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DEVELOPMENT OF ROAD TRAFFIC ASSIGNMENT AND ASSESSMENT SUB-MODEL APPLIED IN THE TRAFFIC STUDY OF THE CITY OF ZAGREB

ABSTRACT

The described sub-model is just one small segment of the Traffic Study of the City of Zagreb, in the development of which numerous foreign and national experts and institutions took part. After comprehensive collection and processing of input data, the traffic experts, using the software package "MVA TRIPS" for the analysis and search for optimal solutions to the problem of traffic system, provided the models of public urban transit for the future.

This paper describes the analysis and assessment of sub-models in road traffic assignment for the morning peak, afternoon peak and average off-peak hours. The principles of assignment procedure have been described as well as the convergence tests. The following has been specified: the users categories, the public transit pre-load, and the passenger car unit (PCU). The key guideline in selecting the route is a generalised formulation of costs presented in the paper. The procedures of calibration and the assessment of the finite model have also been defined according to the screenline flows, link flows, and travelling times. In the end, the summary is given of the basic characteristics of the finite travelling matrices.

KEY WORDS

traffic study, sub-model, economic evaluation, road traffic, traffic safety, public transport, passenger car

1. THE TRAFFIC STUDY OF THE CITY OF ZAGREB IN GENERAL

1.1. Introduction

The Zagreb City Council has entrusted the British company MVA to prepare a General Traffic Plan of the city. The aim of the Traffic Study of the City of Zagreb is to develop a number of General Traffic Plans of the city for the years 2005, 2010 and 2020.

1.2. The objectives of the general traffic plan

At the beginning of elaborating the General Traffic Plan, the intentions of the Plan need to be fully understood, that is, its objectives should be clear. Then, the reaching of these objectives determines the direction and the form of the Plan as well as details contained in every Plan. After that, the key element in the plan assessment is the level of achieving the objectives.

The following objectives have been elaborated and agreed upon with the Zagreb City Council as appropriate for developing the General Traffic Plan of the City:
- improvement of economic efficiency of the traffic system;
- protection of the environment against harmful impact of traffic;
- increase in the safety of passengers, and
- increased availability - easy accessibility of traffic facilities.

2. ELABORATION OF ROAD TRAFFIC ASSIGNMENT SUB-MODELS

Introduction

This paper describes the elaboration and assessment of sub-models in road traffic assignment for morning peak, afternoon peak and average off-peak hours.

The time intervals have been defined in the following manner:
- morning peak hours from 7 to 8.59,
- off-peak hours from 06.00 to 06.59, from 09.00 to 14.59, from 17.00 to 19.59,
- afternoon 15.00 to 16.59.

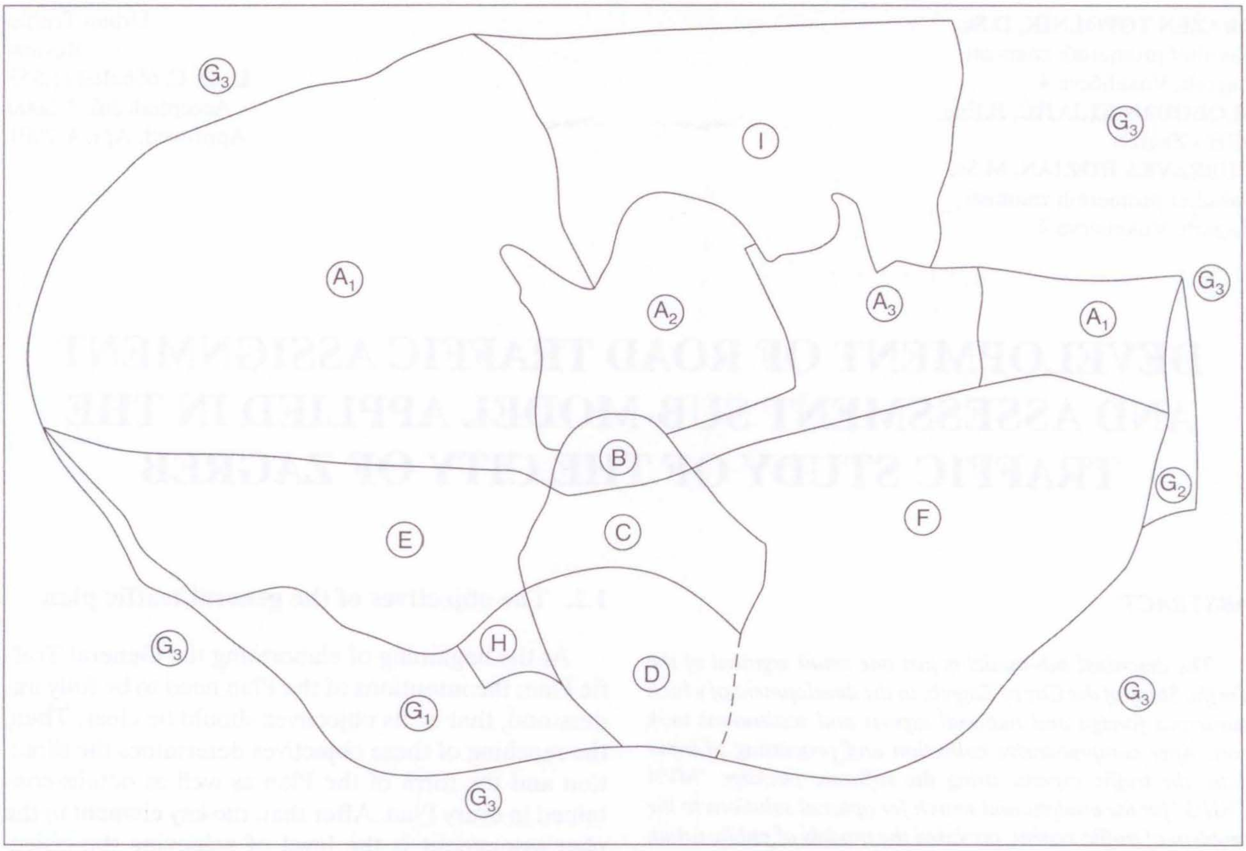

Figure 1 - System of sectors and screenlines

In order to present the distribution of journeys within the city, a system of sectors has been developed which is based on screenlines used for the survey carried out among the drivers (Figure 1). The cordons are imaginary lines that include movements within sectors or groups of sectors eliminating the possibility of failing to count the traffic or of double counting (Figure 2).

