TRIP GENERATION BY BRAZILIAN AND SPANISH SHOPPING CENTRES

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SUMMARY: Shopping centres originated in the USA during the 1950's and grew at a phenomenal rate over there before, admittedly at a slower pace, extending their success all over the world. By looking at the particular features of shopping malls in each country, especially in relation to the socio-economic characteristics of the population, this work sets out to make a comparative analysis of studies already made in Brazil and Spain on this modern phenomenon, using as a starting-point the experiences in the USA. The authors compile the models and parameters used in studies on shopping centres in Brazil and Spain with reference to the generation of trips made to them and modal choices, while they also provide general information on the classification and number of shopping centres found in these particular countries. In this way, it is desirable that an overall vision of the subject may be obtained and that the study may make its own contribution to the development of research on the planning of shopping centres.

1. INTRODUCTION:

The growth in the construction of shopping centres began in the Fifties in the USA and was consolidated over the following years, but in less intense fashion, all over the world. So, while in the States there are more than 44,000 shopping malls (ICSC- INTERNACIONAL COUNCIL OF SHOPPING CENTRES, 1999), in Brazil, even though the rate by which they have been installed has been rising, there are only about 160 (ABRASCE - BRAZILIAN ASSOCIATION OF SHOPPING CENTRES, 2000), and in Spain little more than 380 establishments (AECC - SPANISH ASSOCIATION OF COMMERCIAL CENTRES, 2000).

In this light, the States continue to supply the main reference point for the generation of knowledge, techniques and methods related to this type of venture, and in fact much of this experience has been exploited in other countries. Nevertheless, given the particular features of shopping centres, which are for the most part due to the socio-economic characteristics of the population, there is a recognised need to produce specific research for each country geared to the planning of malls and their effects on trends in traffic and transport.

Acknowledging this need, this work seeks to produce a comparative analysis of existing studies in Brazil and Spain on shopping centres, using as a basis those already developed in the USA. Some socio - economic characteristics of these countries are shown in a concise form in Table 1. This work seeks to take a panoramic vision of the topic and of the perspectives for future research which may help to refine investigations of this type of commercial establishment.

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As a first step, the shopping centres are characterised, and their classification and distribution are established; a general picture of how these centres fit into the three countries under examination consequently emerges (section 2). On the basis of the practical approaches available, the idea is to provide a comprehensive methodology for the planning and analysis of the impact of shopping centres on the road and transport systems (section 2). From this methodology, the stages of trip generation (sections 3 and 4) and modal choice (section 5) were selected in the hope that they could be modelled and refined. The first stage was chosen as it reflects the origin of the entire process of analysis, and the second owing to the little attention it has received in existing studies; these earlier works were developed for the most part in the United States, where trips to shopping malls depend in the main on motor cars.

Table 1
Socio-economic characteristics of the USA, Brazil and Spain
(GEIPOT,1998 and OECD,1999)

Caracteristics	USA	BRAZIL	SPAIN
Population (10^6)	268	164	39
Surface Area (10^3 km^2)	9,364	8,547	506
Populations per km^2	29	19	79
Urban Population (% of total)	77	80	77
Fleet of motor vehicles (10^3)	203,297	25,336	17,959
Rate of car ownership (number of inhabitants per vehicle)	1.3	6.5	2.2
GDP ($ 10^6)	7,834,036	820,381	532,034
GNP per capita ($)	29,080	4,790	14,490
Life expectancy (years)	76	67	78

Information has been gathered from: i) the studies of Goldner (1994) and data produced by ABRASCE (the Brazilian Association of Shopping Centres) for Brazil, ii) data collected by AECC (Spanish Association of Commercial Centres) and supplied by Spanish enterprises, in addition to the analysis of the work of consultants such as Calvet and Borrull (1995), among others, for Spain, and iii) studies emanating from the ITE (Institute of Transportation Engineers), the ICSC (International Council of Shopping Centres) and described by Peyrebrune (1996) for the USA.

