

Case Study: Sao Carlos, Brazil

The Brazil case study was performed using the same TES for the other trials, but in addition, the updated current TES version was applied to the Brazilian study area. Modifications were also simulated for the study area using the current TES version as detailed in the following subsections.

Original TES calculation

The Brazil trial assessment was performed in an inner city area of Sao Carlos, a medium sized Brazilian city of approximately 200,000 residents. A visual inspection was performed and the study area was estimated to contain approximately 893 house units (one unit equals one bedroom house, two units equals two bedroom house etc.). Applying the Brazilian medium for the South East region of Brazil (IBGE, 2006a) of 1.9 people per bedroom (unit) gives an estimated population for the study area of 1696 residents. The study area comprises 16 blocks of mixed land uses, in a grid format of one way roads as illustrated in *Figure 1*.



Figure 1: The Sao Carlos study area – aerial and road map

There are several bus routes that serve the study area and various parks, schools, supermarkets, and workplaces at a short distance from the residents. From observation of the paths and roads within and

surrounding the study area, it was determined that walking was safe, although uncomfortable, but cycling was not safe on any of the roads due to insufficient space, busy roads and observed dangerous and intolerant driver behaviour towards pedestrians that was assumed to be similar for cyclists. It was very difficult to see any cyclists in the study area and those seen were generally pushing their bike.

The 2001 census data used for this report shows that 35% of the adult (18 to 65 years old) Sao Carlos population are unemployed and 6.4% are university students (IBGE, 2006b). Employment and various activities are found to be distributed throughout the study area. These employment locations within the study area are estimated to provide almost 2000 jobs. Following the TES method, workers travel to the closest available work sites. Because there is enough employment inside the study area, no-one is required to travel outside the study area for work.

A visual and aerial inspection of the location of residences within the study area was performed. It was assumed all residents were evenly distributed amongst the available housing in the study areas. Cars and motorcycles were distributed to houses that could not feasibly walk, cycle or use the bus for all required activities. For the study area, (345 vehicles/1000 people) there were enough vehicles to allow all residents requiring a vehicle to use this mode (IBGE, 2006b). The housing and activity locations were then incorporated into TransCAD to allow trip distances to be calculated using the available modes according to the TES method. The following energy consumption was used and assumes an average number of 50 people per bus and 2.5km per liter of diesel for Sao Carlos buses, these details were verbally provided by the director of the Sao Carlos transport department, Sandra Ichikawa, on the 10th of October 2006. A 14.5% share of motorcycles is also assumed (IBGE, 2006b) with an average consumption of 40km/liter based upon a 125cc Suzuki (MOTONLINE, 2006), which appears to be a common motorbike size.

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|----|----------------|------------------------------------|
| 1. | Walk and Cycle | 0MJ/km |
| 2. | Bus | 0.31MJ/pkm or 0.8L(Diesel)/p.100km |
| 3. | Car/Motorcycle | 2.91MJ/km |

Note: For cars the following consumption is assumed: 10Litres/100km (Petrol - 68%) 11.1Litres/100km (Alcohol - 32%) (MME, 2006), (MONTEIRO, 1998, p. 61).

Energy calculations were performed for all residents following the TES method, the results of these calculations over the combined three study areas are presented in *Table 1*.

Table 1: Energy and trip data for the study area separated into “common activities”

Age Group	No.	Main Activity (5x/week) - School/University/Work										
		Walk		Bus (0.31MJ/pkm)			Car/Motorcycle (2.91MJ/km)					
		Trip	Dist	Trips	Dist.	Energy	Diese	Trip	Dist.	Energy	Petro	Alc
0 to 5	138	74	199	12	320	12	0	52	644	974	20	12
6 to 14	275	181	245	2	320	2	0	92	678	1814	38	22
15 to 17	120	79	245	1	320	1	0	40	678	788	16	10
18 to 64 - workers	552	552	75	0		0	0	0		0	0	0
- students	108	0	0	29	105	94	2	79	150	3457	72	43
- 65 and over	348 155											
Total	1696	886	135	44.4	797	110	3	263	920	7032	146	87
		Food Shopping (2x/week)										
		Walk		Bus (0.31MJ/pkm)			Car/Motorcycle (2.91MJ/km)					
		Trip	Dist	Trips	Dist.	Energy	Diese	Trip	Dist.	Energy	Petro	Alc
0 to 17	533											
18 to 64	1008	243	328	362	730	328	8	503	662	3872	80	48
65 and over	155	37	328	41	730	37	1	77	662	593	12	7
Total	1696	280	328	403	730	365	9	580	662	4465	93	55
		Recreation (1x/week)										
		Walk		Bus (0.31MJ/pkm)			Car/Motorcycle (2.91MJ/km)					
		Trip	Dist	Trips	Dist.	Energy	Diese	Trip	Dist.	Energy	Petro	Alc
0 to 9	275	254	250	0		0	0	21	630	77	2	1
10 to 17	258	238	238	0		0	0	20	630	73	2	1
18 to 64 ^a	1008	930	238	0		0	0	37	630	136	3	2
65 and over	155	143	238	0		0	0	12	630	44	1	1
Total	1696	156	240	0		0	0	90	630	330	7	4
		Weekly Totals										
		Walk		Bus (10.1%)			Car/Motorcycle (25.3%)					
		Trip	Dist	Trips	Dist.	Energy	Diese	Trip	Dist.	Energy	Petro	Alc
Trips/Wee	1014	655	177	1028	744	474	12	256	793	11827	246	14

