emp_Sitio (Tbl Empleados del Sitio); Veh_Sitio(Tbl Vehículos del empleado); Via_Sitio (Información de Viajes)
	(Travel information of non-employee)	Usu_Num	Visitor number	
		Usu_Origen	Place from where the Visitor is coming	
		Usu_Int	Origin intersection geocode	
		Usu_hora	Arrival time to the site	
		Usu_modos	Mode of transportation person used to get to the site	
		Usu_Ocup	If the person used automovil, number of passengers in it	
		Usu_Tarif	Bus fare (if this mode was used)	
		Usu_Destino	Place where Visitor is headed after leaving this place	
Usu_Proposito	Purpose of the visit to the site			
Usu_Int2	Destination intersection geocode			

Appendix B

Development of person-trip attraction rates (initial model).
General steps and process tables.

GENERAL STEPS TO COMPUTE MODEL TRIP RATES AND ITS COEFFICIENT OF VARIATION

1. Establishing expansion factors, for each workplace "i"

Employee expansion factor:

Visitor expansion factor:

$$\epsilon_i = \frac{\# \text{ employees at work}}{\# \text{ employees surveyed}}$$

$$v_i = \frac{\# \text{ visitors counted}}{\# \text{ visitors surveyed}}$$

2. Establishing total (expanded) trips attracted and produced (by trip purpose) at each workplace "i"

from Employees:

from Visitors:

$$E_trHBW_{a_i} = (\epsilon_i)(HBW_{a_i} \text{ trips, empl survey})$$

$$V_trHBW_{a_i} = (v_i)(HBW_{a_i} \text{ trips, visit survey})$$

$$E_trHBN_{a_i} = (\epsilon_i)(HBN_{a_i} \text{ trips, empl survey})$$

$$V_trHBN_{a_i} = (v_i)(HBN_{a_i} \text{ trips, visit survey})$$

$$E_trNHB_{a_i} = (\epsilon_i)(NHB_{a_i} \text{ trips, empl survey})$$

$$V_trNHB_{a_i} = (v_i)(NHB_{a_i} \text{ trips, visit survey})$$

$$E_trNHBp_{i} = (\epsilon_i)(NHBp_{i} \text{ trips, empl survey})$$

$$V_trNHBp_{i} = (v_i)(NHBp_{i} \text{ trips, visit survey})$$

$$E_trTT_{a_i} = (\epsilon_i)(TT_{a_i} \text{ trips, empl survey})$$

$$V_trTT_{a_i} = (v_i)(TT_{a_i} \text{ trips, visit survey})$$

$$E_trTTP_{i} = (\epsilon_i)(TTP_{i} \text{ trips, empl survey})$$

$$V_trTTP_{i} = (v_i)(TTP_{i} \text{ trips, visit survey})$$

3. Establishing attraction and production rates (by trip purpose) at each workplace "i"

$$rt_HBW_{a_i} = \frac{E_trHBW_{a_i} + V_trHBW_{a_i}}{\text{Tot employment of workplace } i}$$

$$rt_HBN_{a_i} = \frac{E_trHBN_{a_i} + V_trHBN_{a_i}}{\text{Tot employment of workplace } i}$$

$$rt_NHB_{a_i} = \frac{E_trNHB_{a_i} + V_trNHB_{a_i}}{\text{Tot employment of workplace } i}$$

$$rt_NHBp_{i} = \frac{E_trNHBp_{i} + V_trNHBp_{i}}{\text{Tot employment of workplace } i}$$

$$rt_TT_{a_i} = \frac{E_trTT_{a_i} + V_trTT_{a_i}}{\text{Tot employment of workplace } i}$$

$$rt_TTP_{i} = \frac{E_trTTP_{i} + V_trTTP_{i}}{\text{Tot employment of workplace } i}$$

4. Establish trip rate average and standard deviation for each stratification cell (by trip purpose).

$$\text{Cell average (by purpose)} = \frac{\sum \{\text{trip rates (by purpose) from workplaces in stratification level}\}}{n: \text{# of workplaces in stratification level}}$$

Cell standard deviation: Conventional approach, being careful to use only the rates in the cell (by purpose), and the previously described cell average (by purpose) as \bar{y} .