2. CHARACTERISATION AND CLASSIFICATION OF SHOPPING CENTRES:

The patterns of demand from traffic normally vary in accordance with the categories of the shopping centres, which may be classified according to the size of the overall unit, the type of shops inside and the shop which acts as the focal point (the “anchor”). These aspects are considered by ITE (Institute of Transportation Engineers), according to Peyrebrune (1996), and represent the more traditional and complete classification of shopping centres in line with conceptions set out below:

Neighbourhood Shopping Centres
Cater for the sale of everyday goods (food, medicines and a variety of other staple items), and feature laundrettes, barber shops, cobblers and means of satisfying other habitual needs. The main "anchor" store is the supermarket. The typical size is 5,000 square metres, but they vary from 3,000 to 10,000 square metres (m^2).

Community Shopping Centres
Concentrate on the sale of clothes for men, women and children, equipment and appliances, but also everyday goods. The typical size is 15,000 m^2, but there is a variation between 10,000 and 40,000 m^2.

Regional Shopping Centres
Exist to sell general merchandise, furniture and items for the home, services and leisure. One or two department stores serve as "anchors". Typical size: 45,000 m^2, varying from 30,000 to 85,000 m^2.

Super Regional Shopping Centres
Similar to the regional, but distinguish themselves by offering three or more department stores as "anchors". Typical size: 80,000 m^2, varying from 60,000 to 150,000 m^2.

ABRASCE (the Brazilian Association of Shopping Centres), despite the fact that it does not specify the size of the establishment, adopts a similar classification to the American model by dividing the centres into **Neighbourhood**, **Community** and **Regional**, emphasising in all cases the role of the supermarket as the "anchor". However, it omits to consider the **Super Regional** type, probably on the grounds that establishments with dimensions of in excess of 60,000 m^2 are not frequent there. On the contrary, three new classes are included:

Specialised Shopping
Geared towards a specific mix of shops carrying out a particular group of activities, such as fashion, internal decoration, sailing, sports or motor accessories.

Outlet Centre
In the main, this category consists of stores in which manufacturers sell their own brand names at a discount, in addition to "off-price" retail outlets.

Festival Centre
Almost invariably situated in areas which attract tourists and essentially geared to leisure activities, offering restaurants, fast-food bars, cinemas and other types of entertainment.

Spanish shopping centres are classified according to their sizes into **Commercial Galleries** (with an area of less than 4,000 m^2 of Gross Leasable Area or "GLA"); **Small** (with an area of below 15,000 m^2 of GLA); **Large** (with an area varying between 15,000

m^2 and 40,000 m^2 of GLA) and **Regional** (with an area greater than 40,000 m^2 of GLA). A certain parallel may be detected with the American classification between **Large** and **Community**, which have the same GLA uppermost limit. With the inclusion of **Commercial Galleries**, noticeable too is the stress on smaller-scale establishments (those extending to less than 4,000 m^2 of GLA), which are treated as shopping centres in the other two classifications when they are bigger than 3,000 m^2 of GLA. Room is also made in the classification for those **Based on a Hypermarket**, and these malls are variable in size and feature the hypermarket as the "anchor" store. This approach, as in Brazil, reinforces the importance of this type of activity in commercial centres, and the similar considerations apply to **Zones of Commercial Activities**, whose size is also prone to variation.

The distribution of the shopping centres in the three countries concerned, reflecting the emphasis on the three categories common to the classifications available to us ((a)**Regional**, (b)**Community** and (c)**Neighbourhood**), is presented in Table 2.

Table 2
Distribution of the number (% in relation to the total) of shopping centres, according to the category of the establishment

Country	Class (*)									
	(a)	(b)	(c)	*Sub-Total 1 a+b+c*	(d)	(e)	(f)	(g)	*Sub-Total 2 d+e+f+g*	**Total**
USA (1998)	1,345 3.09%	14,270 32.73%	27,317 62.65%	*42,932* *98.47%*	668 1.53%	-	-	-	*668* *1.53%*	**43,600** **100%**
Brazil (1999)	14 8.9%	98 62.0%	36 22.8%	*148* *93.7%*	8 5.1%	2 1.2%	-	-	*10* *6.3%*	**158** **100%**
Spain (1996)	18 5.4%	58 17.4%	106 31.8%	*182* *54.6%*	-	44 13.2%	103 30.9%	4 1.2%	*151* *45.4*	**333** **100%**

(*) – (a) Regional (40,000 a 60,000 m2); (b) Community (10,000 to 40,000 m2); (c) Neighbourhood (3,000 a 10,000 m2); (d) Super Regional (> 60,000 m2); (e) Commercial Gallery (< 3,000 m2); (f) Based on a Supermarket; (g) Others.

