Solutions to Improve Person Transport System in the Pitesti City by Analyzing Public Transport vs. Private Transport

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Abstract. One of the major problems facing the Pitesti city is the road congestion that occurs in the central area of the city during the peak hours. With all the measures taken in recent years - the widening of road arteries, increasing the number of parking spaces, the creation of overground road passages - it is obvious that the problem can only be solved by a new philosophy regarding urban mobility: it is no longer possible to continue through solutions to increase the accessibility of the central area of the city, but it is necessary, on the contrary, to promote a policy of discouraging the penetration of vehicles in the city center, coupled with a policy of improving the connection between urban public transport and county public transport. This new approach is also proposed in the new Urban Mobility Plan of Pitesti city, under development. The most convincing argument for the necessity of this new orientation in the Pitesti city mobility plan is based on the analysis of the current situation of passenger transport on the territory of Pitesti city: the analysis of "public transport versus private transport" reveals a very low occupancy rate for cars and the fact that the road surface required for a passenger (the dynamic area) is much higher in the case of private transport than in the case of public transport. Measurements of passenger flows and vehicle flows on the 6 penetration ways in the city have been made and the calculations clearly demonstrate the benefits of an urban public transport system connected by "transshipment buses" to be made at the edge of the city, to the county public transport system. In terms of inter-county transport, it will continue to be connected to the urban public transport system by existing bus Station, within the city: South Bus Station and North Bus Station. The usefulness of the paper is that it identifies the solutions for sustainable mobility in Pitesti city and proposes concrete solutions for the development of the integrated passenger transport system.

1. Objectives of the paper
One of the major problems facing the city of Pitesti is the road congestion that occurs in the central area of the city during the peak hours of traffic [11, 12].

With all the measures taken in recent years - the widening of road arteries, increasing the number of parking spaces, the creation of overground road passages - it is obvious that the problem can only be solved by a new philosophy regarding urban mobility: it is no longer possible to continue through solutions to increase the accessibility of the central area of the city, but it is necessary, on the contrary, to promote a policy of discouraging the penetration of vehicles in the city center, coupled with a policy of improving the connection between urban public transport and county public transport.

These ideas have been promoted since 2008 [5, 6, 7] when it was proposed to extend the urban public transport network of Pitesti city to the periurbane area and to connect this extended local public
transport system with the county transport system by means of transhipment stations to be carried out at the edge of the future metropolitan area.

These proposals have not been put into operation, and recent research [4] has shown that road congestion has become a daily phenomenon at several points on the city street network.

The realization of the new sustainable mobility plan for Pitesti city [8] offered the opportunity for a detailed assessment of the demand for passenger transport within the territory of Pitești city, so that the following objective could be set: evaluation of the demand for transport of persons and identifying the measures by which it can become more efficient in relation to traffic generated by means of transport - public transport versus private transport.

2. The researches and results

According to the official statement, "The Pitesti Municipality proposes the elaboration of an integrated urban mobility plan, which is a strategic document meant to plan in a sustainable way the fulfillment of the mobility needs of the people and of the economic sector in the city and its surroundings, for a harmonious socio-economic development and a better quality of life, today and in the future. This strategic document harnesses the existing planning practices for all modes of transport for people and goods and takes into account the principles of integration, socio-economic efficiency, participation and evaluation."

The area of influence and the external area that affects the population mobility in the Pitesti city includes all the neighboring towns and villages (Ștefănești, Bradu, Albota, Moșoaia, Băbana, Bascov, Marăcineni) plus Mioveni, the industrial pole nearby, as shown in Figure 1 [12].

![Figure 1. The influence area for the mobility of the people of Pitești city.](image)

In order to make the ex-post assessment of public transport demand within the influence zone, there were counted the travellers in time-travels within the six main inlets / outlets of the Pitesti city, for the connecting roads with the area of influence shown in Table 1, the survey points being highlighted in Figure 2.
Table 1. Recording stations for volume of passengers and the connecting roads with zone of influence.

| Inlets / outlets | Connecting roads with the Piteşti city |
|------------------|----------------------------------------|
| Viilor           | DN73, DN7                               |
| Prundu           | DN65B                                  |
| Craiovei         | DN65                                   |
| Drăgășani       | DN67 B                                 |
| Băbana           | DJ 703 E                                |
| Bascov           | DN 7, DN7A                              |

Figure 2. The six inlets / outlets of the Piteşti city where the passengers in the buses were counted.

The records in the aforementioned locations took place between 06:00 and 22:00, over a period of 16 hours.

The situation with the number of passengers per hour, for each recording station and cumulated at the city level, is presented in Table 2 [8].