2.1. The assignment procedure

On the urban road networks, the flow which uses any section of the given network is the function of the provided service level. Therefore, the provided higher speed will attract more traffic to use that particular section of the network. However, the more traffic using this section of the network, the lower the speed, resulting in a discouraging effect on the traffic in this area. The assignment procedure needs to find a point of balance between the assigned flows and the level of provided service.

Many models of urban road traffic that use algorithms for finding this point of balance require that the so-called "Wardorp first principle" is satisfied. This principle says that all the used routes will have equal travelling costs, whereas all the non-used routes will have higher costs. In other words, this principle means that no driver can change their route for a faster one.

Obviously, this principle assumes that all the drivers are perfectly aware of the conditions that they will meet whichever route they select for commuting. Also, in the extreme case, although it is highly unlikely that this may happen: there will always be a certain number of drivers who do not travel often and who have poor knowledge of the network. At some places there is a significant variability in the levels of traffic and in congestion at different times from day to day, and the travelling times can be especially variable when the network is under load. Unpredictable things happen, and occasional accidents that may significantly change the conditions from the normal ones. However, experience has shown that in the regions with very busy traffic, accepting of the Wardorp principle gives results which correspond relatively well with the reality, especially in peak intervals where the ratio of commuters (regular passengers) is high.

Research has shown that in urban regions delays at intersections dominate the relations between travelling speeds and flows. Among queues at intersections, the travelling speeds are more dependent on the conditions along the road and the type of the road, than on the flow using the same road. For example, even in case of very low flows, the speeds will be much lower on roads with one lane through the shopping centre, than on two lanes on the open road. Queues and delays at intersections change with variations in flows and therefore this model accepts a detailed simulation of an intersection without the influence of speed on the flows in the link.

The accepted assigning procedure can be called "levelling out the traffic load". The procedure starts with assuming the conditions of free flow and transfers all journeys to the first series of the obtained routes that use the given free flow speeds. Delays at intersections are then recalculated based on the assigned flows, and a new series of routes and journeys are input again. Then the average of these tow series of journeys is calculated. These average flows are then used to calculate a new series of delays at intersections, a new series of routes is made and the journeys input again. Then the new average of new loads is taken and the average of the previous iterations. This procedure is repeated until convergence is obtained.

Different routes can be loaded by different vehicle categories. In that case, two loads are added, after applying the factor which converts them into the usual passenger car unit (PCU), and before new delays are calculated.

2.2. Convergence

Convergence in the assignment procedure is considered to occur when the fare of an average journey in the whole network is sufficiently close to the average minimal fare on the whole network. Statistical method used to determine convergence levels is usually called "delta" and is defined as:

$$\delta = \frac{\sum T_{ijr}(C_{ijr} - C_{ij*})}{\sum T_{ij} C_{ij*}}$$

where:

T_{ijr} – the number of journeys between i and j by using route r,

C_{ijr} – cost of route r between i and j,

C_{ij*} – minimum cost between i and j.

In the Zagreb model, the level of convergence has been set at less than or equal to 0.5% at three successive iterations, for the assignment procedure to be carried out automatically. This is a very demanding level of convergence.

2.3. Categories of users, pre-loading in pubic transport and passenger car unit

Two separate journey matrices are assigned to every iteration of the loading process:

- automobiles and light cargo vehicles, and
- heavy cargo vehicles.

This means that the flows of these two vehicle categories in the network can be presented separately, especially for the sake of environmental evaluation.

Flows of buses and trams travelling on fixed routes were set as pre-load on the road network prior to assigning travelling matrices of light and heavy vehicles. These pre-loads have been obtained from the public transport assignment sub-model.

Every type of vehicle in the road traffic assignment model, including pre-loading of the public transport has been distributed to the appropriate value of passenger car units (PCU) used to ponder the flows of all types of vehicles when delays at intersections were calculated in the model. Thus, the influence of the majority of vehicles on the traffic congestion can be taken into account in an adequate way.

The following passenger car unit (PCU) factors were used:

- automobiles and light vehicles 1.0
- heavy vehicles 2.5
- standard buses 2.5
- articulated buses 3.5
- trams 6.0

2.4. Generalised formulation of costs

The road traffic assignment process forms and imposes loads on the network based on the behaviour of a certain generalised formulation of costs. This is a linear combination of time and distance in the following form:

$$\text{costs} = a \cdot \text{time} + b \cdot \text{distance}$$

There are two series of values of parameters a and b, and each is assigned to each type of vehicles. For automobiles and light vehicles the results of assignment of the previously carried out testing have indicated that only time was the appropriate generalised formulation of the price for the route selection. For heavy vehicles the formulation has been used which is based on operative costs of cargo vehicles and value of time.

The values of parameters a and b are presented in Table 1.

