Method of preventing unwanted traffic in the “Tudor Vladimirescu” University Campus

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Abstract. In 1970’ when the university campus was built the road infrastructure was designed for a very small number of cars. Over time technology has advanced and the number of vehicles has risen. According to the Directorate of Vehicle Registration from Iasi in 2015 there were 173 619 registered vehicles, about 11,000 vehicles in addition to 2014. This rise in vehicle numbers has lead to a particular problem in which, vehicle drivers prefer in some cases the use of back alleys and back roads to get to the destination. The ”Tudor Vladimirescu” University Campus is not a main road of transit, is a residential area that does not support a high number of vehicles and especially does not support heavy vehicles. In our case study we observed the tendency of drivers to use the campus roads as a method of bypassing rush hour traffic in their route, especially in the case of taxi vehicles as well as light trucks and vans that use the campus roads as access to the commercial stores and restaurants that are situated in the front of the campus. In the study of ”Tudor Vladimirescu” University Campus traffic, on terrain vehicle number collection has been conducted, this was done one week, day by day, and this has revealed that:
● the number of cars which enter in the campus area is high.
● a lot of cars only transit the campus on route to the commercial area.
● 25% from that cars are taxis
● trucks and light trucks have been present.

In this paper we present a solution that resolves these problems which have been identified in the analysis of the current campus status. In terrain measurements mathematical calculations accompanied with PTV Vissim software simulations using real world data have been used to confirm the proposed solution is viable.

1. Area location and characteristics of the building

“Tudor Vladimirescu” Campus have almost 15 000 of students, is a powerhouse polarization of social-cultural and economic activities at locally level.

“Tudor Vladimirescu” Campus is located at the intersection of parallel 47 ° 9’ 20” north latitude and the meridian 27 ° 36’ 24” east longitude. The campus has contact with Metallurgy district by Blvd Chemistry , with Rosh Bridge by the Dimitrie Mangeron boulevard and with Bucsinescu district by Tudor Vladimirescu street.
Based on the traffic study and careful analysis of traffic documentation solutions adopted must ensure functionality, social and economical efficiency and the level of service necessary road infrastructure proposed.

The buildings in this area were built between the years 1970-1980, when the index engine in Romania and parking lots needs were much lower.

For access on campus were provided four roadways as follows:
- One entry on campus between the dorms T18 and T19 (figure 2);
- One entry through the right side of the complex Iulius Mall;
- One exit through the left side of the complex Iulius Mall;
- One entry and exit on the embankment, Chemistry street (figure 3)

2. Traffic problems identified in the analyzed area
As a residential area from Iasi "Tudor Vladimirescu" Campus have a few problems which we identify at the first contact with the study area. The most problems it was identified at Prof. Vasilescu Petrescu Street:
The lack of designated parking places – in the Campus there are more cars than parking spaces and a lot of this parking spaces are occupied by drivers from out of the campus.

Illegal parking - A lot of these cars from the images there are not at the students, there are cars of people who came at the pubs in campus.

Lack of sidewalks for pedestrians – if you are pedestrian is difficult to walk through campus because they don’t have sidewalks and the area is not signalized like a residential area even it is.

Asphalt bumps and pot holes – because the last time when was asphalted it happens a long time ago the road surface presents a lot of fissures, holes or humps. This problem can affect the average speed in traffic.

Insufficient release rainwater – when the weather are bad and it’s start to rain for some time, the rainwater does not drain through canalization, it is accumulates making it impossible to boarding into the car.

Heavy machines that accelerate degradation of the roadway – there are a lot of pubs in the campus and one big mall. In each morning trucks come at this and transporting goods. The road infrastructure wasn’t build for heavy traffic and this one can affecting the road structure and can make it to degrade much faster.

Transit campus by drivers just to shorten the road – the drivers which have trouble at near of the campus they take the shortcut through the campus, especially taxis drivers which prefer to go via campus to avoid the agglomeration from the main street.

Figure 4. Illegal parking which makes it hard access of the vehicles

Figure 5. Illegal parking create a small access for cars can create problems for drivers
3. Methodology to calculate the traffic capacity of the street

For calculate the traffic capacity of the main streets on the campus we will use the STAS 10144/5-89 which refers to calculating traffic capacity of roads according to traffic characteristics and urban conditions for smooth flow and traffic safety.

