Travel behavior in Cluj-Napoca suburban area

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Abstract: This paper presents a study about the travel behavior in western suburban area of Cluj-Napoca, Romania. Traffic data and data from an online travel survey were used to create information from which several findings were highlighted. Furthermore, several push and pull measures were suggested in order to reduce car dependency and thus to improve urban mobility in the area. Therefore, the collection of data regarding travel behavior was addressed in order to conduct comprehensive analysis and to establish an appropriate direction to urban mobility development.

Key-Words: sustainable mobility, travel behavior, WIM system, online travel survey, Cluj-Napoca urban area

1 Introduction

Today, worldwide urban areas are home to the majority of people (1). Due to the increase of population, the urban areas are facing difficulties in ensuring satisfying mobility and accessibility to everyday activities in order to maintain the quality of life at proper standards (2). In this sense, both the local administration and the population share the responsibility for the level of impact that transportation causes on the environment. On one hand, the local administration is mainly responsible for the transport supply and transport services while the population is responsible for its choices, meaning its travel behavior.

The trend in transport research and policy has shifted from the urban core, namely the city, to the larger area that it influences. The studies are undertaken at different spatial levels according to the size of the city's impact area, usually considered as rings and measured in the radius of isochrones. Therefore, taking into account the expansive development trend of the areas in the vicinity of the urban core – suburban, metropolitan – the traffic volumes accounted here have become very important in the process of shaping urban transport sustainability (3). In this respect, a broad scientific literature supports the goal and highlights the means to reduce the private car usage by increasing the use of alternative modes of transport.

Furthermore, both the local and the regional scale characteristics of the urban environment are subject to provide more sustainable travel choices (4).

The paper is organized as follows. Section 2 is clearly stating the objectives of the study. This is followed by a brief presentation of the Romanian urban areas' characteristics. Section 4 presents the study area, the methodology and raw data used for the study and the analysis. Section 5 summarizes the main findings and discusses the possibilities to achieve the main goal of attaining sustainable mobility by decreasing the car usage. Section 5 highlights the main conclusions and presents some recommendations.

2 Objectives and scope

This study aims to explore the travel behavior in western suburban area of Cluj-Napoca, Romania, in order to identify possibilities to reduce car usage

and thus to improve urban mobility as a means of attaining urban sustainability. The present study does not aim to consider the exhaustive analysis of travel behavior characteristics (5) but the main aspects related to modal share, car usage aspects and public transport acceptability.

3 Romanian urban areas

During the last decade, Romanian urban areas have known a real economic growth (6), which made them attractive to an increasing number of people (7). Thus, following the worldwide trends, Romanian urban areas are also facing an expansion which causes an increasing transportation activity (8), especially of the road traffic in close proximity of the cities (9). Under those circumstances they struggle to attain a more sustainable development.

On the other hand, urban areas are dealing with administrative changes. The establishment of the metropolitan areas proved to be very beneficial although some time was needed in order to get the local administrations to undertake jointly actions. Metropolitan areas are associations of urban and rural localities. In Romania, each commune, town or city is considered a separate territorial and administration unit (in Romanian: unitate administrativ-teritoriala, U.A.T.). Those units have different ranks which are attributed according to the law (10) from 0 for the capital to 5, the lowest, for the villages. In Romania, the metropolitan areas are concentrated around a major city (Bucharest –rank 0 or a county capital – rank I) and they include a series of towns (rank III) and communes (rank IV) with their villages (rank V).

Data regarding transport and urban mobility is usually available in European and national statistics but for the entire country and for general purposes only. Detailed data at the city level are usually scarce or unavailable and when it is at disposal, often there is no standardization so it is not possible to compare different urban areas. All the barriers that impose limitations to achieve the travel behavior data are present in the case of Romanian urban centers too (11).

4 Travel behavior in Cluj-Napoca urban area

Analyzing travel behavior in the urban area of Cluj-Napoca is a very important issue, especially since the available information is scarce, too general discussing the metropolitan area (12), or too focused on the city itself (13) or on specific points in the suburban area (14). The research problem of travel behavior analysis imposes a complex data collection. In this respect, different data sets have been colected.

