

A STUDY ON INTERMODAL PASSENGER TRANSPORT AT REGIONAL LEVEL.

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Abstract: In the last *White Paper*, The European Commission identified the necessity of inter modality for passengers as a solution for improvements travelling conditions and to facilitate modal transfers and finally a more sustainable transport in Europe. This paper aims to analyze the public transport of passengers in Olt County and study the intermodal passengers transport in this region. Based on this study, can be found solutions to increase the attractiveness of rail transport, against the road transport, which is less environmentally friendly, with lower transport capacity and less energy efficient.

1. INTRODUCTION

Intermodal transport may be defined as the transportation of a person or a load from its origin to its destination by a sequence of at least two transportation modes, the transfer from one mode to the next being performed at an intermodal terminal. The concept is very general and thus, it means many things to many people: transportation of containerized cargo by a combination of truck, rail, and ocean shipping, dedicated rail services to move massive quantities of containers and trailers over long distances, main transportation mode for the international movement of goods, central piece in defining transportation policy for the European Community, trips undertaken by a combination of private (e.g., car) and public (e.g., light rail) transport, and so on. Both passenger and freight transportation can be examined from an intermodal perspective; in this paper we study the intermodal transport potential for people in Olt County.

2. THE INTERMODAL PASSENGER TRANSPORT

Generally, the external effects caused by motorized vehicles, which include air pollution, greenhouse effect, noise, energy consumption, safety and congestion, are increasingly more serious than the negative effects produced by public transport, but the development of public transport has to need heavier financial support.

Although, the concept of intermodal transport isn't recent, it still bears the problems of articulation about the integration of various transports and the consistency between the public transport supply and the motorized vehicle demand. To promote these intermodal trips, the intermodal system must be organized so that passengers regard it as a valid alternative, or estimate the advantage offered in relation to the trip with one mode of transport.

3. THE SUPPLY OF PUBLIC TRANSPORT IN OLT COUNTY

Olt County is located in Southern Romania, on the lower river with the same name and is a classified county bordering the Danube River. It has access to the Black Sea via the Danube ship port Corabia. The total area is 5498 km², representing approximately 2.3% of the country. Regarding the population, Olt County ranked 18 with 489274 inhabitants (in 2002), with an average density of 89 inhabitants per square kilometer.

Public transport modes that ensure the movement of passengers across the Olt county area are the road mode and the rail mode.

Existing rail network includes the following branches in Olt County (figure 1):

- *the main line 900, traverses the county on east-west direction, parallel with DN6 - double line, electrified;*
- *the line 901, cross the county from northeast to west along the National Road 65 - a simple line, non-electric;*
- *the line 201, extended by line 910 on north-south rail axis County - simple lines, without electricity.*