It can be clearly seen that although as a nation Brazil is 17 times larger than Spain (in km^2), it has less than half of its quantity of shopping centres, despite the fact that the average size of its malls is greater - around 22,780 m^2 of GLA, in comparison to 15,600 m^2 in Spain. The distribution of the shopping centres confirms a higher participation by larger-scale establishments in Brazil. It can also be seen how, in relation to the three common classes (regional, community and neighbourhood), the profile of the Spanish malls corresponds more closely to the American model, although the latter does not take account of complexes with less than 3,000 m^2 of GLA (yet these represent 13.2% of the total in Spain). On the other hand, in Spain and Brazil alike the significance of the supermarkets is clear for all to see, and this is a factor which, in conjunction with their location in central areas (in other words, in relatively more densely populated areas closer to residential

nuclei) - a characteristic common to both countries - affects the composition of the demand and trips.

The growth rates of the Shopping Centres establishment range from 4 to 7% a year in Brazil and Spain, which is twice the USA's rate. In Brazil, the Shopping Centres usually present competing advantages in relation to trade centres concerning the climate, public security and parking availability aspects. In Europe, and particularly in Spain, is given a higher attention on the alternatives trade centres' preservation, specially on its historical areas. In USA is given an emphasis to infrastructure and urban facilities as Shopping Centres based on cars. On the other hand, in Brazil, which have one of the worst income distribution, the Shopping Centres demand has a higher purchasing power than the traditional trade centres.

Although in the bibliography some structures to evaluate the impact of poles which generate traffic in the transport system may be found, in this study the analysis of the treatments which have been favoured focuses on the situations in Brazil and Spain, in order to conform to the scope of this inquiry.

In Brazil, Goldner (1994) developed a methodology which lent itself to shopping centres and to the conditions of the country, including a recognition of the restrictions of databases on traffic and transport. This work highlights the external impact of the traffic produced by customers who favour the car, the bus and their own walk mode, and the structure for global analysis is based on the methodology adopted by Grando (1986) and U.S.DOT (1985). It includes a comprehensive study on modal choice, which for the very first time was the focus of specific attention and formally inserted in the process of global analysis.

In the case of Barcelona, the work of Calvet and Borrull (1995) and the studies of consultants which have been subjected to analysis demonstrate a methodology, which, while it may not be formally structured, present as basic stages the trip generation, trip distribution, the study of supply, the allocation of traffic and the scale of parking. There is also a preoccupation with access, not only for cars but also for public transport and pedestrians, as well as an interest in areas reserved for the parking of lorries and taxis and the internal circulation of vehicles and people in the shopping centre.

If a comparative analysis is made of the methodology in Goldner (1994) and the methodology derived from the studies of Calvet and Borrull / Consultants (1995), it will be observed that the former is more detailed and more systematised, despite the fact that it covers a more limited field of actuation, while the second is more ample in scope (it concerns itself with the areas destined for the safekeeping of trucks and taxis, besides the internal circulation of vehicles and people in the shopping centre), and its focus is both more general and less formalised. In both cases we may remark on the various impacts on the transport system which originate from trips by car, public transport and on foot, and that the analytical structure rests on the four traditional stages of transport planning (trip generation, trip distribution, modal split, traffic assignment).

By observing these two different methodologies, it is possible to develop a global structure which is presented in a schematic form, as in Figure 1, through an all-inclusive conception which focuses on the main aspects of interest. This structure contemplates not only the impacts on the system linked to the traffic which gains access (cars, buses and pedestrians), but also the internal needs to store vehicles (cars, lorries and taxis) and allow the free passage of vehicles and persons within the shopping centre.

