OPTIMISATION OF A COMPLEX JUNCTION. CASE STUDY: VALEA CASCADELOR – PRECIZIEI JUNCTION IN BUCHAREST

Adrian VILCAN[1], Viorel NICOLAE[1], Eugen IONESCU[2]
[1]University of Pitesti, [2]Urban Trafic srl Bucuresti, Romania

Article history:
Received: 15.07.2013; Accepted: 10.09.2013.

Abstract: *The current paper presents the utility of the applications of the traffic engineering, transport planning and transport modelling concepts and tools in urban environment for optimising the urban transport system. The analysed practical case considers a specific junction of one of the main corridors of the city road network of Bucharest. It is shown and proved how the urban transport model can be detailed, up-dated and then used for optimising both the layout and operation control in one main particular junction.*

Keywords: junction; optimization; VISUM.

INTRODUCTION

The optimisation of the junctions in the urban environment is crucial for achieving a high level of service on the street network in order to increase accessibility of persons and goods and for accomodating in better conditions the demand for the mobility.
In the current example are presented the results of optimisation of the junction Valea Cascadelor – Str. Preciziei in Bucharest. This junction is located on the route to the A1 motorway linking Bucharest to Pitesti and also to the numerous commercial, industrial, residential and business areas that have been developed in the last 10-15 years in the Western part of the Romanian capital city.
This optimisation process has been carried out by up-dating and up-grading the peak hour transport models for Bucharest in VISUM 12.52-00 transport planning/modelling software tools. The peak hour transport models for Bucharest are unique and very advanced tools that have been continuously developed based on the basic Bucharest transport model of the BucharestTransport Master Plan of 2007 – 2008. Considering this approach in the process of optimising the road traffic system in Bucharest could help both authorities and private developers to take the most efficient decision by implementing the most suitable measure for enhancing the traffic performance and the Level of Service in the urabd transport system of Bucharest.

BASIC CONDITIONS

In the following are presented the basic conditions results after the model up-dating and up-grading in the study area.
It is observed from the above that the total demand in the analysed junction is of 3.000 PCU's *(Passenger Car Units)* per hour at the PM peak. Under current conditions of traffic management the LOS *(Level of Service)* is F, with an average delay of 53 seconds per vehicle. It is mentioned that currently the junction is not signalised and specific right-of-way rules are in place.

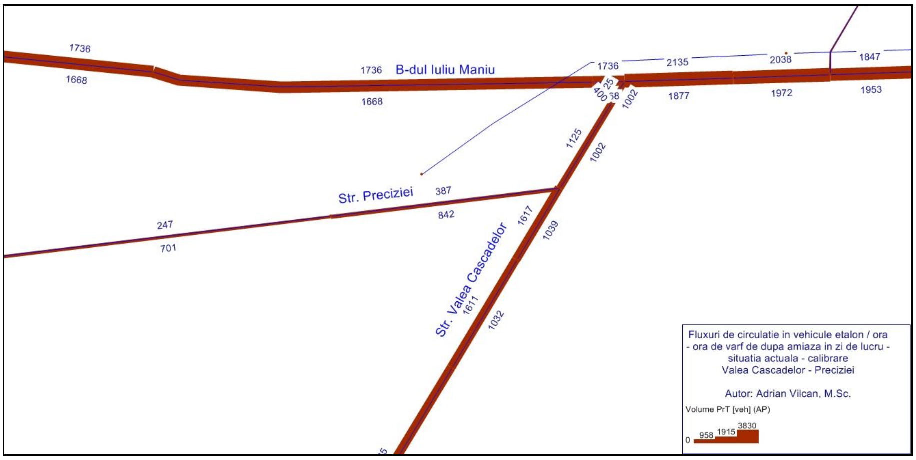

Figure 1. Traffic flows at the PM (post-meridian) peak hour after the model up-dating and up-grading for the current conditions.