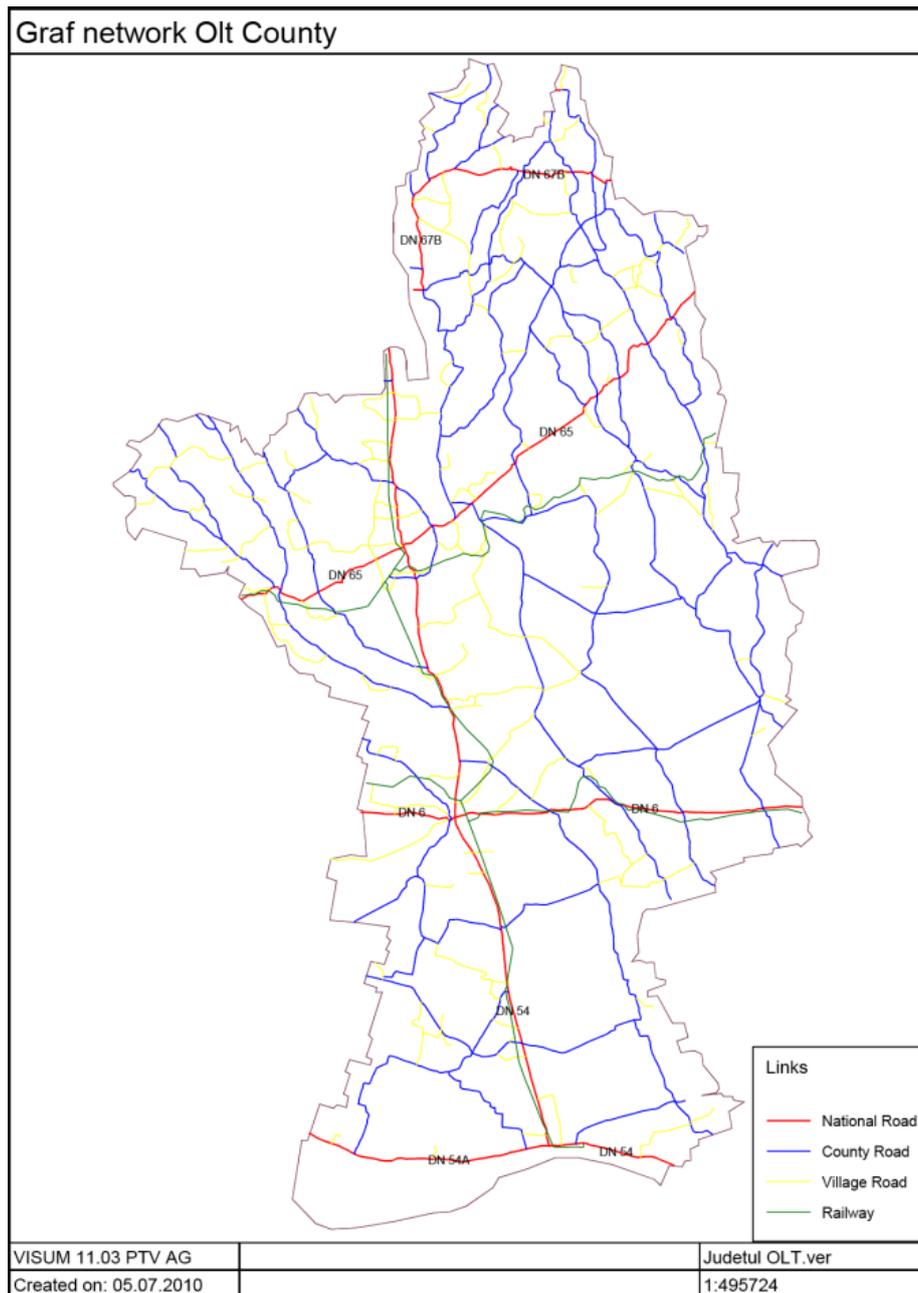


Figure 1. The graf network for Olt county.

It should be noted that the city of Piatra-Olt is a very important railway junction of the Oltenia region, where three lines intersect (line 901, line 910 and line 201) belonging to

two railway lines (main line 200 Arad - Sibiu - Timisoara, Brasov and main line 900 - Craiova - Bucharest). On the line 910, the traffic section Caracal - Corabia is operated by the rail operator REGIOTRANS Brasov, the other lines are operated by the national operator CFR. Transportation on the Danube is negligible in the public passenger transport system.

The main characteristics of the two modes of transport that ensures the movement of passengers in the Olt county are presented in Table 1 [3], [8]. Is notice a significant deviation between the values of the two sets of parameters, higher values for road public transport vehicles, except vehicles capacity which is higher for rail vehicles.

Table 1. The characteristics of public transport supply.

| Characteristic | Road Transport | Railway Transport |
|---------------------------------------|----------------|-------------------|
| Network length [km] | 2217 | 219 |
| Number of stations | 285 | 44 |
| Number of lines | 116 | 4 |
| Trip numbers/ pairs of trains per day | 474 | 51 |
| Commercial speed [km/h] | 32 | 40 |
| Operators number | 34 | 2 |
| Network density [km/km ²] | 403.2 | 39.8 |
| Vehicles capacity [seats] | 16 – 48 | 130 – 384 |

Analysis of transport supply in terms of number of departures and arrivals on time intervals during the day, in the main mobility centers where the two modes of passenger public transport are in competition is achieved in the following figures.