Table 1 - Road traffic assignment parameters

Parameter	Light vehicles	Heavy vehicles
a	1.00	1.00
b	0.00	2.81

2.5. Calibration

Calibration is a procedure of adjusting the model in order to improve its compatibility with the obtained data. Two main areas of adjustment are possible in practice:

- adjustment of matrices to include activities that have not been quantified during the phase of development of matrices, and

- adjustment according to the coded links and intersections in the network.

In this model, the process was first carried out by the assignment procedure and comparison of the obtained flows on the link initially with the flows on the screenline and cordon, and then a detailed comparison was carried out with the recorded flows at certain locations at which the research was carried out.

The comparisons of screenlines and cordons mainly serve to insure that the procedure of developing the matrices provides correct total volumes of traffic in the assignment procedure. In that case, the assignment matrices were first increased by 12.5% to reflect the intra-zone travelling and other useless information collected during the survey. Besides, the flows in some sectors of matrices have been factored by the time interval in order to insure the balance of travelling to and from the centre for these sectors in accordance with the traffic count data.

Apart from the above described adjustments of matrices, no other adjustments were performed. Matrices have not been limited therefore to any of the screenline flows that would follow the initial development of matrices.

Initial network coding is based on the general procedure of using the link data collected during inventory-making of the network and on the data about the intersections collected at locations at all intersections with traffic signalling and roundabouts and on the pattern of other types of intersections.

During calibration, the assignment flows were used to analyse the actual functioning of certain intersections in the model by testing the directing of traffic in the network and by calculating the delays at modelled intersections. In this way the intersection coding is improved as necessary in order to insure that the behaviour in the model is an acceptable simulation of the actual behaviour at location.

It is important to keep in mind that the counts themselves used to assess how the model is functioning contain errors. Manual counts of the type carried out in Zagreb typically contain errors in the range of ± 10%. Moreover, there will be certain variations in the daily volumes of traffic, that have been reflected in the counts performed on different days and weeks. The adjustment for time variations is usual, using the data from automatic traffic counters (ATC) but here this was not possible because the data obtained by automatic counting were not available. We have no other choice but to assume that the counts were correctly done and to try to obtain a model that will generate maximally correct results, but it should not come as a surprise if there are differences between the modelled flows and the traffic count.

2.6. Assessing the screenline flow

The road traffic sub-model was evaluated at two levels: first, at the screenline level (described in this paper), and second, at the more precise level of location.

The main purpose of assessing the flow at the screenline level was to check whether:

- the total demand in the journey matrix, generated by processing the data obtained by surveying the drivers corresponds to the level of observed demand;
- the general distribution of journeys within the demand matrices corresponds to the observed movements; and
- general directing calculated from the assignment model corresponds also to the observed movements.

Assessing the model at a more precise level of link flow has the primary objective of testing whether the directing used during assignment is realistic.

The analysis of modelled and recorded flows uses summation statistics SS (known also as GEH), and modelled as:

$$SS = (\text{recorded} - \text{modelled})^2 / (0.5\,(\text{recorded} + \text{modelled}))$$

It should be kept in mind that the flow unit used in SS statistics is a vehicle per hour, and not a passenger car unit (PCU) used in the assignment models.

SS statistics has been developed in order to obtain greater tolerance for big differences in the percentages at lower flows, since there is no need to worry about the modelled flow that differs by 40% from the count, if the count amounts to only 100, but there is reason to worry if the count amounts to 1000. The reason for introducing such statistics is the impossibility of the absolute difference or relative difference to reflect the differences in a wide range of flows that are present in the Zagreb model.

The normal tendency is towards SS values for screenlines that would satisfy the following calibration goals:

< 5	85% screenlines,
< 7	95% screenlines,
< 10	100% screenlines.

A whole series of counts were performed during data collection, and these were related to locations at which the drivers were surveyed or independently on the whole main area of the Study. Additional data can be found in the research report. From this series of traffic counts, 26 screenlines were made, which divided the study area into smaller areas.

The screenline and cordon system used for assessment is presented in Figure 2. The first group of screenlines, numbered from 1 to 16, is composed of traffic counts carried out at locations where the drivers were surveyed, whereas screenlines numbered from 17 to 26 contain independently performed traffic counts.

Table 2: Summarised presentation of screenline assessment

	Percentage of screenlines that satisfy criteria for SS		
	< 5	< 7	< 10
Screenlines 1 - 16 only			
Goal	85%	95%	100%
Morning	69%	81%	94%
Off-peak	69%	81%	88%
Afternoon	81%	100%	100%
Screenlines 1 - 26			
Goal	85%	95%	100%
Morning	62%	81%	92%
Off-peak	69%	81%	88%
Afternoon	58%	85%	92%

The goals used to assess the screenlines are similar to other models used in Great Britain. Comparisons of screenlines regarding time intervals and goals to be achieved are presented in Table 2.

Generally, taking into consideration the remarks regarding accuracy and assessment of the counts, as well as dimensions and complexity of the Zagreb model, in our opinion, these results are satisfactory. They are comparable to the similar data for the models developed at other places.

2.7. Assessment of the link flows

The normal tendency is towards SS values for links that would satisfy the following calibration goals:

< 5	75% screenlines,
< 7	85% screenlines,
< 10	95% screenlines,
< 12	100% screenlines.

There is a total of 170 counts on the links for comparison with the recorded and modelled link flows. The assessment of the flows at certain links is a criterion which has less chance of being satisfied, and therefore the goals are less demanding.