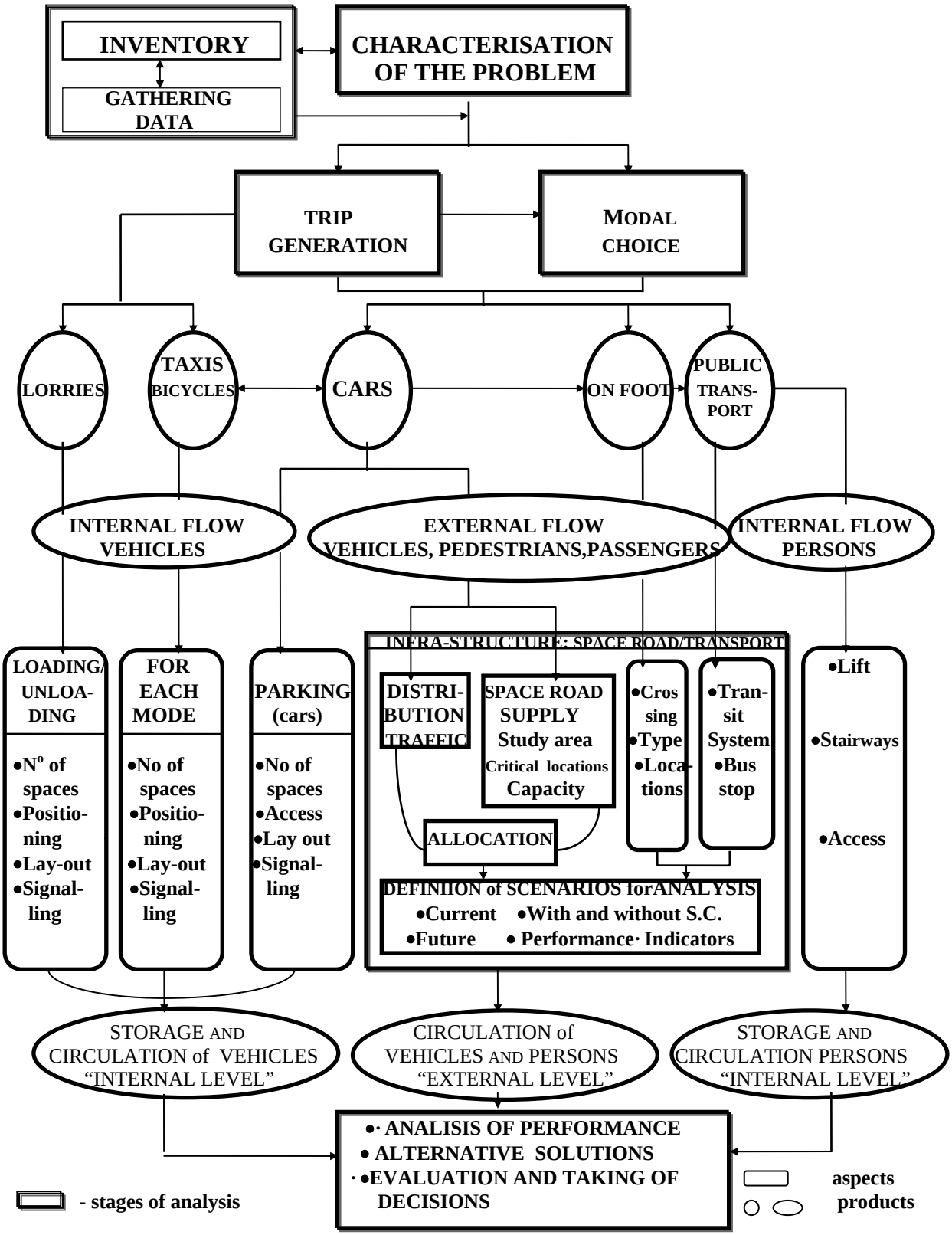

FIGURE 1 - STRUCTURE FOR GLOBAL ANALYSIS OF THE IMPACTS OF SHOPPING CENTRES ON TRAFFIC

3. MODELS OF THE TRIP GENERATION

According to the studies of ITE described by Peyrebrune (1996), the models of trip generation conceived for American shopping centres can be summarised in line with Table 3. In this work, the author developed four different models to explain the number of trips generated in the afternoon peak through four independent variables with different sample's sizes in each case.