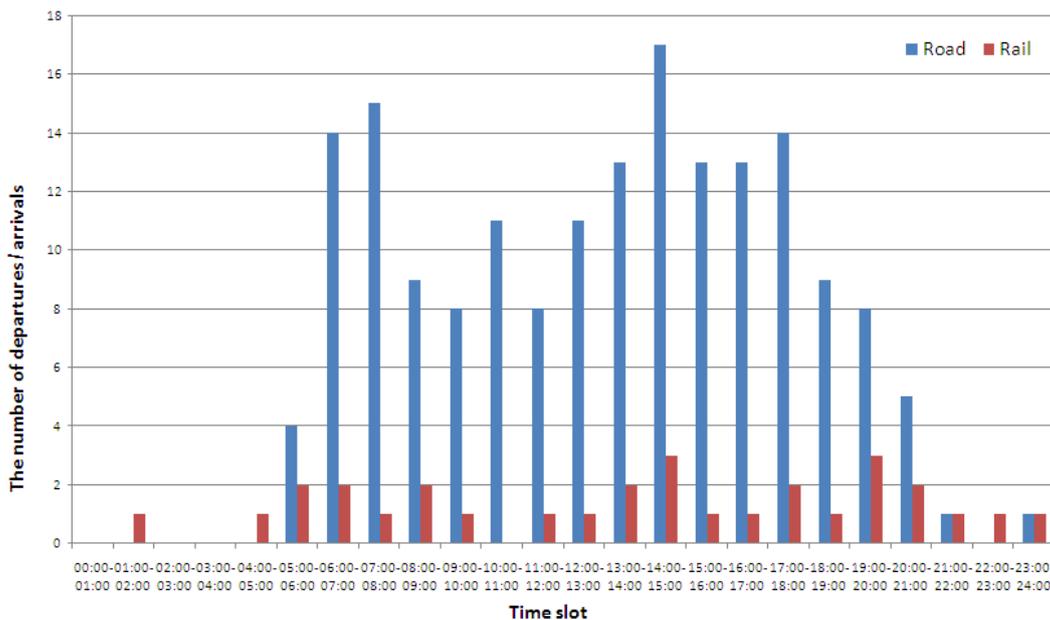


Figure 2. The number of departures/arrivals – railway and road passenger transport in Slatina.

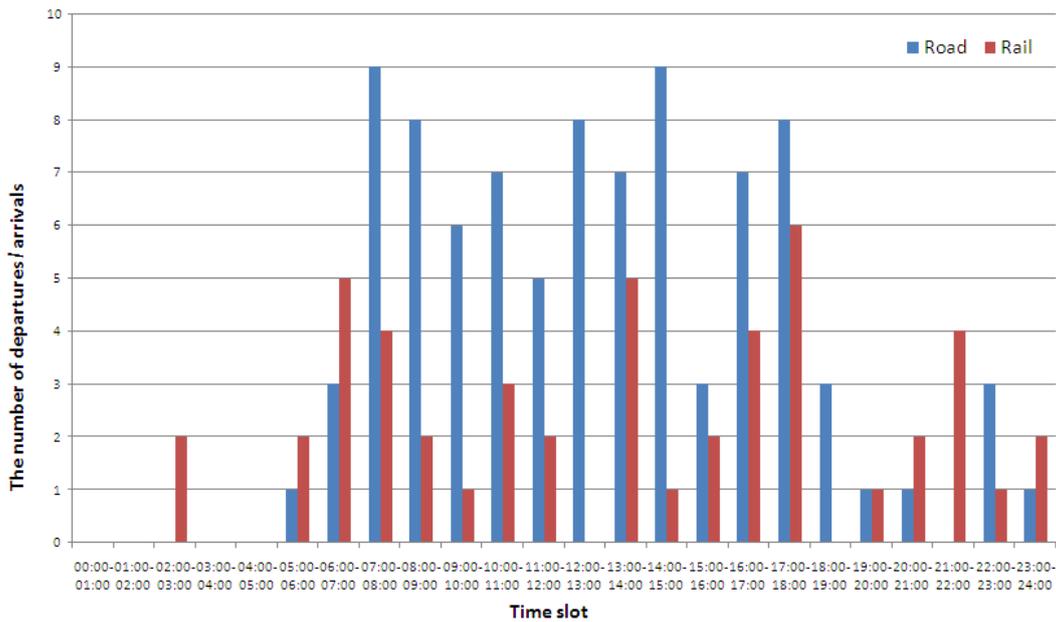


Figure 3. The number of departures/arrivals – railway and road passenger transport in Caracal.