4.1 Study area

The study is focused on the urban area of Cluj-Napoca, situated in the North-West Region of Romania and in the historic region of Transylvania. The study area comprises the city of Cluj-Napoca, and the commune of Floresti, its greatest neighbor (Fig. 1). The two municipalities are part of Cluj-Napoca metropolitan area. The metropolitan area covers 1.510 square km representing 23% of the Cluj county area (15) and hosts more than 411,300 inhabitants (16). The study area is 240.5 sq km large and has 346,765 inhabitants. While the last population census conducted in Romania (17) shows that at the national level the population is decreasing, Cluj-Napoca and Floresti registered different population growth rates which placed them respectively as the second city and the first commune in the national hierarchy.

The connection between Cluj-Napoca and Floresti is very strong and their relationship is further discussed.

During the last decade, the population of Cluj-Napoca increased with 6,623 inhabitants whereas the population of Floresti increased 2.97 times, so it almost tripled. The satellite commune became very attractive, mainly on the basis of reduced housing prices compared to the urban core. On the other hand, differently from housing, the location of main activities and jobs remains more stable in the metropolitan area. According to this phenomenon Floresti developed as a “bedroom” for a majority of population that works and studies in the city of Cluj-Napoca. Furthermore, due to the profile of jobs available in Floresti, the increased specialization of labor division doesn’t favor the residents to find appropriate local jobs in the commune. Anyhow, it has been shown that when new jobs are created, it is not for the benefit of the residents but for the specialists from a larger area (18). Today, the basic function of Floresti is to ensure the housing for a vast majority of people that has the basic activity in Cluj-Napoca. This causes increased commuting trips between the two municipalities and the urban sprawl. Under those circumstances, the connection between the two municipalities is very important.

As it is shown in Table 1, the transportation supply is limited, leaving the only possibility for the commuters to use the road network and the public

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transport services sharing the road with other traffic components.

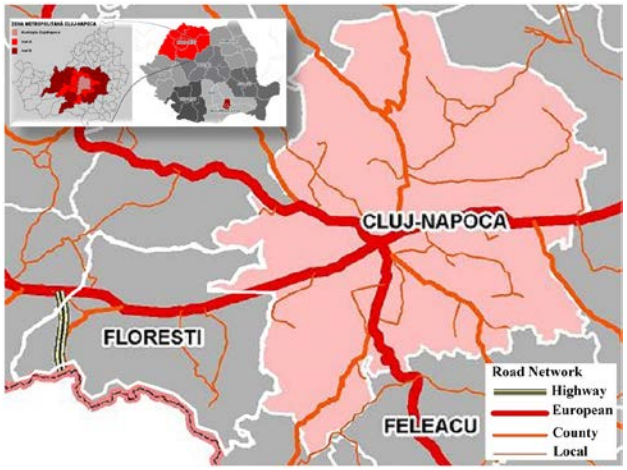

Fig.1. Study area

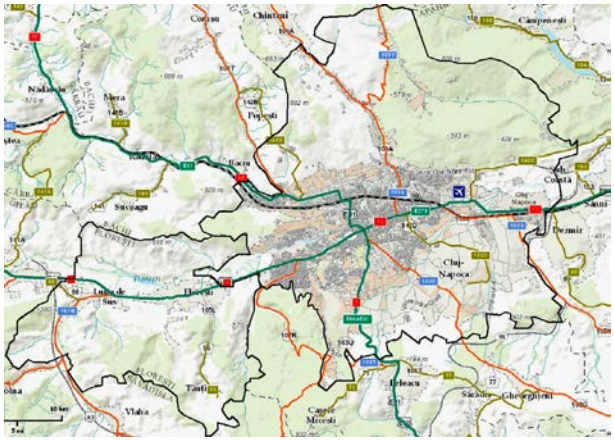

Fig.2. Transportation supply in the study area (19)

Table 1. Study area's basic information

U.A.T.	Cluj-Napoca	Floresti
Components (Rank)	*Cluj-Napoca* city (I)	*Floresti* village, commune residence (IV), *Tauti*, *Luna de Sus*, villages (V)
Characteristic Role	Urban center	Satellite commune
Area (km^2)	179.5	61
Population (inh.)		
2011	324576	22189
2002	317953	7470
Growth (inh.)	6623	14719
Density(inh./km^2)	1808	364
Transport supply (Fig.2)		
	Road	Road
	Airport	-
	Railway	-

There is actually only one connection, a link that is included in the European Road Network (E60, red line in Fig.1, green line in Fig.2) as well as in the National Road Network (DN1). Therefore, the study are has followed a linear urban development model with high rates of commuting traffic.