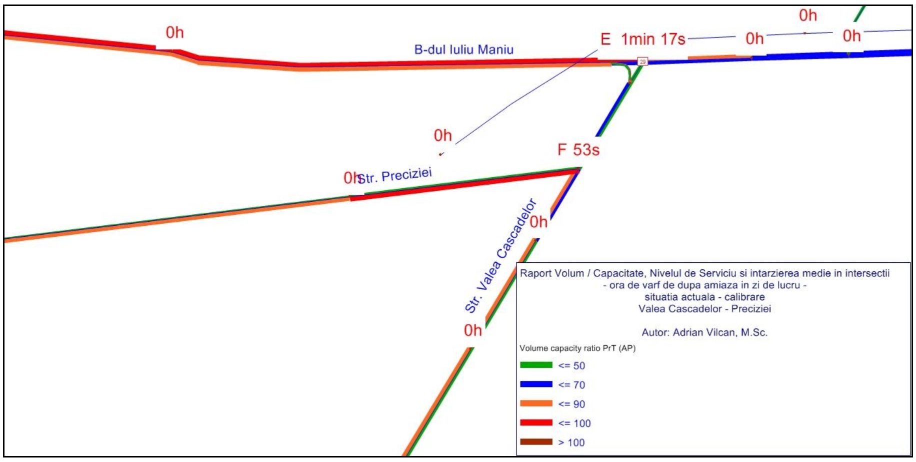

Figure 2. The Volume / Capacity ratio, the Level of Service and average delay in the area – PM peak.

DEVELOPMENT AND TESTING OF THE ALTERNATIVE SOLUTIONS / SCENARIOS

Two alternative packages of improvement measures / scenarios have been considered, as follows:

Scenario 1: Up-grading of the junction as signalised one and optimisation of the traffic signal

Scenario 2: Up-grading of the junction as a roundabout

Both of the above scenarios have considered all specific developments in the study area generating or attracting traffic.

In the figures 3 and 4 there are presented the estimated results of implementing Scenario 1: traffic flows, Volume / Capacity ratio, Level of Service and delays.

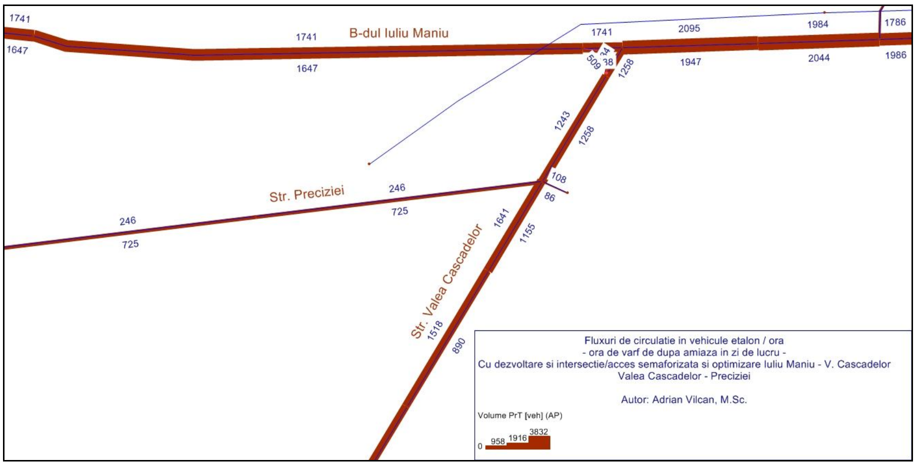

Figure 3. Traffic flows at the PM peak hour – Scenario 1 implementation.

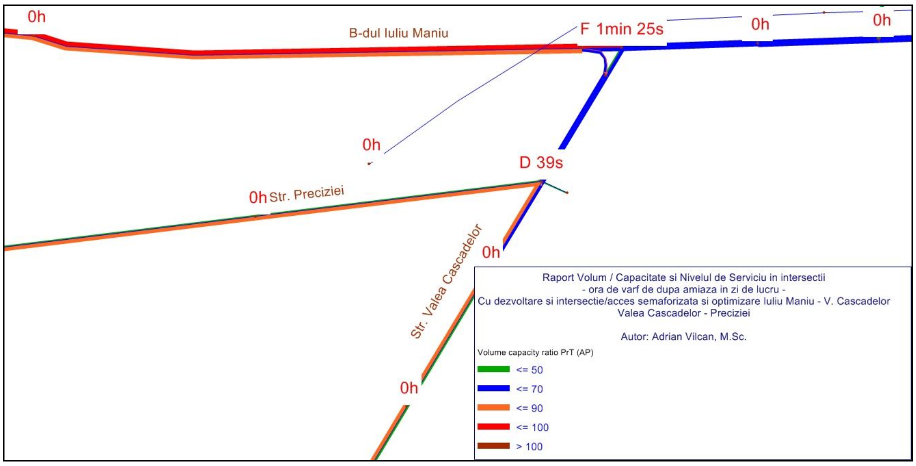

Figure 4 . The Volume / Capacity ratio, the Level of Service and average delay in the area at the PM peak hour – Scenario 1 implementation.

