Parametric behavior in the use of time (activity and travel) in the city

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Research problem

The “use of the city” is not a concept widely discussed in scientific literature. However, there are various scientific disciplines that cover the matter with different approach.

Time is a complex and multidimensional concept, which makes it very difficult to single definition. Interest in **the use of time** arises associated with the characterization of the social conditions of population, and specifically to the detection of social inequalities.

In this context, the research question is if there exist social parameters in the spatial and temporal use of the city. This research understands “social parameter” like as a social behavior which remains relatively constant in different situations. A similar research question was made in 1961, where was proposed the first hypothesis on the possibility that the travel time was relatively constant. In 1970 it was shown empirically that the average travel time behave relatively constant. After that, the hypothesis of constant travel time appears in the literature, being the maximum expression a special issue of Transport Research Part A (1981). The points at issue are still valid, because different studies have shown divergent conclusions.

The purpose of the present research is to characterize the pattern of social behavior in the use of the city (in space and time), to identify whether there is a parametric behavior, in the Metropolitan Area of Barcelona.

Methodology

The study applies a trip chain analysis (like the activity-based transportation model) over the travel survey of the metropolitan area of Barcelona (2001). This analysis has two objects; the first is to allow the validation of the travel database, in order to identify time and spatial codification mistakes. The second object is to construct the information about the time that each passenger spends in each activity (associated with the trip purpose).

With the final database different analysis are developed for different type of day (week and weekend), different social class (high, middle, and low educational class), and different activities (work, study, shop, social, personal, leisure, etc). One of this is the construction of the functional probability of travel and activity times, for different purposes (to work, to study, to shop, leisure, social, etc.).

In order to calculate the functional probability it has been necessary to proceed in the following manner:

- First we construct the time distribution of travel and activity (t) for each k activity, in all the urban system. This distribution is built using all the trips and the activity k realized in a t temporal period, and then divided by all observations for purpose k in all the urban system.
- Secondly, we calculate the inversely cumulated probability (starting by the highest value). In other words, the inversely cumulated distribution is the probability that a given traveler completes the trip, or the activity, at least in a given time.

The inverse cumulative distribution of times for each purpose is the new indicator of "functional probability" to access and to develop the activities inside the city. The functional probability was compared to identify similarity behavior.

To compare two cumulated distribution we construct a "differentiation index", based on the sum of the absolute value of the difference between the cumulated probabilities for the entire time interval, divided by 2. This index have value between 0 and 1, where 0 means that the two distribution are equal, and the 1 value 1 means that one distribution must re-organized the 100% of the value to be equal to the other distribution. Low values (under 0.2) of the differentiation index means that the two distributions are similar.

Results

The original database has 17.310.838 trips (per week), whose destinies are urban activities (the return home is not considered). The trip chain analysis identifies 2.795.566 trips with different mistakes (16%), the most of them are mistakes in the spatial (zone) codification. This problem is very important, because loses all the trip chain for the analysis.

The average number of trips in the Metropolitan Area of Barcelona per weekday is 2.335.170, and per weekend day is 1.192.042.

The structure of purpose of the use of the city is given by the structure of trip purposes. Thus, on a weekday, the highest proportion is working 38%, followed by studying with 25%, and then shopping and social purposes with 11% and 10% respectively. The weekend will change the purpose structure, being leisure and entertainment the highest proportion with 27%, then shopping with 20%, followed by working and social reasons both with 16%.

The Functional Probability

The functional probability, as a "willingness to spend time on travel and on the activity", was calculated by social class, and by different activities. Table 1 and 2 shows the functional probability by social class and by activities respectively.

Table 1: Functional probability of time (activity and travel) by social class.

	Development activity			Travel to the activity		
Time (min)	Low	Middle	High	Low	Midle	High
0 - 5	100,0	100,0	100,0	100,0	100,0	100,0
5 - 10	95,6	95,8	96,1	95,2	97,0	97,0
10 - 15	95,1	95,1	95,5	92,5	95,5	95,4
15 - 20	94,2	94,4	94,7	70,2	80,4	83,9
20 - 25	92,4	92,9	92,9	35,8	49,7	53,7
25 - 30	92,1	92,6	92,7	35,1	48,8	52,1
30 - 35	91,8	92,3	92,3	32,7	45,6	48,2
35 - 40	89,8	90,5	90,6	12,7	19,0	22,5
40 - 45	89,5	90,3	90,4	12,4	18,5	22,0
45 - 50	88,8	89,9	89,9	10,4	15,4	18,6
50 - 55	85,6	87,7	87,8	6,6	9,1	10,9
55 - 60	85,3	87,5	87,7	6,5	9,0	10,7
60 - 65	84,8	87,2	87,1	6,3	8,7	10,3
65 - 70	81,8	85,2	84,8	2,2	2,8	3,7
70 - 75	81,6	85,0	84,6	2,2	2,7	3,5
75 - 80	80,9	84,5	84,0	2,0	2,3	3,3
80 - 85	78,2	82,8	82,2	1,4	1,5	2,5
85 - 90	78,1	82,6	82,2	1,4	1,5	2,5
90 - 95	77,7	82,4	81,8	1,4	1,5	2,4
95 - 100	73,8	80,2	79,0	0,8	0,9	1,2
100 - 105	73,7	80,0	78,8	0,8	0,9	1,2
105 - 110	72,2	79,0	77,7	0,7	0,9	1,0
110 - 115	68,4	76,6	75,3	0,6	0,6	0,9
115 - 120	68,2	76,4	75,2	0,6	0,6	0,9

Table 1 show, for example, the probability that an activity takes an hour is 85.3% for a person of lower class, 87.5% for the middle class, and 87.7% for the upper class. Moreover, for a trip of an hour, the lower class has a probability of 6.5%, the middle class of 9% and 10.7% upper class. In general, it is noted that travel times are more constrained than the development times of activities. Moreover both times (in activities such as travel times to the activities), have no significant differences between social classes (differentiation index is 0.14 for activity time, and 0.13 for travel time).