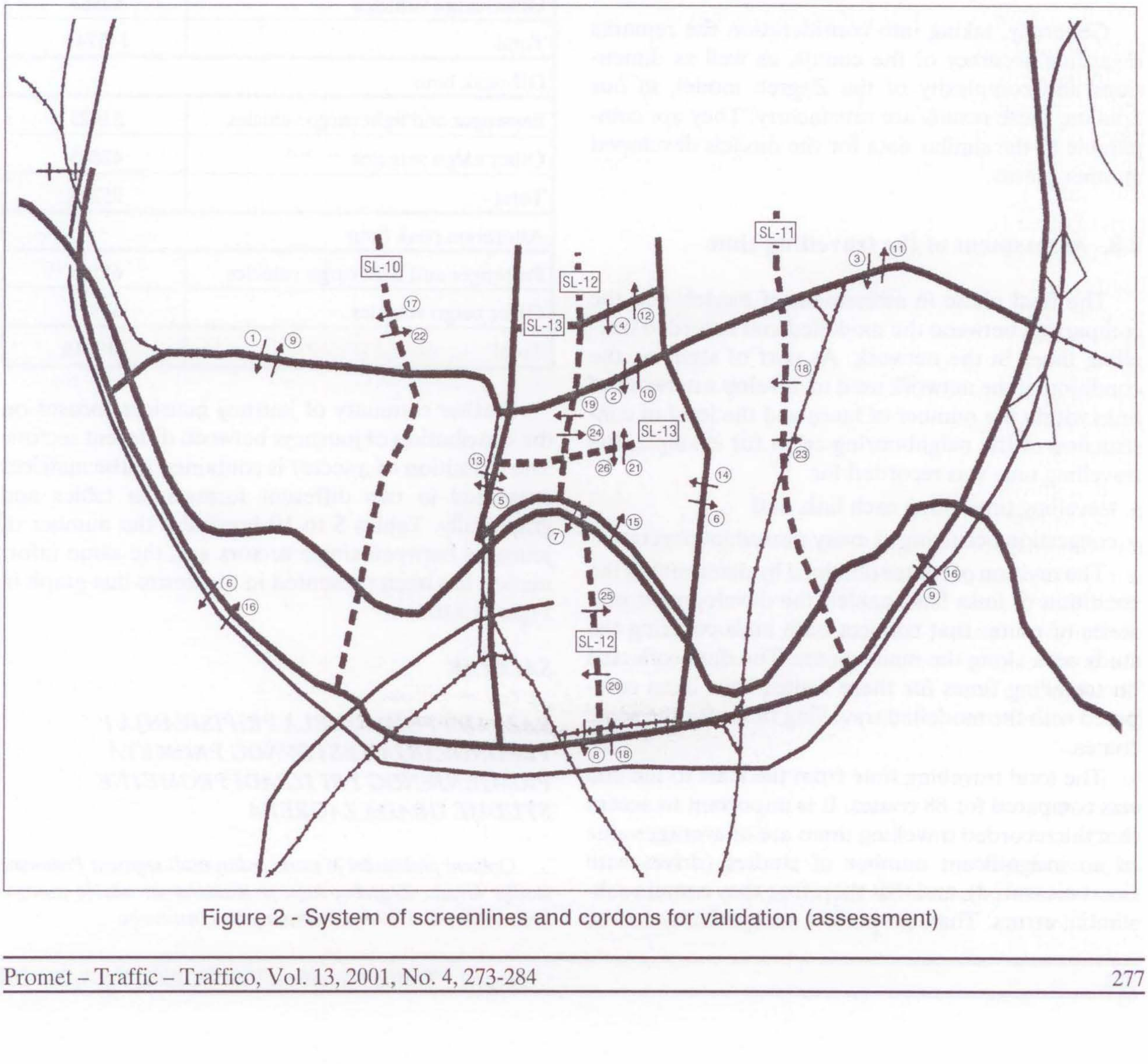

Figure 2 - System of screenlines and cordons for validation (assessment)

The goals used to assess the screenlines are similar to other models used in Great Britain. Comparisons of screenlines regarding time intervals and goals to be achieved are presented in Table 3.

Table 3: Summarised presentation of link flow assessment

	Percentage of screenlines that satisfy the criteria SS			
	< 5	< 7	< 10	< 12
Link flows only on screenlines 1 - 16				
Goal	75%	85%	95%	100%
Morning	51%	66%	79%	88%
Off-peak	64%	71%	85%	91%
Afternoon	50%	58%	80%	88%
Link flows on screenlines 1 - 26				
Goal	75%	85%	95%	100%
Morning	44%	58%	72%	82%
Off-peak	51%	59%	75%	82%
Afternoon	52%	54%	73%	78%

Generally, taking into consideration the remarks regarding accuracy of the counts, as well as dimensions and complexity of the Zagreb model, in our opinion, these results are satisfactory. They are comparable to the similar data for the models developed at other places.

2.8. Assessment of the travelling time

The final phase in assessment of models was the comparison between the modelled and recorded travelling times in the network. As part of studying the condition of the network used to develop a network of links within the number of lanes and the level of construction of the neighbouring areas for example, the travelling time was recorded for:

- travelling time along each link, and
- congestion occurring at every passed intersection.

The revision of routes obtained by determining the condition of links has enabled the development of a series of routes that connect both ends covering the study area along the main routes. The data collected on travelling times for these routes have been compared with the modelled travelling times for the same routes.

The total travelling time from the start to the end was compared for 88 routes. It is important to accept that the recorded travelling times are of average value of an insignificant number of studies (drives with times measured), and that therefore they contain substantial errors. Thus, no perfect compatibility can be expected then. In the given circumstances and taking into consideration the complexity of the Zagreb model, in our opinion the assessment of travelling times is acceptable.