There is also a matter of debate regarding the connection of Cluj-Napoca to the A3 Highway which runs in the opposite extremity of Floresti (A3, yellow and black line in Fig.1, gray line in Fig.2). This connection also brings more traffic on the road between the two municipalities.

The above mentioned issues regarding economic and demographic aspects, land use, urban form, and transport supply characteristics were described in order to highlight the strong connection between Cluj-Napoca and Floresti.

4.2 Methodology and data analysis

Travel behavior data in the study area is scarce so, in order to conduct any analysis in this respect, the data must be collected.

This paper proposes a two stage methodology. First, the data collection is conducted in order to assess travel behavior characteristics. On one hand, traffic data is collected by means of a weigh-in-motion (WIM) system (20) (21) and analyzed in order to determine traffic characteristics. On the other hand, the travel behavior data is collected from a recent travel survey focused on Floresti.

In the second stage, the results are used to establish correlations between the data sets in order to achieve some information/knowledge about the appropriate solutions to improve the urban mobility in the study area. Thus, the research problem, the characterization of the travel behavior in the urban area of Cluj-Napoca is addressed.

This study is focused on extracting meaningful information about travel behavior by compiling data, and it is not aiming to develop a new theoretical approach on the subject.

4.2.1 Traffic data analysis

The research is aiming to measure some physical aspects of travel behavior. Traffic data does not quantify any characteristic of the travel behavior but it is relevant in this analysis in respect of traffic flows (11).

Traffic data was collected over a period of 2 years, starting April 2013 until June 2015, with the aid of a WIM station placed on the road connection between Cluj-Napoca and Floresti (22). Long duration continuous traffic data in a specific

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location of a road has a broad area of utility but in this study they are employed as a very expressive visual tool that illustrates the changes in traffic over time.

The annual average daily traffic obtained by processing the data is illustrated in Fig.3 and it presents a smooth increase of vehicles' volumes. Regarding the variation of passenger cars' volume, it has evidently increased over the studied period.

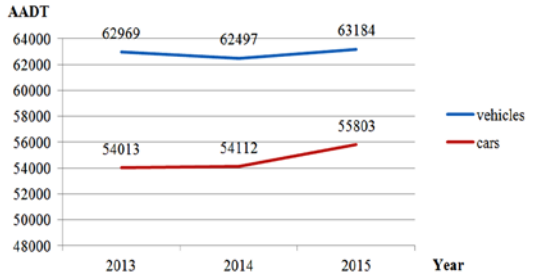

Fig.3. Annual average daily traffic in the study area

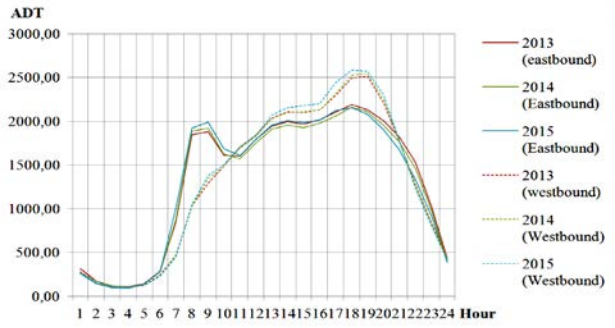

Fig.4. Average daily traffic in the study area

The average daily traffic is presented in Fig.4. This clearly shows that the carriageway is intensely used by commuters. The free-flowing speed is around 72 km/h (45 mi/h). Results have shown that road capacity has not been exceeded, considering an ideal value of 1,900 pc/h/ln (23).

The highest traffic volumes (80% of capacity) are encountered during working days afternoon hours (17:00-19:00). This happens on the lanes heading West that is outside the Cluj-Napoca inner city. Traffic heading in the opposite direction is at its peak in the morning (70% of capacity). Yet, commuters spend hours on their daily travel although they are commuting on short distances either by car or bus.