5. Establish weighted average trip rate for each stratification cell (by trip purpose).

$$\text{Weighted average trip rate attr} = \frac{\text{Total cell attractions (by trip purpose)}}{\text{Total cell employment}}$$

6. Establish coefficient of variation of weighted average trip rate for each stratification cell (by trip purpose).

$$\text{Coefficient of variation} = \frac{\text{Cell standard deviation}}{\text{Weighted average trip rate attr}}$$

Table B1. Aggregate workplace survey data (initial model)

Economic Activity	Data from sample	Area Type						Totals
		1 CBD High	2 CBD Low	3 Urban High	4 Urban Low	5 Suburban	6 Rural	
	No. Sites	4	1	2	13	11	9	40
	Employees at work	1840	2	10	976	3070	706	6604

Table B2. Average cell rate from individual trip rates of workplaces in stratification level.

Economic Activity	Trip Purpose	Area Type						Totals
		1 CBD	2 CBD Fringe	3 Urban	4 Suburban	5 Suburban Fringe	6 Rural	
	No. Sites	4	1	^{B-3} 2	13	11	9	40
	HRW	2 000	2 000	2 400	2 305	1 877	1 739	2 027

Table B3. Standard deviation of cell rate from individual trip rates of workplaces in stratification level.

Economic Activity	Trip Purpose	Area Type						Totals
		1 CBD	2 CBD Fringe	3 Urban	4 Suburban	5 Suburban Fringe	6 Rural	
	No. Sites	4	1	^{B-4} 2	13	11	9	40
	HRM	0.000	N/A	0.566	1.443	0.236	0.438	0.872

Table B4. Aggregate workplace person trip attraction by trip purpose.

Economic Activity	Trip Purpose	Area Type						Totals
		1 CBD High	2 CBD Low	3 Urban High	4 Urban Low	5 Suburban	6 Rural	
	No. Sites	4	1	2	13	11	9	40
	HRW	3680	4	24	1809	5945	1057	12519

Appendix C

Development of person-trip attraction rates (second model).
Process tables.

Table C1. Aggregate workplace survey data (second model)

Economic Activity	Trip Purpose	Area Type				Totals
		1 & 2 CBD	3 & 4 Urban	5 Suburban	6 Rural	
Basic	No. Sites	5	15	11	9	40
	Employees at work	1842	986	3070	706	6604
	Total employment	1842	986	3077	706	6611
	Employees surveyed	22	70	55	45	192
	Visitors	142	519	240	333	1234
	Visitors surveyed	25	68	54	45	192
Retail	No. Sites	10	24	17	4	55
	Employees at work	43	186	84	26	339
	Total employment	47	202	86	26	361
	Employees surveyed	41	112	80	16	249
	Visitors	1247	3202	1149	320	5918
	Visitors surveyed	48	107	81	20	256
Services	No. Sites	12	80	46	18	156
	Employees at work	105	721	872	1090	2788
	Total employment	115	830	932	1094	2971
	Employees surveyed	60	385	226	87	758
	Visitors	2385	14911	17759	4166	39221
	Visitors surveyed	58	399	222	89	768
Totals	No. Sites	27	119	74	31	251
	Employees at work	1990	1893	4026	1822	9731
	Total employment	2004	2018	4095	1826	9943
	Employees surveyed	123	567	361	148	1199
	Visitors	3774	18632	19148	4819	46373
	Visitors surveyed	131	574	357	154	1216

Table C2. Average cell rate from individual trip rates of workplaces in stratification level.