Calculating the traffic capacity of the streets is performed for taking vehicle flow. Circulation ability or maximum number of vehicles that can move in an hour, the fluent and safe movement depends on several factors like:

- the circulation that can be with discontinue flow (blinking or pulsating) with stops at intersections, or continuous flow without stopping at intersections when they are uneven or directing traffic in the system is coordinated (green light).
- traffic characteristics by the intensity and frequency of arrivals average speed of circulation of vehicles or traffic composition on vehicle categories, including constructive and dynamic characteristics.
- main street network structure, which refers to the geometry of the streets, distances between intersections and pedestrian crossings, their layout and equipment.
- the tread surface characteristics or planarity and roughness
- psychological and physiological characteristics of drivers of vehicles: perception and reaction time and time limit for waiting at intersections

At the calculation of traffic capacity must considered cases of bad weather conditions circulation, with local concentrations of pollutants or other adverse conditions, cases are considered an exception to the normal situation of circulation and does not take into account the calculating traffic capacity.

Determination of the maximum intensity of traffic in the future is taking into account the prognosis increase in circulation for 15 years, which represent a minimum period. The determining factors in calculating traffic capacity are:

- Speed of movement;
- The composition of traffic (vehicles travel speeds below 20 km / h represent traffic slow);
- Geometry of the street depending on the speed set design;
- Distance between junctions;
- The organization and control of circulation.
The parameters for calculating traffic capacity are presented as follows.

**Fluency F** in the current section of the street, the street and expressing functional quality is determined by the relationship:

\[
F = \frac{v}{v_B} = 0 \ldots 1
\]  

(1)

where \(v_B\) – design speed of the artery [km/h]

\(v\) – circulation speed [km/h]

| Table 1. The quality of fluency |
|---------------------------------|
| F  | 0,5 < F < 1,0 | 0,3 < F < 0,5 | 0,15 < F < 0,3 | 0 < F < 0,15 |
| The quality of fluency | Very good | Good | Reduced | Very reduced |

Succession and **interspace between successive vehicles** on a traffic lane is:

\[
i = \frac{1000 \cdot v \cdot e}{3600} \text{ [m]}
\]  

(2)

where \(e\) - transition interval [s]

\(v\) - circulation speed [km/h]

**Succession minimum interspace** \(i_{min}\) corresponding landing distance required to stop the vehicle is:

\[
i_{\text{min}} = \frac{v^2}{26 \cdot g \cdot f} + \frac{v}{3,6} \cdot t + S \text{ [m]}
\]  

(3)

where \(v\) - circulation speed [km/h];

\(g\) - gravitational acceleration; \(g = 9.81 \text{ [m} / \text{s}^2]\);

\(f\) - coefficient of friction braking energy;

\(S\) - safety space [m], usually is equal with the car’s length. For calculating the used values are:

- \(S = 4.5 \text{ [m]}\) - for current circulation;
- \(S = 10 \text{ [m]}\) to slow traffic;
- \(t\) - the time of perception - reaction [s].

**Traffic density D:**

\[
D = \frac{1000}{i} \text{ [number of vehicles/km]}
\]  

(4)

**The maximum capacity of circulation**, for a band:

- for continuous, is

\[
N^c = \frac{1000 \cdot v}{i_{\text{min}}} = \frac{1000 \cdot v}{\frac{v^2}{26 \cdot g \cdot f} + \frac{v}{3,6} \cdot t + S} \text{ [vehicles/hour]}
\]  

(5)

- for discontinue flux, the maximum capacity of circulation \(N\) for a band improves a coefficient

\[
N = N^c \cdot K
\]  

(6)

where:

\[
K = \frac{A / v}{A / v + v / \left(1 / w_a + 1 / w_i\right) + T_r} < 1
\]  

(7)
\[ K = \frac{T_c}{T} < 1 \]  

\( A \) [m] – distance between intersections, including pedestrian crossings, at the same level; 
\( v \) [m/s] – speed of circulation; 
\( w_a \) [m/s²] - acceleration from starting the vehicle; 
\( T, T_c \) [s] – traveling during A period, for discontinue/continue circulation; 
\( w_i \) [m/s²] - to stop the vehicle deceleration; 
\( T_r \) [s] - the waiting time input signal intersection equipped with traffic lights.