However, it is to be mentioned that the existing traffic flow equilibrium is rather fragile, despite the increased free-flowing speed. Any predicted or unpredicted bottleneck-type event would cause major flow disturbances upstream. This is in spite of the fact that commuters are well aware of the location layout and are familiar with the studied carriageway section. Moreover, considering the recent developments and evolution, it is estimated that traffic volume will increase in the studied area, thus approaching or even surpassing capacity.

4.2.2 Travel survey data analysis

Travel behavior in the study area is collected from an online travel survey conducted in 2013 (24) over 60 days.

The required survey sample size for a 95% confidence level and ±5% confidence interval consists of 390 respondents. However, in total, 465 people completed the survey of which 92% where residents of Floresti with different periods of residency (Table 2). The sample representativeness was verified and the great percentage of young population that got involved in the study is accordingly to the age groups in the study area and also similar to the young population in the European urban areas (25).

The focus group was Floresti – Cluj-Napoca commuters. The majority of respondents (92%) declared that they conducted their main activity in Cluj-Napoca while 6% in Floresti and 2% in other places. A wide range of aspects regarding the mobility were investigated but only the travel behavior related aspects are presented here.

Table 2. Basic information on the sample

Residency (years)	1-2	3-4	5-6	7+
in Floresti	32%	50%	11%	7%
Age groups	<18	18-26	26-40	40-60
	1%	11%	75%	13%
Persons in household	1	2	3	4+
	10%	39%	32%	19%
Cars in household	0	1	2	>2
	12%	68%	19%	1%
Car occupancy (pers.)		1	2	>2
		28%	44%	28%
Commuting time (min./trip)	<10	10-20	20-30	>30
	3%	12%	28%	57%

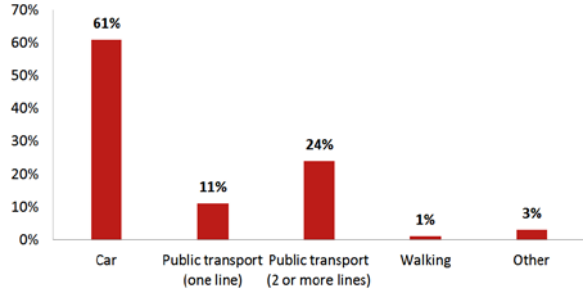

Fig.5. Modal share in the study area

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The preferred transport mode is the car as 61% of participants declared that they travel by car (Fig. 5). Public transport is used by 29% of respondents every day during the weekdays while 48% of them never use it.

The participants were asked to rate on a scale from 1 to 5 the degree of satisfaction regarding public transport services and the results are presented in Table 3. The degree of satisfaction on public transport is considered by the rates of three major elements: quality, safety and comfort, and accessibility. The rate is calculated as the average mean of the values assigned by participants on the components of the three chapters. It can be observed that all major elements are considered acceptable with rates between 2 and 3 points.

Table 3. Degree of satisfaction on public transport 1 – unsatisfied; 5 – very satisfied

Indicator	Rate
Quality	**2.3**
Public transport network overall	1.8
Travel speed	2.7
Driveway's condition	2.9
Stops' condition	1.9
Safety and comfort	**2.2**
Safety and comfort of the service	2.5
Users' information system	2.3
Purchasing passes and tickets	1.8
Service accessibility	**2.3**
Stops' accessibility	2.5
Waiting times at stop	2.1

Convenience and comfort are the two psychological factors considered to affect mode choice while journey time is the most important instrumental factor in the same respect (26). Thus, in order to determine the willingness of the population to substitute cars with public transportation in their commuting journeys, some specific questions were introduced in the online travel survey. As a result, it was found out that in a hypothetical situation when the quality of public transport services would be improved the population is willing to substitute public transport for car journeys at different levels (Table 4). At the same time, the participants stated the travel time that they consider acceptable for walking to the public transport stop. The majority (59%) would walk 5 minutes to bus stop whereas 38% of the participants would agree to walk for 10 minutes in this respect.