Table 3
Models of trip generation for the afternoon peak - the American example

Independent variable	N	Equation	R2
100 m^2 of GLA	365	Ln(T)=0.632 Ln(GLA)+3.572	0.80
Volume during afternoon peak (VOL)	20	Ln(T)=0.225 Ln(VOL)+5.405	0.12
Employees (EMP)	75	Ln(T)=0,429 Ln(EMP)+4.437	0.57
Parking places (PAP)	113	Ln(T)=0,538 Ln(PAP) + 3.183	0.77
N= number of cases Ln = Napierian logarithm T= number of trips generated at peak time during the afternoon			

As can be seen, the explanatory variable of GLA or "gross leasable area" is the coefficient providing the most correlation, and according to this criterion reflects the best performance.

In the case of Brazil, too, Goldner (1994) identified this variable as the one with the highest capacity for explanation in the generation models, offering acceptable coefficients of correlation. On this basis, that author elaborated models able to relate the number of daily trips on a typical Saturday during the year (VOLSAT) to the GLA of the shopping centre, as demonstrated in Table 4.

Table 4
Models for generation of trips on a typical Saturday in the year - the Brazilian example

Dependent variable	N^o of cases	Equation	R2
Shopping Centres in central areas			
VOLSAT	15	2057.398 +0.308 GLA	0.77
Shopping Centres in central areas with a supermarket			
VOLSAT	15	1732.776 + 0.305 GLA	0.89

Calvet and Borrull (1995), when looking at the case of shopping centres in Barcelona, adopted a rate of "attractiveness" for trips which was also related to the GLA of the enterprise, and recommended a ratio of 90 customers for each 100 m^2 on a Saturday.

Both the Brazilian and Spanish models alike produce a daily circulation of trips, but in the first instance they are related to motor cars and in the second case to the different means of transport. On the other hand, the American models give the number of trips by cars during the peak times.

As a result, in the cases of Brazil and Spain alike, it becomes important to know the Percentage of Peak Hours (PPH) in order to transform the daily values into peak hourly movements. Under the Spanish procedure, as the generation covers the total of trips, it is important to take into account the distribution according to modes, which will be predominantly governed by the positional circumstances of the shopping centre (see section 6) and the experience of the team responsible for the study. It believes that such team is important on the Shopping Centre's characterisation and classification, on the choice of models and more appropriate procedures, influencing the results and the its reliability on represent the reality.

According to the approach taken by Goldner, the PPH is 8.98 % for the period falling between 18:00 and 19:00 hours on a Saturday and 9.88 % for the same period on a Friday. In the view of Calvet and Borrull, the PPH can be found between 10 and 18 %, in which 14 % is more common on weekdays and 11 % on Saturdays. Relatively higher values of PPH are a significant feature in Spanish conditions, as the parameter for maximum accumulation is taken into account, whereas in Goldner there is a focus on the flows of arrivals / departures at an establishment.

In order to permit a more refined evaluation of the differences between the models adopted in the USA, Brazil and Spain, five typical sizes for shopping centres were selected, covering different scales of ventures, to which are applied the models already described which are associated with each of the various countries. Consequently, the American model will be the reference point for the first equation presented in Table 3 and will be based on the GLA of the mall. The Brazilian model will correspond to the example indicated by Goldner for the shopping centre in central areas (see Table 3), while the Spanish model will adopt the rate proposed by Calvet and Borrull, and in both instances they are increased by the parameters recommended by the respective authors, that is to say, PPH and the modal distribution. If these models and parameters are applied to each of the various sizes of shopping centres, bearing in mind that they are located in central areas, the number of motor cars generated during peak hours is obtained, and a concise version of the results is set out in Table 5.

Table 5
Results of the models for traffic generation

Size of the shopping centre	Number of motor cars / hour		
(m^2 of GLA)	USA	Brazil	Spain
2,500	589	430	495
10,000	912	704	990
25,000	1,299	1,115	1,733
50,000	1,626	1,527	2,475
80,000	2,190	2,350	3,960

It emerges that, in the case of shopping centres on smaller scales (those up to 10,000 m^2), the results for the Brazilian model give values which are below (by around 15 to 40 %) the corresponding values for the USA and Spain. In the instance of the larger malls, the forecasts found in the Spanish model are much higher (from around 50 to 80 %) to those observed in Brazil and the USA. This may be explained by the differences in average size of establishments between these countries which served as a basis for the conception of the model. In all likelihood, the perspectives suggested for Spain offer results which are over-estimated for larger shopping centres, while the contrary probably occurs in Brazil, and in these cases there is a need for more compatible and appropriate alternative procedures.