2.9. Characteristics of finite journey matrices

As emphasised in this chapter, as part of the assessment procedure, some changes in the journey matrices have been done. The content of matrices of finite journeys has been summarised in this chapter. The total number of vehicle journeys (in passenger car units - PCU) for the main matrix categories have been summarised in Table 4. This emphasises a greater number of journeys in the afternoon peak hours as compared to the morning hours.

Table 4 - Summary of matrices of the outgoing vehicle journeys (PCU - passenger car units)

Time interval	Journeys
Morning peak hour	
Passenger and light cargo vehicles	62857
Other cargo vehicles	50887
Total	113744
Off-peak hour	
Passenger and light cargo vehicles	52423
Other cargo vehicles	42805
Total	95228
Afternoon peak hour	
Passenger and light cargo vehicles	65108
Other cargo vehicles	53911
Total	119019

Further summary of journey matrices focuses on the distribution of journeys between different sectors. The definition of a sector is contained in the matrices presented in two different formats: in tables and graphically. Tables 5 to 10 represent the number of journeys between single sectors and the same information has been presented in the desire line graph in Figures 3 to 8.

SAŽETAK

RAZRADA PODMODELA PRIPISIVANJA I VREDNOVANJA CESTOVNOG PROMETA PRIMJENJENOG PRI IZRADI PROMETNE STUDIJE GRADA ZAGREBA

Opisani podmodel je samo jedan mali segment Prometne studije Grada Zagreba, koja je izrađena uz učešće mnogobrojnih stranih i domaćih stručnjaka i institucija.

Table 5: Demand from sector to sector (passenger and light cargo vehicles) for the morning peak hour

	A1	A2	A3	A4	B	C	D	E	F	G1	G2	G3	H	I	Total
A1	990	348	248	2	695	817	267	1162	377	79	0	623	57	0	5573
A2	221	342	220	9	1203	732	320	598	264	33	0	426	10	0	4377
A3	300	226	1678	187	989	609	245	630	956	46	0	659	23	0	6547
A4	21	57	273	171	130	112	86	53	173	6	56	251	0	0	1389
B	470	737	690	46	1034	703	284	587	392	4	0	252	18	45	5262
C	366	476	471	24	981	1021	762	782	452	22	0	764	23	0	6144
D	500	391	356	168	966	880	1447	789	686	107	0	977	27	43	7337
E	1388	869	544	35	882	1063	952	2978	667	263	0	1503	187	28	11359
F	101	218	777	136	264	180	441	378	815	43	0	348	9	11	3721
G1	72	24	54	6	37	68	33	298	92	27	1	32	5	6	755
G2	0	0	4	0	4	0	0	1	0	0	0	11	0	0	20
G3	812	839	731	333	823	1104	640	1717	1350	83	23	832	60	84	9431
H	17	29	60	0	21	67	88	30	20	19	0	54	6	0	411
I	0	0	0	0	90	121	85	122	31	4	0	66	14	0	533
Total	5258	4556	6106	1117	8119	7477	5650	10125	6275	736	80	6798	439	217	62859

Table 6: Demand from sector to sector (other cargo vehicles) for the morning peak hour

	A1	A2	A3	A4	B	C	D	E	F	G1	G2	G3	H	I	Total
A1	836	315	234	2	568	817	228	1047	264	40	0	485	38	0	4874
A2	211	269	197	9	1069	717	262	520	247	33	0	328	10	0	3872
A3	300	206	1475	101	943	599	214	499	588	35	0	553	23	0	5536
A4	21	57	232	53	130	81	86	50	98	6	0	180	0	0	994
B	401	664	523	46	916	655	263	571	289	4	0	249	17	45	4643
C	347	446	390	24	812	898	440	701	272	12	0	447	9	0	4798
D	452	391	343	52	904	752	1092	617	591	101	0	635	27	29	5986
E	1286	731	516	9	832	979	754	2424	503	205	0	1046	137	18	9440
F	86	162	634	34	221	152	329	198	404	43	0	239	9	11	2522
G1	54	24	36	6	37	68	33	181	66	17	0	32	5	6	565
G2	0	0	4	0	4	0	0	1	0	0	0	0	0	0	9
G3	553	694	489	206	757	682	586	1453	794	83	23	476	42	40	6878
H	17	29	12	0	21	42	69	30	20	8	0	35	3	0	286
I	0	0	0	0	90	117	61	114	29	4	0	59	14	0	488
Total	4564	3988	5085	542	7304	6559	4417	8406	4165	591	23	4764	334	149	50891

Nakon iscrpnog prikupljanja i obrade ulaznih podataka, prometni su stručnjaci uz pomoć programskog paketa "MVA TRIPS" za analizu i iznalaženje optimalnih rješenja problema prometnog sustava ponudili modele javnog gradskog prijevoza za budućnost.

U ovom je članku opisana razrada i vrednovanje pod-modela u pripisivanju cestovnog prometa za jutarnje vršno, poslijepodnevno vršno i prosječno izvanvršno razdoblje. Opisana su načela postupka pripisivanja i testovi konvergencije. Specificirane su: kategorije korisnika, predopterećenost javnog prijevoza i jedinica putnički automobil (PAJ). Ključna odrednica izbora trase je uopćena formula troškova prikazana u članku. Također su definirani postupak kalibracije i vrednovanje konačnog modela prema tokovima na skrin linijama, tokovi na linkovima i vremena putovanja. Na samom kraju su sažeto prikazane glavne karakteristike konačnih matrica putovanja.