Economic Activity	Trip Purpose	Area Type				Totals
		1 & 2 CBD	3 & 4 Urban	5 Suburban	6 Rural	
Basic	No. Sites	5	15	11	9	40
	HBW	2.000	2.318	1.877	1.739	2.027
	HBN	0.198	0.470	0.698	1.601	0.753
	NHB	0.758	1.309	0.525	1.238	1.008
	TT	0.008	0.000	0.004	0.409	0.094
	All purposes	2.964	4.097	3.104	4.988	3.882
Retail	No. Sites	10	24	17	4	55
	HBW	1.531	4.661	1.804	1.300	2.964
	HBN	33.592	19.984	22.316	20.450	23.213
	NHB	13.199	8.540	3.150	17.297	8.358
	TT	0.000	0.271	1.120	0.620	0.509
	All purposes	48.323	33.455	28.389	39.667	35.044
Services	No. Sites	12	80	46	18	156
	HBW	2.143	2.738	2.064	2.918	2.514
	HBN	39.889	22.725	37.895	20.750	28.291
	NHB	0.783	3.707	6.362	11.462	5.160
	TT	0.000	0.000	0.229	0.280	0.100
	All purposes	42.815	29.170	46.549	35.410	36.064
Totals	No. Sites	27	119	74	31	251
	HBW	1.890	3.073	1.976	2.367	2.535
	HBN	30.207	19.367	28.787	15.152	22.790
	NHB	5.377	4.380	4.756	9.247	5.199
	TT	0.001	0.055	0.400	0.361	0.189
	All purposes	37.475	26.874	35.919	27.127	30.712

Table C3. Standard deviation of cell rate from individual trip rates of workplaces in stratification level.

Economic Activity	Trip Purpose	Area Type				Totals
		1 & 2 CBD	3 & 4 Urban	5 Suburban	6 Rural	
Basic	No. Sites	5	15	11	9	40
	HBW	0.000	1.345	0.236	0.438	0.872
	HBN	0.371	1.036	1.984	2.115	1.601
	NHB	1.083	2.640	0.519	0.887	1.724
	TT	0.017	0.000	0.014	0.824	0.411
	All purposes	1.189	4.224	2.380	3.208	3.270
Retail	No. Sites	10	24	17	4	55
	HBW	0.726	10.066	0.463	0.887	6.755
	HBN	45.228	34.555	33.080	39.709	35.871
	NHB	15.183	15.507	4.712	20.880	13.801
	TT	0.000	1.327	3.281	0.886	2.043
	All purposes	51.009	50.453	35.395	58.966	46.168
Services	No. Sites	12	80	46	18	156
	HBW	0.731	2.908	1.158	3.969	2.565
	HBN	113.592	36.259	41.670	25.504	47.134
	NHB	1.022	7.794	10.773	15.327	9.905
	TT	0.000	0.000	1.550	1.186	0.931
	All purposes	113.396	38.017	43.580	33.044	48.796
Totals	No. Sites	27	119	74	31	251
	HBW	0.700	5.127	0.946	3.083	3.760
	HBN	79.925	34.149	38.623	24.599	41.861
	NHB	10.854	9.664	9.020	14.413	10.365
	TT	0.007	0.596	2.001	1.035	1.222
	All purposes	81.416	39.297	41.144	34.327	45.558

Table C4. Aggregate workplace person trip attraction by trip purpose.

Economic Activity	Trip Purpose	Area Type				Totals
		1 & 2 CBD	3 & 4 Urban	5 Suburban	6 Rural	
Basic	No. Sites	5	15	11	9	40
	HBW	3684	1833	5945	1057	12519
	HBN	56	83	110	138	387
	NHB	114	498	334	443	1390
	TT	4	0	35	61	101
	All purposes	3859	2415	6424	1699	14397
Retail	No. Sites	10	24	17	4	55
	HBW	73	677	153	42	945
	HBN	1054	3287	1727	89	6157
	NHB	679	1450	231	273	2632
	TT	0	26	47	12	86
	All purposes	1805	5441	2158	416	9820
Services	No. Sites	12	80	46	18	156
	HBW	218	2451	1889	2297	6855
	HBN	4227	23822	27454	3152	58655
	NHB	47	2962	4543	2947	10499
	TT	0	0	95	30	125
	All purposes	4493	29234	33981	8426	76133
Totals	No. Sites	27	119	74	31	251
	HBW	3976	4961	7986	3396	20319
	HBN	5337	27193	29292	3378	65199
	NHB	840	4910	5108	3663	14520
	TT	4	26	177	104	312
	All purposes	10157	37089	42563	10541	100350