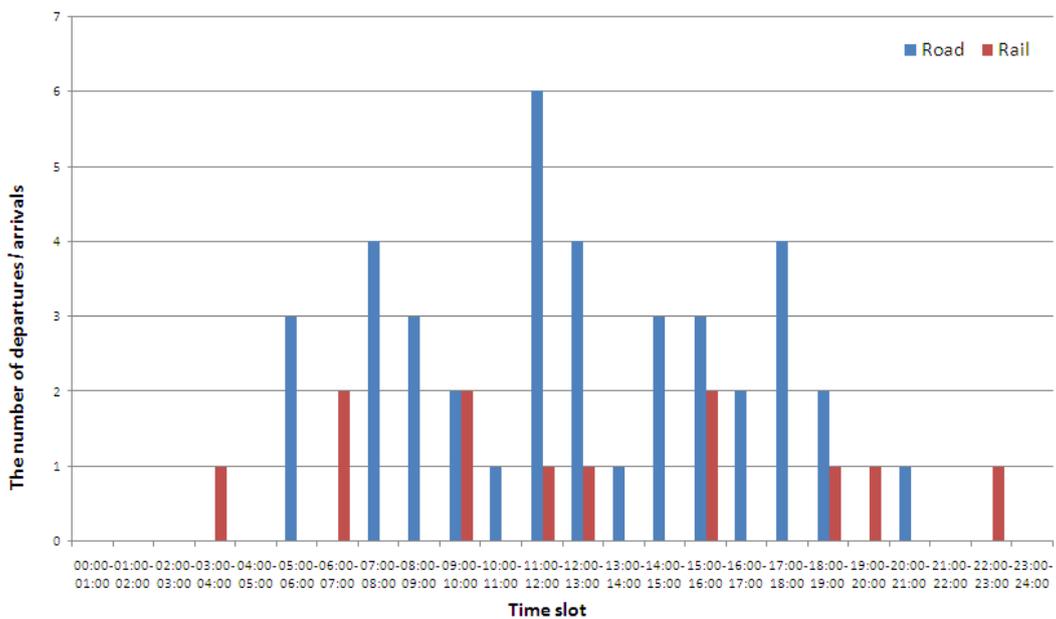


Figure 4. The number of departures/arrivals – railway and road passenger transport in Corabia.

From figures 2, 3 and 4 is showed that the supply transport by scheduled buses and minibuses is much more varied than in the case of rail. For rail transport has been taken into account the schedule of slow and fast trains [8].

4. THE TRANSPORT DEMAND IN OLT COUNTY

Transport demand modeling involves a series of mathematical models that attempt to simulate human travel behavior. The travel simulation process follows trips as they begin at a trip generating zone, move through a network of links and end at a trip attracting zone. The simulation process is known as the four step process for each of the four basic models used in the overall process (figure 5).

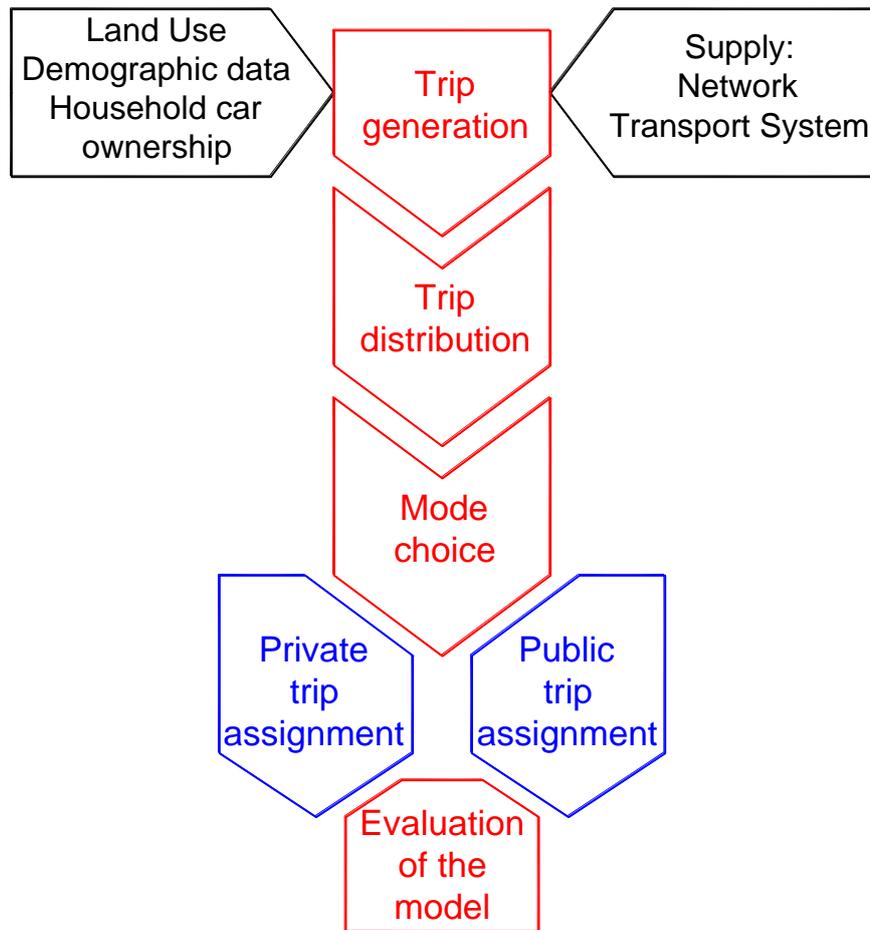


Figure 5. The regional travel model.

Trip generation. In the first stage of *the four steps model*, generating trips, socio economic and demographic structure of areas of traffic constitutes inputs to the applied regression model used to estimate the number of trips generated by each area.

The number of generated trips for each zone is given by the formula:

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$$N_{gen} = \sum_i a_i \cdot x_i \text{ [trips]} \quad (1)$$

where:

- x_i are socio - economic variables;
- a_i are calibration coefficients of the regression model.