Table 7: Demand from sector to sector (passenger and light cargo vehicles) for the off-peak hour

	A1	A2	A3	A4	B	C	D	E	F	G1	G2	G3	H	I	Total
A1	785	266	292	10	491	361	271	1330	185	28	0	578	25	0	4622
A2	212	278	224	16	830	477	334	616	302	27	1	456	11	0	3784
A3	261	221	1278	125	632	436	268	430	606	36	6	719	8	0	5026
A4	21	23	138	47	42	28	51	44	64	6	5	227	2	0	698
B	491	830	632	42	1017	715	452	792	384	44	1	422	16	66	5904
C	344	437	439	28	861	813	653	1002	333	77	0	646	33	32	5698
D	271	334	268	51	787	483	1121	726	308	121	2	750	61	32	5315
E	1330	616	430	44	932	600	823	2975	474	210	2	1375	63	52	9926
F	185	302	606	57	306	134	317	327	531	21	4	517	14	21	3342
G1	28	27	36	6	57	65	103	224	33	23	0	51	36	2	691
G2	0	1	6	5	0	0	2	2	7	0	0	0	0	0	23
G3	578	456	719	227	609	545	632	1451	830	53	22	649	38	30	6839
H	25	11	8	2	16	33	61	63	9	36	0	38	2	2	306
I	0	0	0	0	66	36	27	55	33	2	0	30	2	0	251
Total	4531	3802	5076	660	6646	4726	5115	10037	4099	684	43	6458	311	237	52425

Table 8: Demand from sector to sector (other cargo vehicles) for the off-peak hour

	A1	A2	A3	A4	B	C	D	E	F	G1	G2	G3	H	I	Total
A1	664	245	191	10	417	301	232	1140	137	22	0	437	21	0	3817
A2	199	240	195	16	757	425	243	481	179	22	1	327	11	0	3096
A3	224	196	1091	108	557	363	219	372	429	27	4	484	8	0	4082
A4	21	23	120	43	35	22	38	38	46	6	3	172	2	0	569
B	417	757	557	35	967	647	402	706	311	29	4	395	13	61	5301
C	310	395	379	22	750	755	579	921	272	68	0	453	25	28	4957
D	232	243	219	38	703	429	963	604	241	106	2	543	52	31	4406
E	1140	481	372	38	833	551	675	2606	351	160	2	1042	55	38	8344
F	137	179	429	43	248	109	279	251	341	21	1	284	14	19	2355
G1	22	22	27	6	55	51	90	172	33	20	0	38	29	2	567
G2	0	1	4	3	0	0	2	2	2	0	0	0	0	0	14
G3	437	327	484	172	507	407	458	1104	461	36	14	380	29	21	4837
H	21	11	8	2	13	25	52	55	9	29	0	29	2	2	258
I	0	0	0	0	61	34	26	40	29	2	0	21	2	0	215
Total	3824	3120	4076	536	5903	4119	4258	8492	2841	548	31	4604	263	202	42818

Table 9: Demand from sector to sector (passenger and light cargo vehicles) for afternoon peak hour

	A1	A2	A3	A4	B	C	D	E	F	G1	G2	G3	H	I	Total
A1	822	291	249	8	453	350	481	1336	97	69	0	782	16	0	4954
A2	284	190	386	16	706	439	377	837	210	23	0	808	28	0	4304
A3	267	229	1640	259	665	412	342	524	747	52	4	705	58	0	5904
A4	83	17	287	256	45	23	162	33	185	6	0	321	0	0	1418
B	669	1160	953	125	1065	631	788	1162	422	31	4	729	20	87	7846
C	601	910	623	107	992	944	1116	1596	339	176	0	733	64	181	8382
D	257	308	236	83	1636	838	1437	603	184	65	0	1265	85	168	7165
E	1117	575	606	51	1185	590	1584	2972	256	405	1	2336	29	165	11872
F	363	254	919	191	362	154	778	524	685	56	0	817	16	19	5138
G1	76	32	44	6	98	36	99	286	59	39	0	28	19	4	826
G2	0	0	0	54	0	0	0	0	0	1	0	0	0	0	55
G3	599	409	634	242	380	540	897	1638	489	78	12	573	52	64	6607
H	54	9	22	0	17	22	26	179	0	5	0	58	6	13	411
I	0	0	0	0	43	17	39	30	16	6	0	81	0	0	232
Total	5192	4384	6599	1398	7647	4996	8126	11720	3689	1012	21	9236	393	701	65114

Table 10: Demand from sector to sector (other cargo vehicles) for afternoon peak hour

	A1	A2	A3	A4	B	C	D	E	F	G1	G2	G3	H	I	Total
A1	721	266	249	8	387	342	435	1238	82	52	0	532	16	0	4328
A2	217	190	333	16	636	415	377	704	156	23	0	668	28	0	3763
A3	219	229	1352	216	504	412	330	497	609	35	4	471	11	0	4889
A4	83	17	162	74	45	23	50	9	51	6	0	199	0	0	719
B	546	1030	909	125	893	563	725	1095	351	23	4	659	20	87	7030
C	601	910	547	78	869	803	954	1470	286	176	0	715	41	86	7536
D	220	253	207	83	1517	483	1085	558	149	65	0	1158	67	120	5965
E	1007	500	480	48	1154	529	1393	2581	143	246	1	1978	29	155	10244
F	254	237	565	116	267	93	653	499	359	40	0	484	16	17	3600
G1	39	32	33	6	47	36	93	224	59	21	0	28	8	4	630
G2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G3	467	315	533	173	357	328	583	1140	342	19	12	384	34	56	4743
H	36	9	22	0	16	8	26	132	0	5	0	41	2	13	310
I	0	0	0	0	43	17	26	20	16	6	0	39	0	0	167
Total	4410	3988	5392	943	6735	4052	6730	10165	2603	717	21	7356	272	538	53924