4. A PROPOSAL FOR A MODEL FOR TRIP GENERATION FOR SPANISH SHOPPING CENTRES

To enable a better understanding of Trip Generation in Spain, data were collected from a sample of eleven Shopping Centres in that country, and of these four feature the hypermarket as the major component in the commercial area, while seven can be described as large-scale, where the hypermarket prevails as one of the "anchor" stores.

The first four were called first generation Shopping Centres and the other seven were known as second generation. The first generation malls possess an average gross area of 12,070.75 m^2, while the average retail area in the hypermarket is 9,835.50 m^2.

In the case of second generation Shopping Centres, the average gross leasable area is in the order of 32,453.57 m^2, in which the hypermarket accounts for an average of 10,976.29 m^2 in the retail area.

If one looks at the entire sample (in other words, the 11 Shopping Centres), the average gross leasable area is 25,041.64 m^2 and the average retail area of the hypermarket is 10,561.45 m^2. It will be perceived that the size of the Shopping Centres in the sample for Spain is greater than the average of the malls which are members of the AECC (Spanish Association of Commercial Centres) and comes close to the Brazilian average for members of the ABRASCE (Brazilian Association of Shopping Centres).

In order to give a better notion of the sample which has been reviewed, Table 6 shows the rates for generation of trips, in other words the number of daily journeys per $100m^2$ of the gross leasable area in the Shopping Centre and the number of trips per $100m^2$ in the area reserved for sales at the hypermarket. It is important to emphasize that the rate for trip generation at the hypermarket is an estimate derived from its number of customers, and the rate has been supplied by the entrepreneur.

Table 6
Rates of Trip Generation in the Sample Shopping Centres

Nº	m^2 of retail area at the Hypermarket	Trips / 100m^2 in retail area at the Hypermarket	Average rate	Gross Leasable Area at Shopping Centre(m^2)	Trips / 100m^2 of Shopping Centre	Average rate
1	8,547	53-70	61.5	9,724	46-82	64
2	8,540	59-71	65	10,780	46-56	51
3	10,400	58-62	60	13,289	45-49	47
4	11,855	62-77	69.5	14,490	51-63	57
5	10,800	45-50	47.5	19,243	25-30	27.5
6	11,000	55-65	60	22,310	27-31	29
7	10,500	95	95	28,462	35	35
8	12,234	68-65	66.5	29,000	22-27	24.5
9	10,000	40-55	47.5	32,130	15-20	17.5
10	14,000	55-60	57.5	33,600	25	25
11	8,300	200	200	62,430	25-31	28
Average	10,561,45		75.45	25,041,64		36.86

On table 6, the column 3 presents the hypermarket trips attraction's rates, separately, while the column 6 presents the whole Shopping Centre trips attraction's rates including the hypermarket ones. As will be realised from a glance at the data in Table 6, in the case of first generation Shopping Centres (numbered from 1 to 4), the rate of journeys to the hypermarkets is higher, and represents a considerable portion of the trips to the Shopping Centres. This result is hardly a surprise, when it is recalled that the dimensions of the hypermarket are of a significant proportion. In the instance of second generation Shopping Centres, the difference between the rates of trips to the hypermarket and to the Shopping Centre is much higher, but in both cases is typically inferior to the 90 customers per 100 m^2 advocated by Calvet and Borrull (1995). It believes that higher capacity to attract trips from the hypermarket justify the preparation of Shopping Centre's specific models with this kind of activity, beyond to encourage users with different profile, inclusively increasing the preference for foot and bus trips.

The model which is obtained, which relates the gross leasable area at the shopping centres to the number of trips attracted during the course of a typical day (and this value is gathered from the average rates for trips found in Table 6), can be expressed by Equation 1.

$$\mathbf{NTSC = 2977.08 + 0.1944\ GLA} \qquad \mathbf{(1)}$$
$$\mathbf{(2.478)\qquad (4.695)}$$

In which :
R2 = 0.71009
Tmin = 2.201 at a confidence level of 95 %.

Where:

NTSC = number of trips attracted by the shopping centre in a typical day;
GLA = Gross Leasable Area at the shopping centre.