An important parameter as the basis for generating travel is the household car ownership. For Olt County this parameter is below country average [7].

The number of trips attracted to each traffic zone is determined according to points of interest located in that area (jobs, administrative centers, health centers, schools, commercial areas) (figure 6). By applying these procedure, in which the used data were obtained by count trips made at the level of some zones from studied area [6], there were estimated 38133 trips in a usually working day in all Olt county.

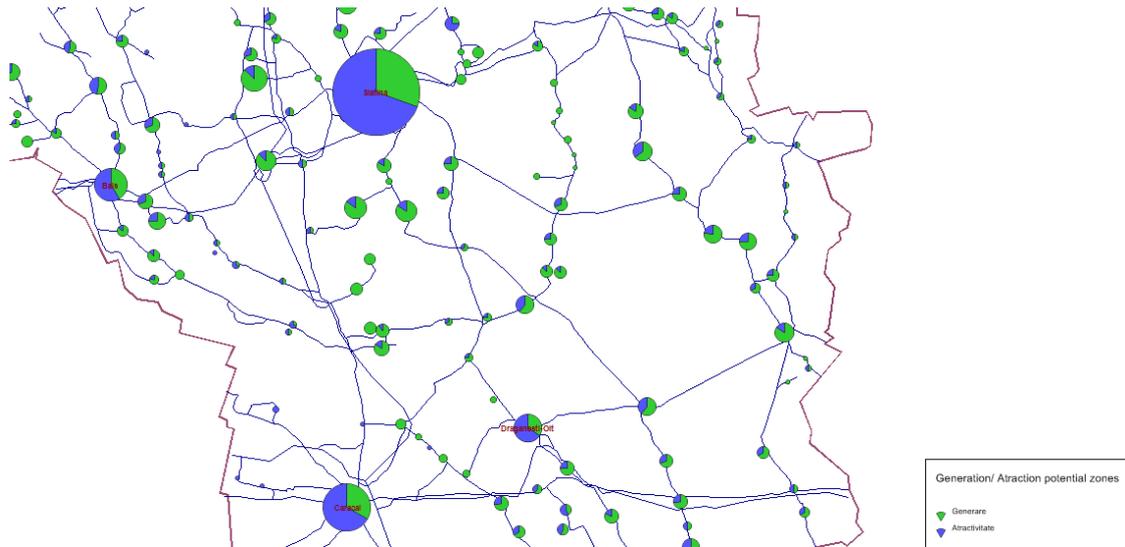


Figure 6. Generation/attraction potential zones.

Trip distribution. The trips beginnings and ends in each zone are linked together to form an origin – destination pattern of trips through the process of trip distribution. The most commonly used procedure for trip distribution is the gravity model. The gravity model is of the form:

$$T_{ij} = g_i \cdot a_j \cdot f(d_{ij}) \text{ [trips]} \quad (2)$$

where:

- T_{ij} are the flows estimated to be produced between the “i” and “j” traffic zones;
- g_i is the generation and application from “i” area;
- a_j is attract demand in the “j” area;
- $f(d_{ij})$ is the difficulties function in making travel between zones “i” and “j”.

Mode choice. Ownership of private cars, the timetable of public transport, the cost and the duration of trip are parameters of the utility function which is associated with each mode of transportation. This function is used for choosing the transportation mode. The mathematical model that estimates the probability of choosing a particular transport mode is *Logit* model:

$$P_k = \frac{e^{-\beta C_{ij}^k}}{\sum_m e^{-\beta C_{ij}^m}} \text{ [%]} \quad (3)$$

$$C_{ij}^k = \sum_p \varphi_{kp} \cdot x_{kp} \text{ [m.u.]} \quad (4)$$

where:

- C_{ij}^k is total cost to make the journey using “k” transportation mode;
- φ_{kp} is the equivalence parameter for the variables of time, cost monetary movement;
- x_{kp} are components of the generalized travel cost;
- k represents private car, public transportation;
- β is the calibration model coefficient.

By applying *Logit model*, it results that in Olt county 70 % from all travels are made with public road transportation system, which is managed by the County Council. Also, in the morning peak hour 7:00 – 8:00 (figure 7), the rail transportation system supply for passengers does not fulfill the estimated travel demand. In Olt, the road network is more dense than the railway one, which crosses the county along the national roads (figure 2). In the rush hour interval, the train schedule does provide only in a small extent the link between the rural and urban areas, which are the main interest economic and social points to achieve trips.