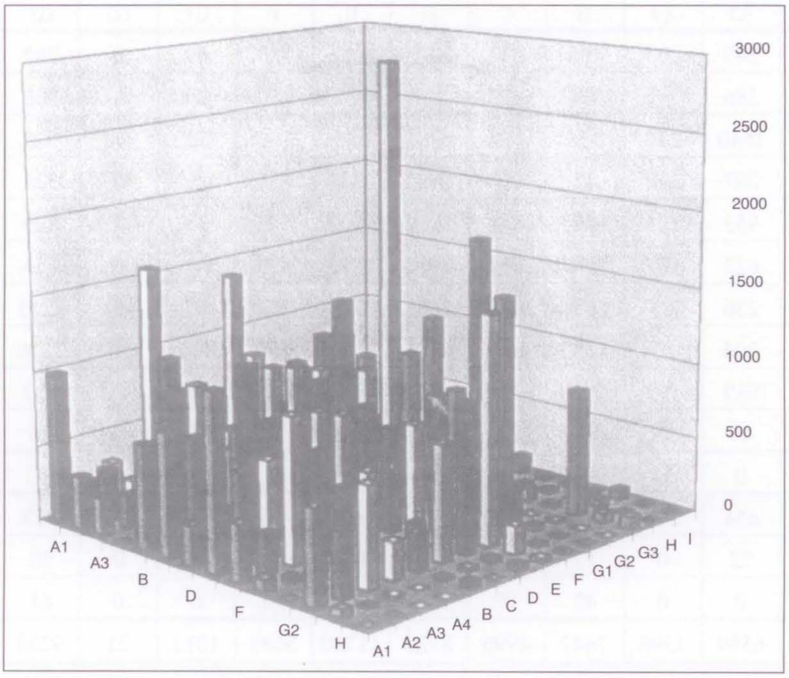

Figure 3 - Demand from sector to sector (passenger and light cargo vehicles) - morning peak hour

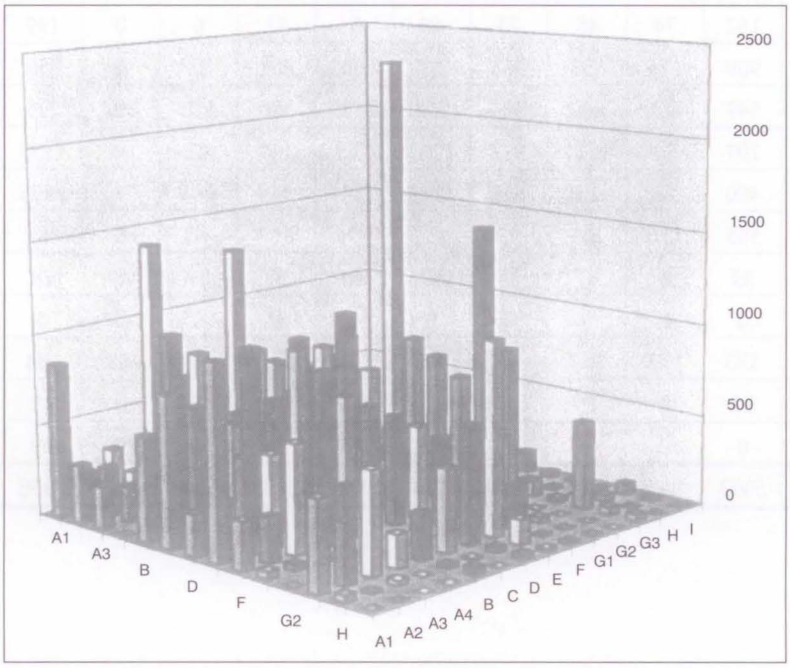

Figure 4: Demand from sector to sector (other cargo vehicles)-
-morning peak hour

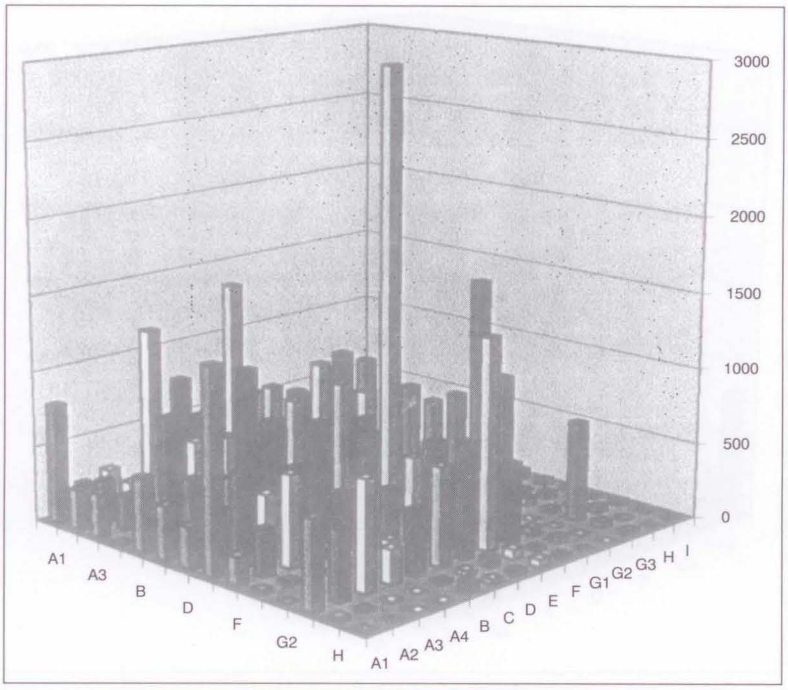

Figure 5: Demand from sector to sector (passenger and light cargo vehicles) -
- off-peak hour