From the above figures it is observed that the total PM traffic flows managed by the junction have increased with 10% to 3.330 PCU's/hour, and the LOS has been improved to D with an average delay of 39 sec.vehicle.

The junction layout, the traffic signal and the LOS in detail are shown in Figure 5.

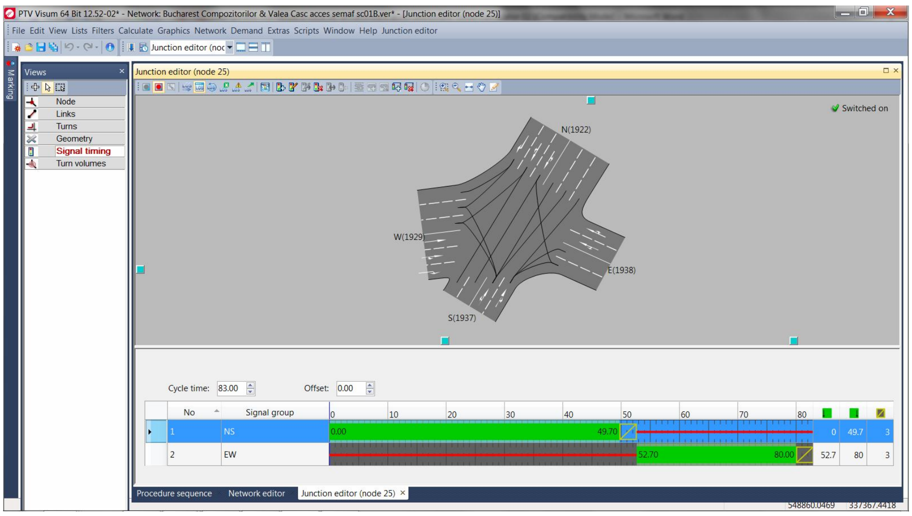

Figure 5. Configuration of the junction and of the signal at Valea Cascadelor – Preciziei.

Cycle duration: 83 seconds.
Phases: phase 1 N-S (on Valea Cascadelor) 0 to 49.70 seconds, thus with 49.70 seconds of green followed by 3 seconds of yellow;
Phase 2 (B-dul Preciziei and local access) 52.70 to 83 second, with a total duration of 30.30 seconds green followed by 3 seconds of yellow.
Node 25:
Level of Service

Control Type	Signalized
Method	HCM 2000 *(Highway Capacity Manual, 2000)*
Average Delay	39.45
Average LOS	D
V/C	0.98
Loss Time	6

Volume and Adjustments by Movement												
Approach	N			E			S			W		
Movement	L1	T	R1	L1	T	R1	L1	T	R1	T	R1	R2
Base Volume	39	1138	66	1	1	105	178	931	46	221	1	502
PHF *(Peak-hour factor)*	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Peak 15 Volume	10	284	17	0	0	26	45	233	12	55	0	126
Adjusted Volume	39	1138	66	1	1	105	178	931	46	221	1	502

Volume and Adjustments by Lane Group								
Approach	N		E		S	W		
Lane Group	C	R	C	R	C	C	R	R
ID	4546	4548	4544	4545	4552	4549	4550	4551
Lanes	LT, T	R	LT	R	LT, RT	T	R	R
Control Type	Perm	No Left	Perm	No Left	Perm	No Left	No Left	No Left
V, Volume	1177	66	2	105	1155	221	1	502
PLT, Proportion Left Turns	0.03	0.00	0.61	0.00	0.15	0.00	0.00	0.00
PRT, Proportion Right Turns	0.00	1.00	0.00	1.00	0.04	0.00	1.00	1.00