5 Results and findings

The study presents the characteristics of a corridor development in the study area which causes high rates of commuting. Annual average daily traffic and average daily traffic were established on the basis of WIM data collection on the road connection between the localities in study. Traffic congestion is connected to the peak hour volumes. Results have shown that travel behavior in the studied area has a major influence on flow conditions and level of service.

Road capacity is approached during the morning and afternoon peak hours. Currently, under normal traffic flow conditions, there is no generalized congestion or prolonged traffic jams. However, it is estimated that traffic volume will increase and, consequently, affect flow quality. The extent to which traffic congestion affects urban mobility shall be discussed in a further study.

Furthermore, the online travel survey conducted in the area was used to explore the modal preferences of a young population that became recently resident in the suburban area (82% for up to four years until 2013). This population continues to work in the urban core so creating a significant volume of commuting traffic. They are the promoters of unsustainable urban mobility as they are travelling by car in a great share of 61%. The car occupancy is reduced. While 90% of the households are home to more than one person only 72% of respondents travel in somebody's company. Moreover, in 20% of the households there are at least two cars which are generally used since 48% of participants never use public transport for commuting.

However, participants presented a strong will to shift from car use to public transport under the circumstances of having improved public transport services for local travel (47%). There is a partially declared willingness by a large share of participants (62%) to choose public transport services instead of personal car for commuting outside Floresti in case that the public transport services would be improved. A small share of respondents does not consider any modal shift under the circumstances of improved public transport.

Table 4. Willingness to shift from car use to public transport if the public services would be improved

Use improved public transport services to…	Neutral	Partial	Total
travel outside Floresti	10%	62%	28%
travel within Floresti	11%	42%	47%

Moreover, when questioned if they would agree to a dedicated public transport lane, the participants

rated this possibility from 1 to 5 as illustrated in Table 5.

Table 5. Degree of acceptance of a public transport dedicated lane (1 – strongly disagree to 5 – strongly agree)

Rate	1	2	3	4	5
Participants (%)	9%	4%	14%	10%	63%

6 Conclusion and recommendation

The study of the western suburban area of Cluj-Napoca permits to identify some specific characteristics. The link between the suburban area and the urban core has been highlighted in order to define the role of Floresti as a "dormitory" of Cluj-Napoca. The land use development registered in the last decade was to a large extent of massive housing. The major growth of inhabitants which continue to work in the urban core is thus increasing the commuting on the road which is the only transportation connection in the area. Therefore, the car use which is preferred by the inhabitants in the area is increasing and enhancing the congestion on the link.

Changing individual travel behavior is not an easy task especially in car dependent areas (27).

With the aid of both the long-term real-time traffic and the online travel survey data basis important findings were reported. Information was used to establish several measures with immediate impact in reducing car usage and thus in improving the urban mobility. In perspective, the data and findings are very useful for further research.

Collecting data is very important for transport analysis. As newer and cheaper opportunities to collect travel behavior data are at hand (WIM system, online travel survey) they were explored in order to make an effective contribution to adding up some information to the research and practice in the case of travel behavior in Cluj-Napoca urban area.

In suburban areas such as the study area in this paper, the autonomy and mobility that cars provide to the commuters could be substitute to some extent with improved public transport services and thus provide the opportunity to change the travel behavior. In this sense, it is important to build more space for public transport. Alternative roads in the northern and southern part of Floresti with dedicated public transport lines are needed in order to increase the connectivity with Cluj-Napoca. In turn, this opportunity will attract more car traffic but through a sound design the public transport would be favored on the two new road connections. The travel behavior change also targets the personal inclinations towards the preferred transport mode. The current lifestyles in the study area are not a feasible subject for change but the available modes of transport are. In this sense, the focus is not on providing additional transportation system but on improving and promoting the existing services: redesigning the routes and the stops location, and increasing the headway accordingly to the users' budget at disposal. The responses to the travel survey highlighted the commuters' willingness to shift from car use to public transport in case of services' improvements. This leads to some pull policy possibilities to reduce car dependency: (1) improve the reliability, the speed, and the capacity of public transport services, and (2) provide legal frame and incentives for carpooling and vanpooling. Moreover, stronger effects could be achieved if those measures would be applied along with a well-known push policy of charging car parking.

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