Trip assignment. The task of *the traffic assignment* process is to develop the loadings, or user volumes, on each segment of a transportation network, as well as the turning movements at intersections of the network. For assignment matrixes O/D it was used incremental procedure. Using this procedure, the matrix O/D is divided by percentage in several sub-matrixes, which are affected the network. Search algorithm to find routes takes into consideration links impedance resulting from traffic volumes assignment on previous iteration. Model calibration is performed using data [3] obtained from counting the passengers that are in the public transport vehicles in points county near urban areas (figure 8). Travel demand is affected by proper public transport in peak hour morning traffic, expressed in passenger volume (figure 9).

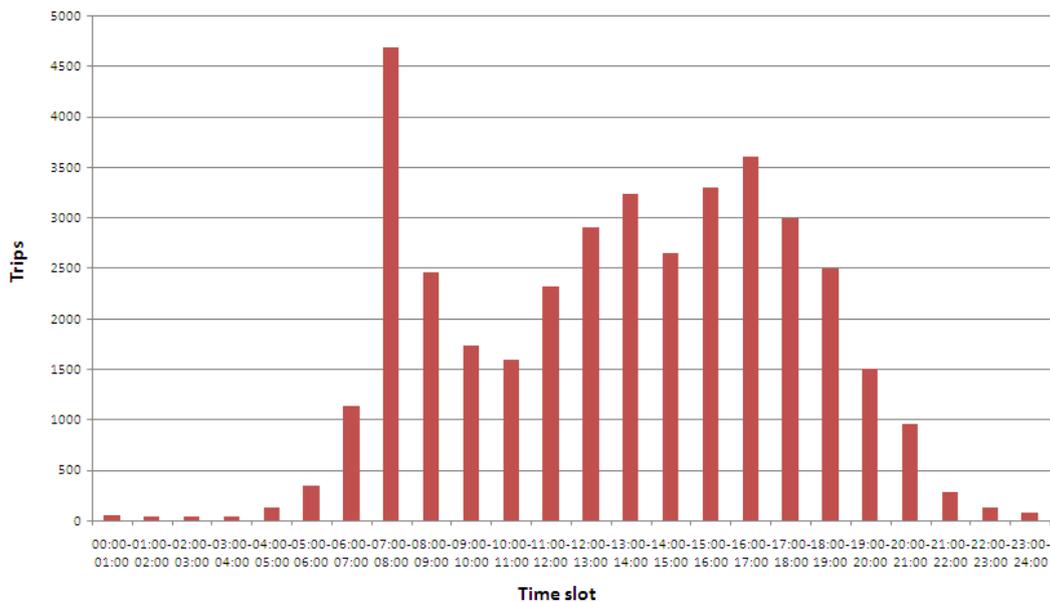


Figure 7. Time distribution for travel demand.

In the European Union, over 60% of the population lives in urban areas. Just under 85% of the EU's gross domestic product is created in urban areas. Towns and cities are the drivers of the European economy. They attract investment and jobs. They are essential to the smooth functioning of the economy (Green Paper).

Taking into consideration administrative - territorial function, and geographic location, Slatina city is highlighted as main attractive point for trips at county level. For passenger road transport, but also for passenger railway transport, the highest usage ratio of transport vehicles is registered on public transport lines which point terminus in this locality. If for public transport system on county level, this remark is a big issue, because on peak traffic periods passenger number overpass transport vehicles capacity with values up to 50 %, for railway passengers transport system this is an increasing of efficiency network functionality.

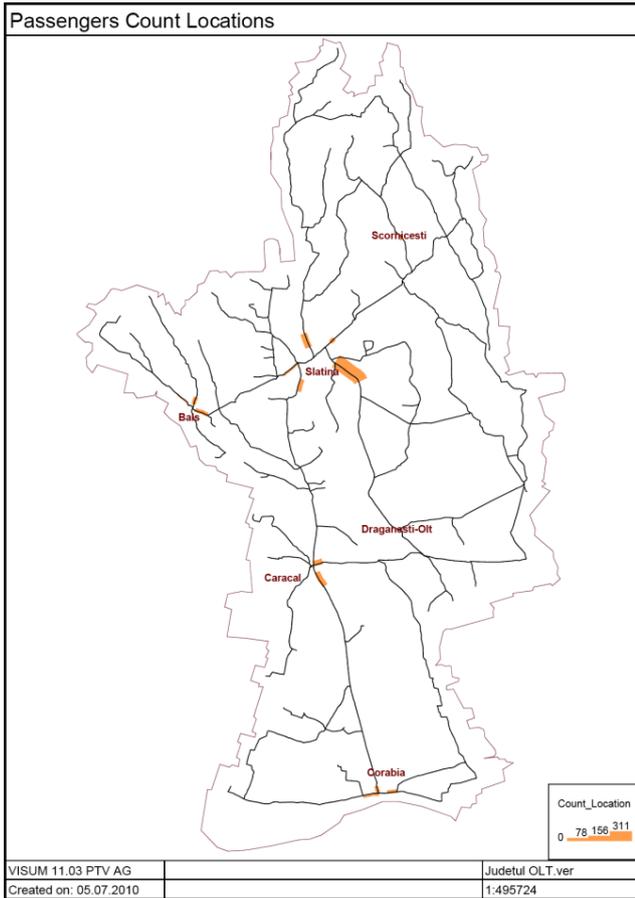


Figure 8. Passengers volume in count location.