Table 2. Number of passengers recorded on time intervals.

| Hourly Interval | Bascov I | Babana I | Dragasani I | Prundu I | Craiovei I | Viilor I | TOTAL I |
|-----------------|----------|----------|-------------|----------|------------|---------|---------|
| 6.00-7.00       | 267      | 38       | 51          | 4        | 98         | 64      | 473     |
| 7.00-8.00       | 236      | 127      | 47          | 26       | 64         | 85      | 93      |
| 8.00-9.00       | 113      | 72       | 47          | 9        | 128        | 64      | 73      |
| 9.00-10.00      | 74       | 52       | 21          | 0        | 81         | 98      | 50      |
| 10.00-11.00     | 38       | 39       | 0           | 4        | 59         | 75      | 64      |
| 11.00-12.00     | 107      | 97       | 12          | 21       | 59         | 40      | 34      |
| 12.00-13.00     | 129      | 143      | 26          | 12       | 44         | 88      | 51      |
| 13.00-14.00     | 157      | 121      | 77          | 26       | 110        | 92      | 135     |
| 14.00-15.00     | 132      | 206      | 4           | 51       | 82         | 58      | 90      |
| 15.00-16.00     | 256      | 105      | 21          | 30       | 92         | 160     | 479     |
| 16.00-17.00     | 137      | 158      | 9           | 60       | 52         | 167     | 80      |
| 17.00-18.00     | 97       | 96       | 9           | 38       | 64         | 172     | 109     |
| 18.00-19.00     | 230      | 115      | 9           | 17       | 39         | 110     | 229     |
| 19.00-20.00     | 86       | 110      | 0           | 55       | 33         | 138     | 145     |
| 20.00-21.00     | 73       | 110      | 0           | 21       | 6          | 77      | 91      |
| 21.00-22.00     | 50       | 40       | 4           | 0        | 59         | 33      | 9       |
| TOTAL           | 2182     | 1629     | 337         | 374      | 1070       | 1521    | 1805    | 2225    | 3987     | 3280     | 8251     | 8404     | 17632    | 17433    |
Graphical presentation of the hourly distribution of passenger flows by public transport means shows that they all have a similar allotment, with maximum transport demand in the morning and afternoon (like in Figure 3 for Podul Viilor), and the same allure has the graph for the cumulative values at all those six inputs / outputs (Figure 4).

**Figure 3.** Hourly distribution of bus passenger flows at Podul Viilor recording station.

**Figure 4.** Hourly distribution of cumulative bus passenger flows for Pitești city.

The largest passenger traffic flow was found at Podul Viilor (Figure 5), as expected, because this is the only main road connecting Pitești city with important industrial destinations in the area of influence: Ștefănești and Mioveni.
During the same time period there were developed six O-D surveys (Origin-Destination) for all vehicles traveling between Pitesti city and its zone of influence [9, 12]. There have been established seven locations for the O-D surveys, creating a "belt" around Pitesti city, and thus all the traffic flows to / from the influence area of Pitesti city was recorded (Figure 6).

**Table 3.** Position of the seven recording points for the O-D surveys.

| O-D survey point | Position of the survey points on the connecting roads with the Piteşti city |
|------------------|--------------------------------------------------------------------------------|
| OD 1             | DN73 Calea Cămpulung, nearby Milestone 1 - Cămpulung 49 km                   |
| OD 2             | DN7, at the IATSA Hotel                                                        |
| OD 3             | DN7C, nearby Milestone 4 - Curtea de Argeș 28 km                             |
| OD 4             | DN7, nearby Milestone 124 - Râmnicu Vâlcea 50 km                             |
| OD 5             | DN65B, nearby Jupiter City Shopping Centre                                    |
| OD 6             | DN67B, nearby Capitol Hotel within Trivale residential quarter                |
| OD 7             | DN65B, nearby Tiriac Auto car dealer in Albota                                 |
For traffic flows, the following categories were recorded: bicycles, motorcycles, scooters, mopeds, passenger cars, taxis, minibuses, buses, vans, pick-ups, 2-axle trucks and derivatives, 3-axle or 4-axle trucks and derivatives, articulated vehicles (5 or more axles), special vehicles, tractors.

The O-D surveys and records in the aforementioned locations took place between 06:00 and 21:00, 15 hours.

The distribution of the vehicle volumes traveling to the areas of influence of the Pitesti city (and therefore of the passenger volumes using private transport or for own interest) recorded during 15 minutes intervals is represented in Figure 7 and it could be observed that it has a similar shape to the distribution of the passenger flows using public transport, which is in line with the demand for passenger transport in Pitesti city and its zones of influence [12].

![Figure 7. Distribution of vehicle flows during 15 minute intervals from Pitești city to its zones of influence [12].](image1)

A similar distribution it was recorded for the traffic from the zones of influence to the Pitești city (Figure 8).

![Figure 8. Distribution of vehicle flows during 15 minute intervals from the zones of influence to the Pitești city [12].](image2)
Thus, it was found that 50000 vehicles go in and out from Pitesti city every day, out of which cars are around 38000 (about 75%).