a “Dist.” = Average one way distance (m) to activity

b In the case of children traveling by car, parents accompany them using zero energy.

c “Energy” units = MJ/Week; “Petrol” units = Litres/week of petroleum, “Diesel” units = Litres/week of diesel, “Alc.” units = Litres/week of alcohol.

According to the TES shown in *Table 1*, 64.6% of trips can comfortably be performed by walking. The relative high walking possibility results in an overall moderate to low transport energy dependence. Of the motorised transport, which makes up 35.4% of all trips, about 28% of this share (10.1% of all trips) could be completed by bus following the mode rules in the TES. Several factors contribute to achieving this level of hypothetical TES mode share, such as bus routes connecting the study areas to recreation reserves, schools and supermarkets; however the TES mode share could be increased if there were bus stops within 200 meters of all residents and common activities.

The summarised Transport Energy Specification for the study area is presented in *Table 2*, which shows that an average of 7.25MJ/Person/Week of transport energy is required for urban and transport system functionality. This is equivalent to the energy required to power a 2kW electric heater for about one hour.

Table 2: The Sao Carlos TES summary

TES Summary Sao Carlos, Brazil					
Car		Bus (Diesel)		Total	
MJ/Trip	4.61	MJ/Trip	0.46	MJ/Week	12302
L/Trip	0.15	L/Trip	0.01	%Energy Petrol	68.3%
MJ/Person/Week	6.97	MJ/Person/Week	0.28	%Energy Diesel	3.9%
L/Person/Week	0.23	L/Person/Week	0.01	%Energy Alcohol	27.8%
Cars/1000 people	345			MJ/Trip	1.21
Area					
Total Area (hectares)	17			MJ/Person/Week	7.25
Density (ppl/hect)	101.6				

The TES specifies that moderate to low transport energy is required for the urban layout of the study area. Medium population density (101.6 people per hectare), unsafe cycle roads and the locations and number of supermarkets negatively contribute to this moderate to low energy requirement.

Updated TES calculation

The application of the current updated version of the TES method to the Sao Carlos study area produced an expected smaller energy dependence result; this was largely due to increased walking distances in the model making more activities accessible by foot. Even with the requirement for external work and shopping trips, the updated TES result was less than half of the original result. The updated TES model assumed 10% work trips must be to the city centre and no other major work centres were applied, for shopping trips 10% were assumed to the city centre and a further 5% to the Iguatemi shopping centre, which is the next closest major shopping area. The other shopping trips (85%) were assumed to all take place within the study area, as the study area contains an estimated 150 retail shops with an estimated total of more than 10,000 m² of shopping floor space (data estimated by visual walkabout of the study area). Without explicit knowledge of retail requirements, this is assumed to be sufficient for 85% of the study area population. The TES summary is provided in *Table 3*.

Table 3: TES summary for Sao Carlos – Brazil, using the updated TES method

Updated TES Summary Sao Carlos, Brazil					
Car		Bus (Diesel)		Total	
MJ/Trip	3.88	MJ/Trip	0.39	MJ/Week	5523
L/Trip	0.13	L/Trip	0.01	% Petrol	61%
MJ/Person/Week	2.81	MJ/Person/Week	0.45	% Diesel	14%
L/Person/Week	0.09	L/Person/Week	0.01	% Alcohol	25%
Cars/1000 people	420			MJ/Trip	0.44
Area					
Área (hectares)	17			MJ/Person/Week	3.26
Density (ppl/hect)	101.6				

Simulations of land use modifications

To reduce energy dependency, two scenarios were simulated for the Sao Carlos neighbourhood. The first simulation included providing provision for residents to use bicycles to access all required activities. This option would require traffic calming, constructing cycle lanes and providing bicycle storage infrastructure; nothing can be done about the topography. The TES transport energy dependency result for this option was 0.38MJ/Person/Week, more than 8 times less than the current situation. The second simulation assumed the bicycle option was not possible and instead involved the addition of a new supermarket to the centre of the study area as shown in *Figure 2*.