### Table 2. The average values of the parameters that intervene in traffic capacity calculations

| Type of traffic       | Calculating average values of parameters                                      |
|-----------------------|--------------------------------------------------------------------------------|
|                       | Speed of circulation, \( v \) [km/h] | Coefficient of friction \( f \), at braking | Time of perception \( t \) [s] | Safe space \( S \) [m] |
| Current travel speed  | 20 ÷ 60                           | 0,30 ÷ 0,45                                       | 0,5 ÷ 1,5                  | 5 ÷ 7                  |
| Slow Traffic          | 5 ÷ 20                            | 0,28 ÷ 0,40                                       | 1,5 ÷ 2,5                  | 10 ÷ 20                |

In general terms, the development of urban circulation may encounter two situations, in relation with the circulation at full capacity, as follows:
- exceeding by 20-30% on the reduced period of time (1÷2h) at capacity circulation limit (unstable regime the circulation until the blocking, which requires measures to improve the operation and planning of streets - flow limit);
- registering an intensity of traffic by 25 to 30% below the traffic capacity limit for current traffic flow speeds running and by 16 to 20% for slow traffic (normal situation in the first stage of the commissioning of the streets - flow possible).

For the purposes of the importance of these roads are classified into four categories, depending on the number of lanes of the carriageway, thus we have streets by:
- Category I, six lanes;
- Category II, with four lanes;
- Category III, with two lanes;
- Category IV, with one lane.

The functional role of streets and category shall be determined in the study of circulation of the village, which specifies:
- main traffic network, composed of streets in category I and II, which ensure communication, transportation, heavy transport technology, penetrations and traffic through the village; the main road network and streets are included in category III where they take over some of the functions listed above;
- secondary road network, composed of streets in categories III and IV, which provides accesses and local ties;
- convenient circulation network, composed of parking, public transport stations, power stations and maintenance of vehicles;

Base speed is determined in relation to the street category, the average intensity of circulation and local conditions.

### Table 3. Streets category

| Street category | Base speed [km/h] |
|-----------------|------------------|
| I               | 60               |
| II              | 50...60          |
| III             | 40...50          |
| IV              | ≤ 25             |
4. Calculation of transport capacity of the section belonging street access on campus on the section between entering and leaving the campus to Mopseria Magic Pizza.

Analyzed section is delimitated to the one end of intersection with Christopher and at the other end by the intersection with road out of campus. The length between the two intersections analyzed section of the street is 188 meters. The section of the street is equipped with a lane (one-way) band having a width of 4 meters. The section of the street in case adjoins dorms T18, T19, T17, T21 and T1-2. The flows of vehicles travelling on the road section analyzed were called as shown in figure 7.

![Figure 7. The flow of vehicles travelling on the road section analyzed](image)

The calculations were carried out according to the method set out based on the following values:

\[ g = 9,81 \text{ [m/s}^2\text{]}; \quad f = 0,6 \text{ [-]}; \quad t = 1,5 \text{ [sec]}; \quad S = 4,5 \text{ [m]}. \]

| Current traffic speed [km/h] | 20  | 25  | 30   |
|------------------------------|-----|-----|------|
| Fluency                      | 0,666 | 0,833 | 1    |
| Interspace of succession [m] | 102,5 | 128,2 | 153,8 |
| Interspace minimum of succession [m] | 15,44 | 19  | 22,88 |
| Coefficient K [-]            | 0,94 | 0,912 | 0,878 |
| Nc [veh ech/h]              | 1294,74 | 1315,74 | 1311,13 |
| Nt [veh ech/h]              | 1219,65 | 1200,28 | 1151,61 |

Table 4. Capacity values for the section of road in case

Mention that the calculation of the coefficient K to improve the circulation flow continuous the following values were used:

- \[ A = 188 \text{ [meters]}; \quad T_r = 0 \text{ [s]} \] – according to the current cycle traffic light
- \[ w_a = 2 \text{ [m/s}^2\text{]}; \quad w_i = 4 \text{ [m/s}^2\text{]} \] – for current traffic speed

We notice that depending on the speed which traffic on the section studied street carrying capacity can vary between 1100-1200 vehicles per hour. Considering that the maximum flow of vehicles travelling on this section is approximately equivalent to 195 vehicles per hour, so the street takes over the entire flow of cars and remains a considerable reserve.
Yet we can further reduce traffic by closing the campus, arguing that the nearly 50% of vehicles entering and then leaving the campus.

5. Results of the traffic measurements
The measurements in traffic surprised totally normal situation, where possible in STAS 10144 / 5-89. The main characteristics of road traffic circulation in STAS 10795 / 1-76 which is determined by the investigation are:
- Intensity;
- Flow;
- Density;
- The components;
- Characteristics of current traffic flows (origin and destination of the journey, the route);
- Traffic speed and average speed of moving vehicles traveled singly or in groups;
- Transition interval and spacing between consecutive vehicles;
- The mass of vehicles driven on the road.