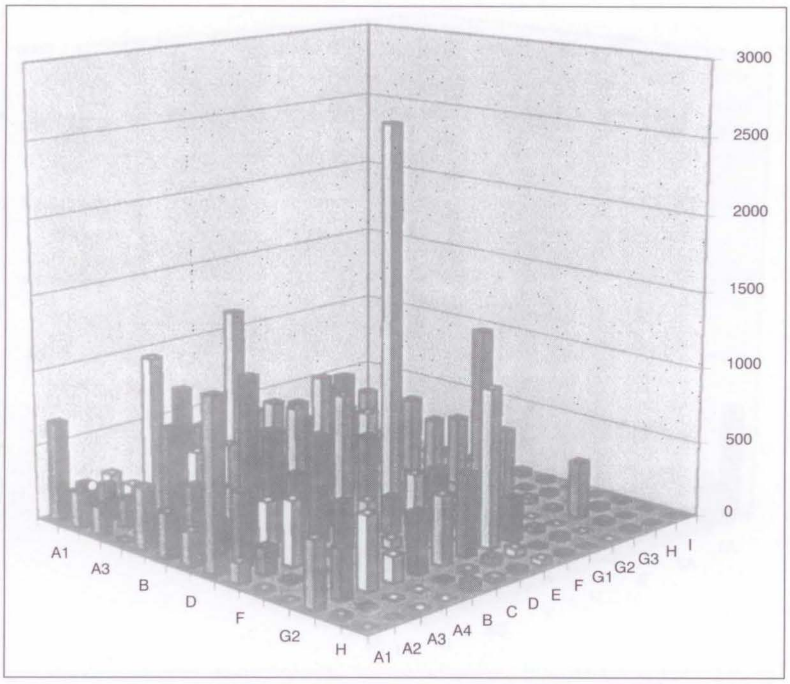

Figure 6: Demand from sector to sector (other cargo vehicles) - off-peak hour

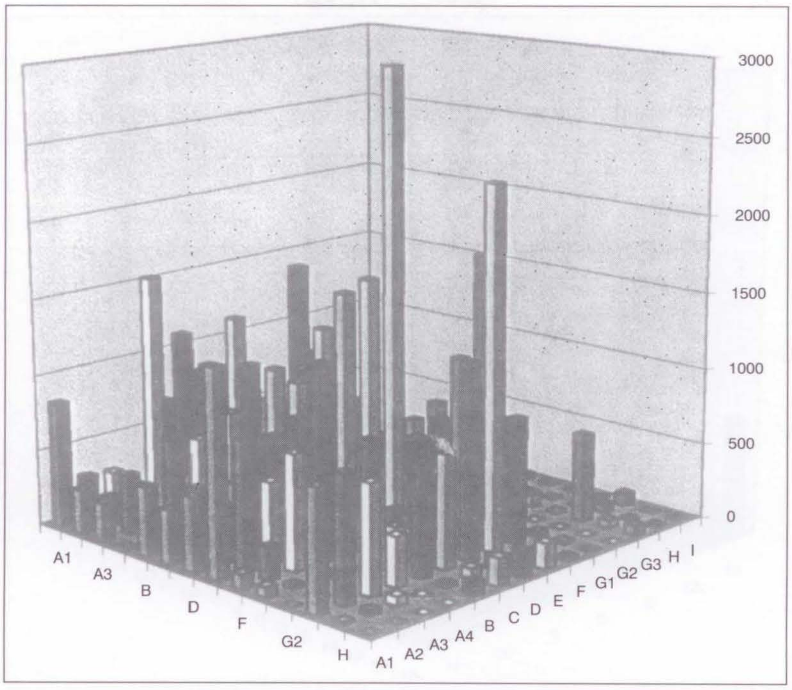

Figure 7: Demand from sector to sector (passenger and light cargo vehicles) -
- afternoon peak hour

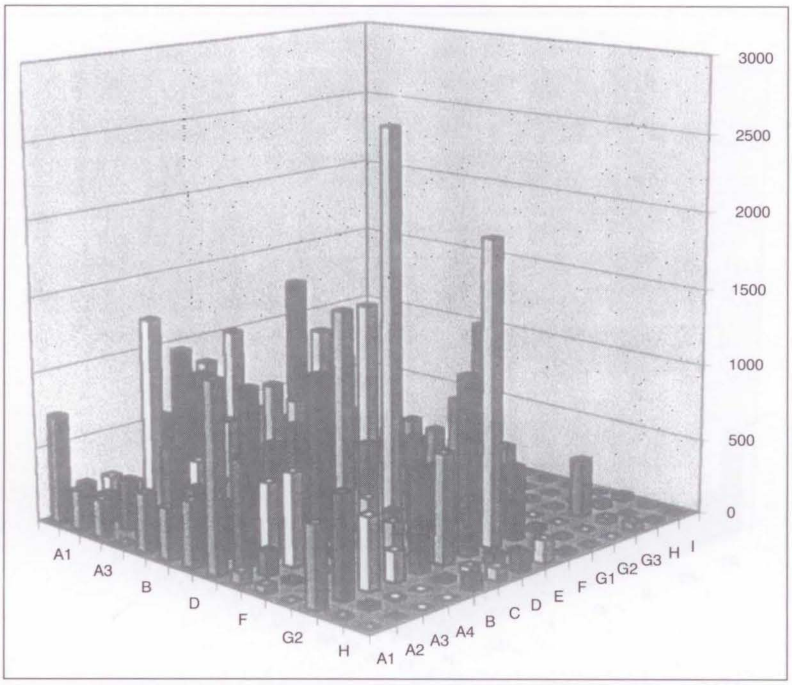

Figure 8: Demand from sector to sector (other cargo vehicles) - afternoon peak hour