Saturation Flow Rate								
Approach	N		E		S	W		
Lane Group	4546	4548	4544	4545	4552	4549	4550	4551
Control Type	Perm	No Left	Perm	No Left	Perm	No Left	No Left	No Left
so, Base Saturation Flow Rate	1900	1900	1900	1900	1900	1900	1900	1900
N, Number of Lanes	2	1	1	1	2	1	1	1
fw, Lane Width Adjustment	0.983	0.983	0.983	0.983	0.983	0.983	0.983	0.983
Phv, % Heavy Vehicles	0	0	0	0	0	0	0	0
fHV, HV Adjustment	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
fg, Grade Adjustment	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
fp, Parking Adjustment	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
fbb, Bus Blocking Adjustment	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
fa, Area Type Adjustment	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
fLU, Lane Utilization Adjustment	0.952	1.000	1.000	1.000	0.952	1.000	1.000	1.000
fLT, Left Turn Adjustment	0.881	1.000	0.933	1.000	0.554	1.000	1.000	1.000
fRT, Right Turn Adjustment	1.000	0.850	1.000	0.850	0.994	1.000	0.850	0.850
fLpb, Left Turn Ped. Adjustment	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
fRpb, Right Turn Ped. Adjustment	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Has Short Lane								

s, Saturation Flow Rate	3132	1587	1743	1587	1957	1867	1587	1587
Capacity, Control Delay, and Level of Service Determination								
Approach	N		E		S	W		
Lane Group	4546	4548	4544	4545	4552	4549	4550	4551
Control Type	Perm	No Left	Perm	No Left	Perm	No Left	No Left	No Left
V, Volume	1176.52	66.4	2.45	105.49	1155.38	221.26	1.08	502.18
s, Saturation Flow Rate	3132	1587	1743	1587	1957	1867	1587	1587
c, Capacity	1875	950	573	522	1172	614	522	522
g/C, Green / Cycle	0.6	0.6	0.33	0.33	0.6	0.33	0.33	0.33
X, Volume / Capacity	0.63	0.07	0	0.2	0.99	0.36	0	0.96
d1, Uniform Delay	10.70	6.97	18.72	20.02	16.31	21.20	18.70	27.34
k, Delay Calibration	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
d2, Incremental Delay,	1.61	0.14	0.01	0.87	41.00	1.65	0.01	50.27
d3, Initial Queue Delay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rp, Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P, Proportion Arriving on Green	0.60	0.60	0.33	0.33	0.60	0.33	0.33	0.33
PF, Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
d, Delay	12.31	7.11	18.73	20.89	57.30	22.85	18.71	77.61
LOS	B	A	B	C	E	C	B	E
dA, Approach Delay	12.03		20.84		57.30	60.80		
Approach LOS	B		C		E	E		
dI, Intersection Delay	39.45							
Intersection LOS	D							

In the Figures 6 and 7 are presented the estimated results of implementing Scenario 2: traffic flows, Volume / Capacity ratio, Level of Service and delays.

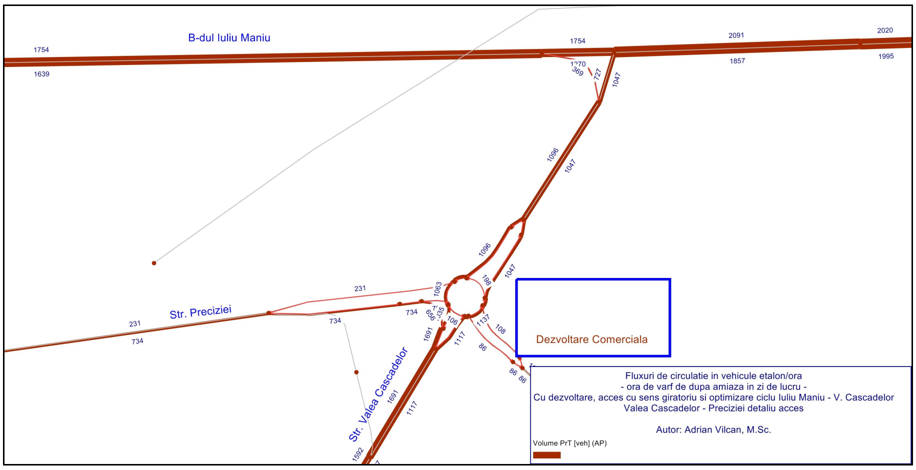

Figure 6. Traffic flows at the PM peak hour *(evening peak hour during a normal working day)* – Scenario 2 implementation.