From the distributions shown in Figures 7 and 8 it was found that, at the peak hours, the hourly traffic volume is about 5000 vehicles / hour, a very high value which can be taken into account in order to recommend to people the alternative of traveling using public transport.

Observations about the load of passenger cars revealed an average number of occupants of 1.25 passengers / car, which means that the daily volume of travellers with their own car is about 1.25 x 38000 = 47500 passengers / day / sense.

This magnitude can be analyzed in relation to the daily number of travellers with the public transport, which based on the data presented in Table 1 is about 17500 passengers / day / sense.

The most relevant analysis criterion is the dynamic area occupied for a passenger by the means of transport in the two cases - bus versus passenger car.

A first assessment can use the comparative information already known through numerous campaigns to encourage the use of public transport despite of passenger cars. Thus, a relevant picture is that presented in Figure 8, where it is highlighted that a bus carrying 75 passengers can replace 60 cars with an average load of 1.25 passengers per car, which would lead to a very large reduction of the occupied road surface, the source of information being an issue of the European Commission [13].

![Figure 9. The road surface occupied by passenger cars or bus carrying 75 passengers [13].](image)

The picture is relevant, but this comparison on the busy road surface can even be done based on an analytical calculation, for a legal speed of 50 km/h in the city.

Since each of the two types of means of transport (the bus or the passenger car) occupies the entire lane on which it moves, the problem is reduced to determining only the length of the area of the occupied dynamic surface, which is calculated from the condition of safety moving, represented by the condition to maintain a safe distance from the front vehicle which allows the driver to safely stop in the safe and comfortable conditions [3].

This means that when the front vehicle make an emergency braking (with the maximum brake deceleration), the vehicle of the traveler will brakes in comfort conditions (with a mean deceleration).

As a result, it could be considered the model in which the safety distance $L_f$ is equal to the distance traveled in the braking process with a deceleration of 5 m/s² for both types of transport [4]:

$$L_f = \frac{u^2}{2d} = \frac{(50 \text{ m/s})^2}{2 \times 5} = 19.2 \text{ m}$$

(1)
Thus, the length of the dynamic surface occupied by a passenger car (having a length $L_{\text{car}}$ of about 4.5 m) will be:

$$L_{d\text{in, ~car}} = L_{\text{car}} + L_f = 5.5 + 19.2 = 24.7 \text{ m}$$

(2)

For the bus (having a length $L_{\text{bus}}$ of about 12 m), the length of the dynamic surface will be:

$$L_{d\text{in, ~bus}} = L_{\text{bus}} + L_f = 12 + 19.2 = 31.2 \text{ m}$$

(3)

Based on these values, the ratio between the dynamic occupied area for transporting the same number of passengers (75) can be calculated for 60 passenger cars carrying 1.25 passengers/passenger car $S_{\text{din,60car}}$ compared to a medium-sized urban bus $S_{\text{din,bus}}$ with the following relation:

$$
\frac{S_{\text{din,60car}}}{S_{\text{din,bus}}} = \frac{60 \cdot 24.7}{31.2} = 47.5
$$

(4)

This is a concrete value, which precisely characterizes the phrase "public transport versus private transport" in terms of the efficiency of the use of the road network in the passenger transport [1, 10].

It was found that in both transport directions (go in or out from Pitesti city), about 38000 passenger cars perform daily the transport of about 47500 persons in their own schedule and that for a person travelling with his own car it is necessary a road surface of 47.5 times higher than for travelling by public transport. These data are extremely useful in formulating proposals to improve the passenger transport in the considered area.

3. Conclusions

The researches carried out in the Pitesti city and its influence areas for the comparative analysis "public transport versus private transport" lead to the conclusion that, in order to improve the level of service of the road network in the Pitesti city, there are needed measures to encourage passengers to use public transport and, as a result, to give up their own passenger car journeys.

This can be achieved by extending the public transport network from the level of the Pitesti city to the level of the proximity influence area (the so-called peri-urban area), which can be legally constituted in the metropolitan area.

This will allow the development of an local public transport system extended throughout the area of influence so that it will be created more attractive public transport conditions for journeys that exceed the administrative limit of the Pitesti city.

These measures made to increase the attractiveness of public transport can be complemented by measures to discourage the use of passenger cars for own use in the central area of Pitesti city, the most easily applied measure being the rates increase in the public parking of the central area.

Regarding the access of cars in the central area of the Pitesti city, the strategy is: "not to meet the increasing demand for access of passenger cars in the central area, but to create conditions for changing the mode of transport at the borders of the metropolitan area - private transport / public transport".

This involves building car parks near the main entry streets in the metropolitan area, where travelers have easy access to the extensive local public transport so as to be motivated to travel further with public transport.
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