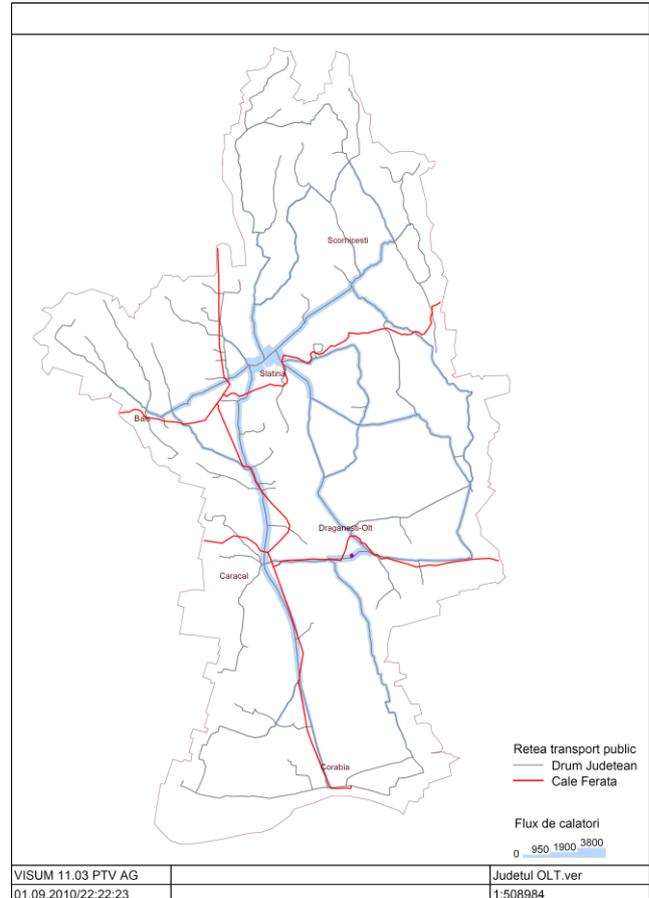


Figure 9. Passenger's volume.

5. PROPOSALS FOR IMPROVEMENT OF PUBLIC TRANSPORT SYSTEM

The particular advantages of the two transport modes are presented on table 2. Is better, instead of a polemic which of the two passengers transport modes is generally superior, to be taken into consideration which is the correct choice to do a trip and promoting integration of analyzed transport modes, in this way being possible that every user to satisfy his trip need on behalf of assurance for sustainable mobility.

Table 2. The particular advantages for transport modes

| <i>Passengers railway transport</i> | <i>Passenger road transport</i> |
|--|--|
| <ul style="list-style-type: none"> • High transport capacity • Comfort (big space for every passenger) and increased safety • Reduced air and noise pollution, especially if the trains have as power source electricity. • Reduced operating costs per passenger km, when the demand is high; • Possibility to transform railway station in intermodal points; • Reduced price for travel ticket • Social tariff | <ul style="list-style-type: none"> • High accessibility • Flexibility (Bus lines path can be modified without making extra investments. • Reduced capital costs • Reduced operating costs per passenger kilometer when the demand is low • High circulation frequency • Circulation schedule adapted to users requests |

Combining the data and information regarding the offer, demand and usage ratio of railway and road transport in Olt county, results that hourly distribution of transport offer is the main factor for choosing transport mode, followed by passenger commodity presented via accessibility of transport mode.