From these figures it is observed that the total PM traffic flows managed by the junction is 3.055 PCU's/hour, and the LOS is A or B with a maximum delay of 10 seconds / vehicle. Traffic control in the junction between B-dul Iuliu Maniu and Valea Cascadelor has been also enhanced by optimising the traffic signals, and as a result the LOS is improved from F to E, with an average delay of 79 seconds / vehicle.

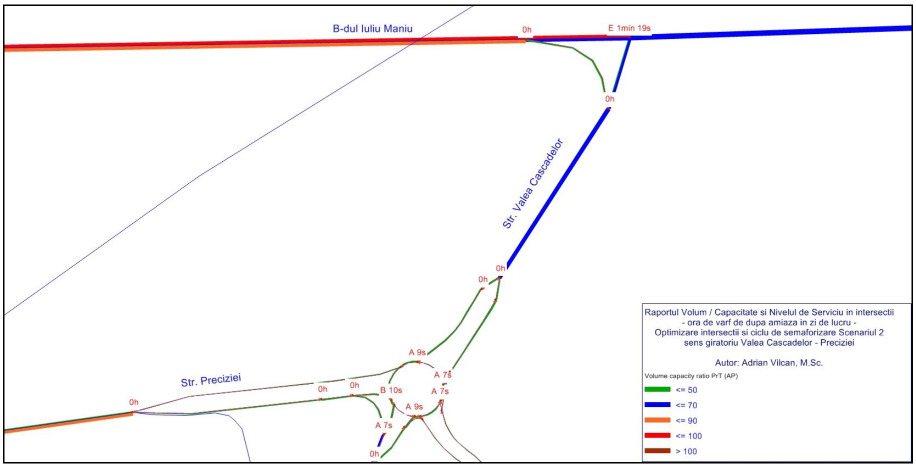

Figure 7. The Volume / Capacity ratio, the Level of Service and average delay in the area at the PM peak hour – Scenario 1 implementation.

CONCLUSIONS

The main conslusion is that the most efficient solution for the junction Valea Cascadelor – Str. Preciziei is the roundabout with 3 lanes, in parallell with the optimisation of the junction B-dul Iuliu Maniu – Valea Cascadelor.
The average delay in the junction Valea Cascadelor – Str. Preciziei is now of 10 seconds / vehicle in the conflict point entering in the roundabout from Str. Preciziei, and 7 and 9 seconds in all other entering points in the roundabout. Considering that the highest delay is 10 seconds per vehicle, the benefit comparing with Scenario 1 – signalised junction (39 seconds/vehicle average delay) is 29 seconds per vehicle. For 3.000 vehicles with an occupancy of 1.6 persons per vehicle it means that the total benefit for the users at the PM peak is: 29 sec x 3.000 x 1.6 = 139.200 man-seconds equivalent to 38.70 man-hours.
The benefit for 200 working days in average per year would be 7.733 man-hours per year, equivalent to 77.330 Euros per year to a Value of Time of 10 Euros/hour.

REFERENCES

Ortuzar, J. de D. and Willumsen, L.G. (1994) - *Modelling Transport*. John Wiley & Sons, Chichester.
* * * (2008) - *Final Report Urban Transport Master Plan Bucharest, Ploiesti and Sibiu*, WSP UK.
* * * (2000) - *Highway Capacity Manual 2000*,Transportation Research Board, National Research
Council Washington, D.C., ISBN 0-309-06681-6
* * * (2010) - *Traffic Engineering Handbook*, 6th Edition, Institute of Transportation Engineers.
* * * (1999) - *Transportation Planning Handbook*, 1999 Institute of Transportation Engineers, ISBN: 0-935403-33-7, Publication No. TB-011A, 1000/TA/0402.
* * * (2012) - *VISUM manual* – VISUM 12.52-00.