If an analogy is made with the procedures carried out for Table 5, a forecast for the number of journeys by car per hour to Spanish malls can be made by using the proposed equation. The values given for malls of different dimensions of GLA can be observed in the final column of Table 7. It should be stressed that the equation gives the number of daily trips and that a percentage of the hourly peak of 14% was used to attain the estimate of hourly journeys.

It is noticeable that the model for trip generation proposed after comparing the values available in Table 7 yields values which are below those formulated by Calvet and Borrull (as shown in the penultimate column), and more closely resembles the results obtained for American and, especially, Brazilian malls for the majority of suggested sizes of GLA (save for those with 50,000 m^2 of GLA).

Table 7
Results for models of traffic generation, including (in bold) the model for equation (1)

Size of the shopping centre	Number of cars / hour			
(m^2 of GLA)	USA	Brazil	Spain	
2,500	589	430	495	**485**
10,000	912	704	990	**689**
25,000	1,299	1,115	1,733	**1,097**
50,000	1,626	1,527	2,475	**1,778**
80,000	2,190	2,350	3,960	**2,594**

5. STUDYING THE MODAL CHOICE

The available bibliography does not furnish examples of many studies on modal choice at American malls, bearing in mind that in that nation there is a marked preference for trips by car.

Keefer(1966) looked at 33 American malls and demonstrated that in only two was the percentage of trips by bus in excess of 5 %. Nearly twenty years later, Hsu (1984) studied 10 American shopping centres and concluded that, when all trips are included, the mean distribution by category at these centres indicated 5.8 % for journeys by bus. This finding confirms the preference for motor cars.

However, in Spain the predominance of journeys by car is not so accentuated. According to studies from the consultants, the modal distribution at peripheral centres produced a percentage of between 70 and 90 % for trips by automobile, while in central malls this figure varies from between 20 and 60%.

In Barcelona, according to Calvet and Borrull, for a shopping centre located in a densely populated zone well served by public transport, trips by motor car represent 50 % of journeys made, underground railway accounts for 20 %, buses for 15 % and journeys on

foot also make up 15 %. These authors maintain that the percentage of trips by car could reach 80% and is conditioned by the availability of public transport.

Goldner (1994) looked at the contemporary circumstances of Brazil and made an ample study of the aspects of modal choice. From a sample of 14 shopping centres, only 02 belonged to the band of 0 -25% for the motor car as the modal choice, 04 fell in the band of 25.1-50% and 05 in the range between 75.1-100%. The average was 53.1 % for the motor car and the standard deviation was 19.3 %.

If shopping centres are analysed in relation to their situations and compared in the light of percentages opting for the car, the characteristic will be noted that those malls which present a percentage below 50 % for trips by car are found within the urban area, in locations where buses are widely available and, in some cases, where they are in close proximity to terminals for public transport.

For shopping centres with percentages in excess of 50 % for trips by motor car, it was perceived how these tended to be located in less densely populated areas and even beyond the urban area.

In order to obtain a fuller vision of the influence of modal choice at Brazilian shopping centres, Goldner (1994) produced models through aggregated and dis-aggregated approaches.

5.1- Aggregated models for modal choice

- For the calculation of the proportion of shoppers who take car (PROBCAR):

$$\mathbf{InPROBCAR = -8.8611 + \underset{(5.534)}{2.2504 InAINCO} + \underset{(3.145)}{0.5504 In\ NGLA}} \qquad \mathbf{(2)}$$

Where:
Ln – napierian logarithm;
AINCO - average income of the consumer frequenting the shopping centre (U$)
NGLA - number of spaces divided by the GLA of the shopping centre (m^2).

In which:
t min = 2.776 (95% level of confidence)
adjusted R^2 = 0.8730
R^2 = 0.9153
multiple R = 0.9567

- For the calculation of the proportion of shoppers who take bus (PROBUS):

$$\mathbf{InPROBUS= 9.8274 + \underset{(2.517)}{0.4030 InEMP} - \underset{(-6.538)}{3.2929 InAINCO} - \underset{(-2.572)}{0.0520 InDIST}} \qquad \mathbf{(3)}$$

Where:
EMP - number of employees at the shopping centre
AINCO - average income of the consumer frequenting the shopping centre (U$)
DIST - distance of the shopping centre from the city centre (km).