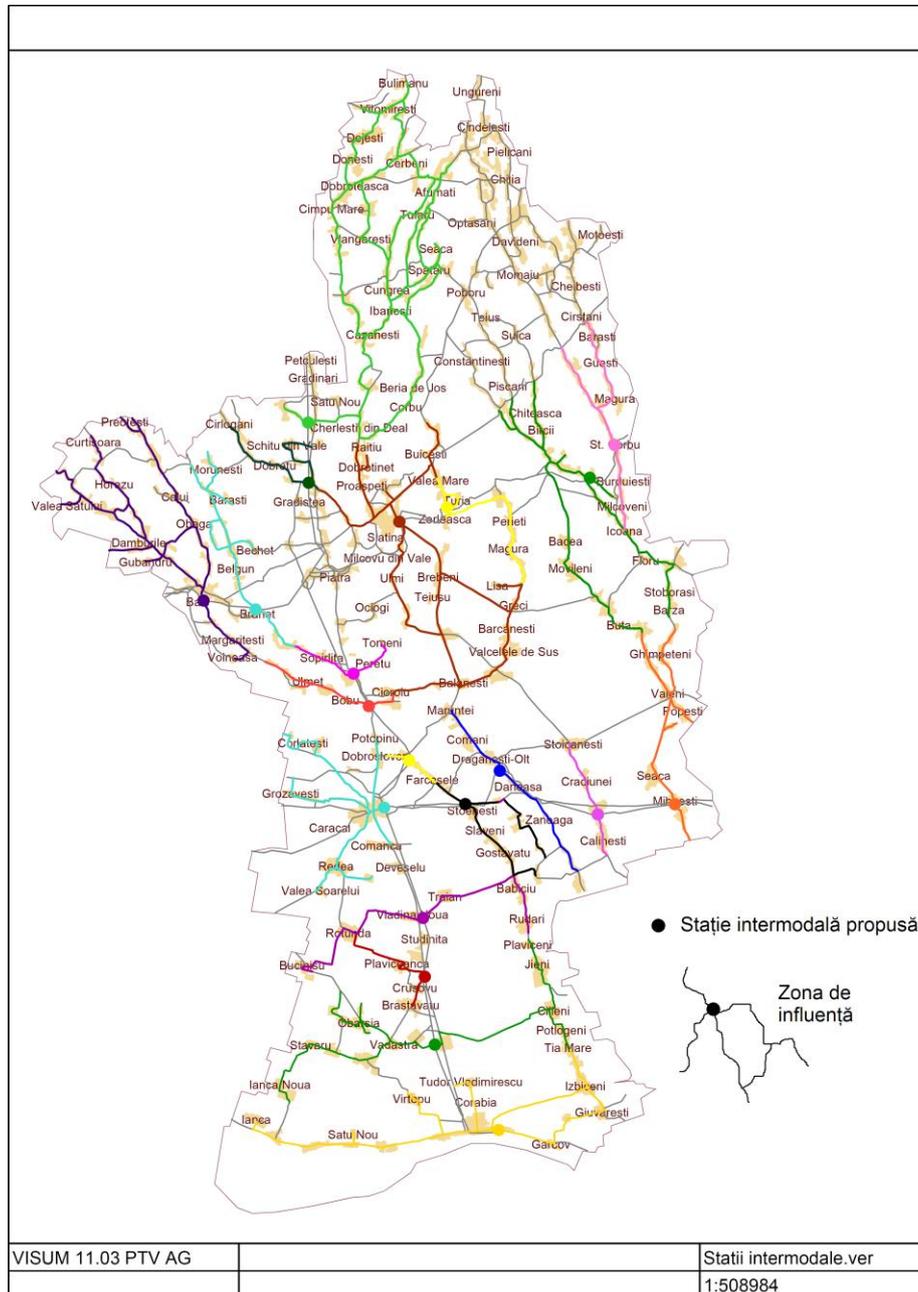


Figure 10. Intermodal stations and areas of influence.

Increasing of attractive for railway transport can be supported using some means like:

- *Adaption of train circulation schedule with slow speed for transport demand which characterize attractive polls for each railway path;*
- *Improvement of accessibility for railway transport – road infrastructure;*
- *Integration of transport modes, railway and road on county level;*

- *Objective modification for passengers transport on county level – complementary mode for railway transport, not competitor;*
- *Intermodal station preparation;*
- *Increasing of commercial speed by infrastructure improvement;*
- *Safety and comfortable transport vehicles.*

By implementing the means above, is obtained a public transport systems restructuration, on county level, in this way the road transport, which is decentralized and in the same time presents high accessibility and flexibility, becomes a transport mode complementary to railway transport, having the role of collecting the passengers from localities which doesn't have such a transport system. This measure goes to increasing of passenger safety, avoiding trips on national roads which ensure the connection between east and west of the country (DN 65, DN 6), roads that have an intensive traffic. In figure 11 are presented the railway station proposed for intermodal purposes and the paths for road public transport that matches with railway transport in those stations.

5. CONCLUSIONS

After analyzing the offer and demand for public transport inside of Olt county, can be presented following conclusions:

- *Travels done inside on Olt county are in most of the cases done between rural and urban area.*
- *In the biggest part of the area, public transport networks, road and railway are overlapping; in the same time, road transport mode presents a high frequency and accessibility, which goes to a bigger usage ratio for this mode compared with railway transport;*
- *To increase public transport system efficiency, in general and service level offered to the passengers, is indicated the integration of two transport modes.*

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