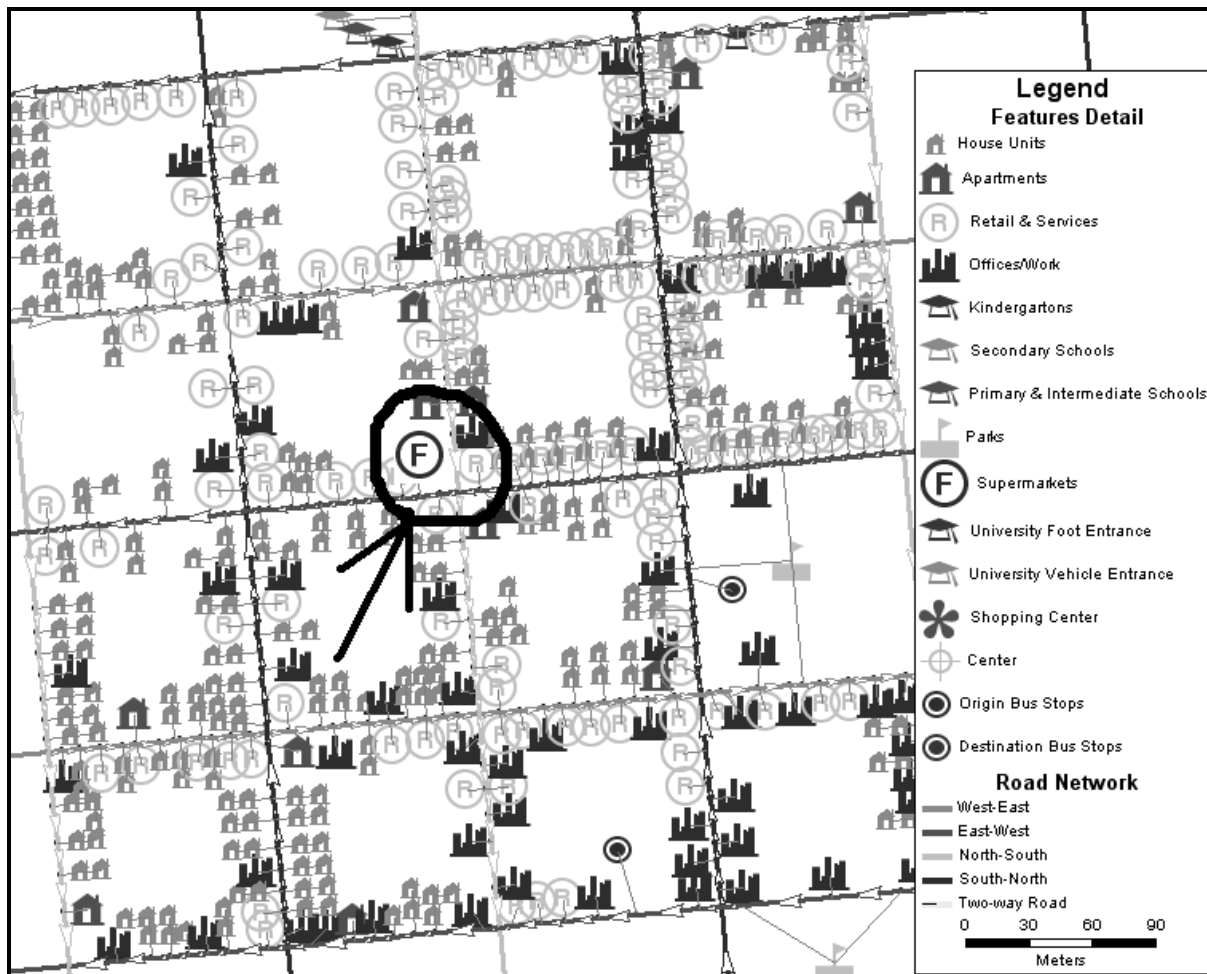


Figure 2: GIS representation of the Sao Carlos study area, including addition of a new supermarket

The TES transport energy dependency result for this option was 0.42MJ/Person/Week, similar to the bicycle option. A third simulation was performed that assumed the application of both options in tandem; the result was close to zero energy dependence - 0.01MJ/Person/Week.

In the case of the supermarket option, complete control is beyond the power of local authorities. However, the desired area could be zoned commercial and special incentives placed for supermarket operators to open a store in this location. Another option would be for the local government to construct an area and provide incentives for a farmers market to operate in this location.