In which:
t min = 1.886 (80% level of confidence)
adjusted R^2 = 0.9020
R^2 = 0.9608
multiple R = 0.9802

It can be seen in the two models (equations 2 and 3) that the indicators conform to expectations; the average income of the consumer at the shopping centre is the variable which can most readily be explained and which has a positive and negative influence on the probability of the use of either the car or bus, respectively. The probability of opting for the car also increases according to the ratio between the number of parking spaces / gross leasable area (GLA), and reflects the ease of parking. The probability of using the bus rises in line with the number of staff employed at the shopping centre and decreases in relation to the distance from the mall to the city centre. In relation to the adjusted R2, both equations present satisfactory results which exceed 0.87. Regarding the statistical test "t", equation 2 gives satisfactory results with a reliability level of 95 %, while the acceptance level of equation 3 is lower, at 80 %, but still within limits regarded as tolerable.

5.2 - Dis-aggregated models for modal choice

The data were collected from two shopping centres in the city of Rio de Janeiro, using questionnaires, and a total of 400 interviews. The shopping centres selected were chosen to reflect two distinct conditions regarding location, as one was positioned within the urban area (central) while the other was found in a more distant situation (peripheral).

The Multinomial Logit model was used for estimation, in accordance with the following specification:

$$U\ car = \beta 1\ TV1 + \beta 2\ C/I1 + \beta 3\ D$$
$$U\ bus = \beta 1\ TV2 + \beta 2\ C/I2$$
$$U\ on\ foot = \beta 1\ TV3 + \beta 2\ C/I3$$

Where:

U = utility for means of transport considered;
TV = travel time;
C/I = cost of trip / family income;
D = dummy variable (There are cars in the household ? Yes – 1 Not – zero).

The results for calibration in the Multinomial Logit model are shown in Table 8.

Table 8
Calibration in the Multinomial Logit model

SHOPPING CENTER				
	CENTRAL		PERIPHERAL	
Variable	**Coefficient**	**T test**	**Coefficient**	**t test**
Travel time	-0.03124	-3.9	-0.03083	-4.7
Cost / Income	-0.3301	-3.9	-0.1611	-1.9
Dummy	1.623	6.7	0.8663	3.9
ρ2	0.4734		0.2590	

As will be seen from the two models proposed, all the variables passed the statistical test "t" and attained levels of reliability over and above 95 %. In relation to the indicators, the variables of trip time and cost / income produce negative ratios, as expected. The figures for p2 improve for the model of the peripheral shopping centre. One of the causes for the differences between the two models, especially in terms of the cost / income variable, is that the peripheral shopping centre charges for parking. The result is an extra burden on the family income.

6. CONCLUSIONS

When an analysis is made of the realities surrounding Brazilian and Spanish shopping centres, the data for American malls serve as reference points, and the influence of socio-economic variables can be very clearly seen in the planning process.

The data on the number of existing shopping centres, the models used for trip generation and the modal distribution towards the motor car reflect the inherent characteristics of each country.

In terms of trip generation, it will be seen that the variable of Gross Leasable Area (GLA) is more frequently used in existing studies. As for models already available, Table 4 points to deviations from the forecasts which were mitigated by incorporating the results of the modelling for the Spanish shopping centres (see Table 6). Nevertheless, it is crucial to emphasise that this is merely a first attempt, if one considers the restricted number of shopping centres in the sample and the data gathered from the entrepreneurs, which related to average rates of trips. Consequently, there is a pressing need to enlarge the sample and collect more precise data in order to formulate models which are more representative of Spanish characteristics.

In relation to the modal choice, it will be perceived that in the USA there is a predominance of journeys by car, while in the case of Spain one notes the participation from the bus and underground trains, and, turning to Brazil, the bus has a considerable presence. More research on the modelling of this stage of the planning of shopping malls would appear to be justified. The strong influence of the factor of location is obvious (in relation to population density and the proximity of residential nuclei), as well as the availability of public transport, which conditions the use of other alternatives for mobility (such as journeys on foot and public transport) and, consequently, affects the modal distribution.

These variations in the nature of trips to the shopping centres in the different countries serve to emphasise the importance of studying shopping centres within their particular circumstances and reinforces the belief that the transport planner needs to be familiar with the particular conditions of each case and, whenever necessary, be prepared to make adaptations to existing studies.

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