As an investigation after traffic characteristics that will be determined, it was used traffic measurements that aim to determine the intensity and components of traffic. After the road network size, the traffic measurement was partial, that included only part of the road network. By type of traffic users, the traffic measurement was referring only to moving vehicles. After the means used to collect information, the investigation method was manual, using operators.

The experimental program was conducted for one week, seven days. (two days with 24 h/day of measurements and five days only 13 h/day – start at 7 a.m. and end at 10 p.m. - of measurements)

![Figure 8. Traffic situation from "Tudor Vladimirescu" Campus](image)

The values from the figure 8 represent all the vehicles which are monitoring during on the one week of measurements. We can observe that in campus, in one week, enter a considerable number of cars and a lot of them, almost 50% prefer the firs exist. This situation conducted at the idea of transit route.
In figure 9 is detailed the traffic measurements on the all week and indicate the traffic in each day of measurements. From the figure can observe when is the critical hour, when the traffic is on the maximum level.

![Figure 9](image)

**Figure 9.** Total flows of equivalent vehicles entering the intersection from dorms T19-T18, for all seven days of measurement - between the hours 7:00 a.m. and 10 p.m.

It is noted that the maximum flow of vehicles occurs on the second day of measurement between 2 p.m. and 3 p.m. Looking at the diagram is observed as traffic intensity depends on students program so around 2 p.m. and 3 p.m. students have break from university and come on campus and in the evening between 5 p.m. and 8 p.m. when students finish the studies at university. A major influence have taxis cars because they transiting the campus to avoid the high traffic on the main street.

![Figure 10](image)

**Figure 10 -** types of vehicles identified during on measurements
The traffic measurements show that, taking into account the type of vehicles that travel through campus, one car in four is a taxi car. More than that we see that half of the cars which entering in the campus between dorms T18-T19 prefer the first exit which leads to conclusion that drivers just transit campus.

6. Proposed solutions for organization of circulation

The solution proposed for traffic management studied on the section of road is to closing "Tudor Vladimirescu" Campus with barriers and to make the access in campus with the type of access-cards. It arrived at this solution because of vehicles which passing through the area, according to the study case, half of the vehicles entering in the campus, leaving them on the first exit, so they transiting the area. By closing the campus it wants to reduce the number of vehicles which transiting the section of road from input to output on the campus. It also wants to automatically selecting the people who come to campus by car.

![Figure 11. Proposed solutions for closing the campus](image1)

![Figure 12. Proposed solutions for closing the campus](image2)
Another advantage of this solution is that we can constantly monitoring vehicles from campus. Dwell time on barrier is between 5 and 10 seconds, so there is no risk of forming a congestion or traffic blockage. This solution can help both mentally and physically the driver (the parking lots can't will no more be occupied by the unwanted cars, we can distribute the parking lots each dorm and so the driver knows that he have an parking space, will not be obligated to search for that space such a lot time).

An importing advantage is that the access is restricted for heavy traffic, which in this moment even if they have restricting on the campus by signs, they transit the campus for bring the goods at the food store or at the mall.

7. Conclusions

The backup capacities of the road studied street are superior flow rates predicted for the period following the commissioning of the barrier and closing the "Tudor Vladimirescu" campus. This closure of the campus would increase control over traffic in the campus and would be monitoring easier. By closing the "Tudor Vladimirescu" Campus with barriers, the number of vehicles that will enter the campus will decrease by 50% because the number of cars which transiting the student complex will fall significantly. If the traffic transit decreases it will increasing the number of free parking and adds a plus at the flow of traffic, reducing the number of illegally parked vehicles. Closing the campus for foreigners by limited the access on campus, it will reduce degradation following the reduce road traffic in time, that it will decrease opportunities to commit a crime. In case of closing the campus, the trucks will no longer have access, thus protecting the road infrastructure over the time, protecting by noise because the truck circulation on the campus should be lower.

8. References

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Acknowledgments

Restricting the access on campus is necessary because more and more taxi drivers are transiting the campus using it as a shortcut for arrives at the destination. Because of unwanted car the traffic on campus is getting more agglomerated, parking lots are fewer and fewer and the people who coming at the pubs from campus put in dangerous the student’s security.

Implementation of barriers with access cards can create a better management of vehicles on campus, reduce transit traffic of cars and prevent rapid degradation of the road by restricting the access of trucks. This solution raises the security of all campus residents and reduces pollution and toxic gases which can affect the student’s health.

From the economical point of view if we close the campus, the administration of campus may have a financial surplus.