Table 2: Functional probability of time (activity and travel) for different activities (uses of the city).

	Development activity					Travel to the activity				
Time (min)	Work	Study	Shop	Social	Leisure	Work	Study	Shop	Social	Leisure
0 - 5	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
5 - 10	99,6	99,6	98,0	72,6	98,4	96,4	95,0	94,4	95,7	94,7
10 - 15	99,5	99,6	96,6	69,7	98,3	94,6	91,9	91,1	93,2	92,2
15 - 20	99,4	99,5	95,5	65,2	98,0	79,1	69,0	62,4	70,0	74,7
20 - 25	99,1	99,5	89,8	59,6	97,4	48,4	32,1	28,7	36,3	38,7
25 - 30	99,0	99,5	88,6	59,3	97,3	47,5	31,3	27,9	35,3	37,9
30 - 35	99,0	99,5	87,3	58,8	97,0	44,5	29,0	25,8	32,3	35,3
35 - 40	98,6	99,4	80,3	55,8	94,2	17,8	13,0	8,3	11,7	13,7
40 - 45	98,6	99,4	79,0	55,6	94,0	17,3	12,5	8,1	11,4	13,4
45 - 50	98,4	99,3	76,4	55,2	93,1	14,2	10,7	7,1	9,7	11,6
50 - 55	98,1	98,7	63,5	52,8	89,0	8,3	6,9	4,6	5,2	5,9
55 - 60	98,1	98,7	62,4	52,7	88,6	8,2	6,8	4,6	5,1	5,8
60 - 65	98,0	98,5	60,5	52,2	87,1	7,9	6,5	4,4	4,9	5,7
65 - 70	97,6	97,4	54,7	49,4	81,1	2,1	2,4	1,8	1,8	1,8
70 - 75	97,5	97,3	53,9	49,2	80,7	2,0	2,3	1,7	1,8	1,8
75 - 80	97,4	97,2	51,5	48,5	79,7	1,8	2,1	1,5	1,6	1,6
80 - 85	96,9	96,7	43,0	46,1	74,2	1,2	1,4	1,3	1,0	1,1
85 - 90	96,9	96,7	42,4	46,0	73,7	1,2	1,4	1,3	1,0	1,1
90 - 95	96,9	96,5	41,4	45,5	73,0	1,1	1,3	1,3	0,9	1,1
95 - 100	96,2	93,1	34,6	42,0	66,1	0,5	0,8	0,8	0,4	0,8
100 - 105	96,2	93,0	34,2	41,9	65,6	0,5	0,8	0,8	0,4	0,8
105 - 110	96,0	92,5	31,1	39,8	62,3	0,4	0,8	0,8	0,4	0,7
110 - 115	95,3	90,0	21,9	36,0	54,3	0,3	0,7	0,7	0,3	0,6
115 - 120	95,2	89,8	21,5	35,8	53,7	0,3	0,7	0,7	0,3	0,6

In this case (table 2), the probability that the activity takes an hour, is 98.1% if it is working, 98.7% if is study, 62.4% if is shopping, 52.7% if is social, and 88.6% if is leisure. Moreover, a one-hour trip has a probability of 8.2% if it is to work, 6.8% if it is to study, 4.6% if it is to buy, 5.1% if it is social, and 5.8% if it is to leisure activities. Again the values show the high constriction of travel times in relation to development times of activities. In this case there are clear differences by activities, being more restricted the times in the shopping and social activities, and larger in the activities of work, study, and leisure. The average differentiation index is 0.50 in activity time and 0.16 in travel time.

Interesting is the similarity in behavior of the activity time of work and leisure, in the sense that the first is a totally conditioned activity, while the second is a totally free from restrictions.

Conclusion

To summarize, the city of Barcelona (2001) presents an oscillating pattern of use. The pattern of trip chains is like a star, always returning home to go out for another activity.

The first conclusion of this work is that there exist social behavior which remains relatively constant (social parameter) in the use of the city in space and time. But also there exists social dissimilarity in the behavior. The social parametrical behavior (no social differentiation) refers to the functional probability of time to access and to develop activities.

The social dissimilarities are generated by the different activities occurring in the city. The activities (use of the city) have different behaviors in terms of functional probability of access and development of the activity. All social classes meet in the same way to these differences in behavior.

Finally it is necessary to rise that the work activity, by its particularities pattern of behavior, must be understood not as a normal activity in the city, but as a factor that is the human interface necessary for the function of the city. If this interface does not exist, the city could not perform its functions (processing, trade, knowledge, etc).

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