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TRANSPORTATION STUDY FOR THE CITY OF KRAGUJEVAC

Key Words

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Traffic forecast;
Land use study

Abstract

The research study of traffic in Kragujevac belongs to a group of expertise documentation made or which is being made, as an analytical basis for the design of General Urban Plan of Kragujevac by the year of 2025. The article shows the basic results of the research carried out during the study, as well as the proposed measures for the advancement of traffic in Kragujevac.

1. INTRODUCTION

The main reason for the creation of the research study of traffic in Kragujevac was to determine the current state and development of the primary road and street network of Kragujevac, as a necessary constituent of General Urban Plan of

Kragujevac by the year of 2025. The spatial coverage of the research study is the area of General Urban Plan, including state roads of the first and second category on the above mentioned territory. The railway infrastructure and facilities, since within the planned period there are not any planned changes in spatial terms, they are not specially considered and in the planned period they are kept in the current state. The zone system of the study contains 104 traffic zones out of which five represent the so called outer zones and 99 are within the borders of the General Urban Plan - local zones. The borders of the local zones are based on statistical division (statistical circles), within the borders of local communities, and the centroids of the outer zones are located on intersection of state roads of the first and second category and the borders of General Urban Plan.

Information basis of the study consists of three groups of data:

1. Socioeconomic data (households, population, employment,...)
2. Characteristics of road and street network (categorization, capacity, regime...)
3. Data on traffic determined through research studies (surveys, traffic counting, speed reduction...)

2. ANALYSIS OF CURRENT STATE

Information basis of the study of traffic in Kragujevac consists of five basic data groups:

1. Characteristics of the basic road and street network,
2. Intensity and structure of traffic on the basic road and street network
3. Travel characteristics of Kragujevac residents, and
4. Socioeconomic characteristics of residents and indicators of economy development
5. Spatial distribution of the basic components of land use on the territory of General Urban Plan.

The existing data sources from the documentation of General Urban Plan were used for forming the information basis. The data were complemented by data obtained in the research through traffic counting and speed reduction on the basic road and street network, and through the survey conducted among the traffic participants, carried out by the method of home interviewing.

All data of the information basis were sorted by certain indicators and shown in numerical-table and graph form.

For the needs of forming information basis the area of the General Urban Plan was divided into local communities within which the division into traffic zones was carried out. The borders of the traffic zones were determined by grouping statistical circles within each local community on the territory of the General Urban Plan, which enabled the data use from the official statistics (through statistical circles) and simultaneously their aggregation to a higher spatial level: traffic zones and local communities.

In total, 104 traffic zones were determined, out of which the zones from 001 to 099, the so called local zones, which are the basic spatial carrier of the information about demographic and economic characteristics of the residents and their travel attributes, as well as the indicators of the intensity of land use. Traffic zones, numerated from 101 to 105 are the so called outer zones and with the aggregated data on traffic on state roads of the first and second priority on the territory of the City of Kragujevac. Traffic zones 101 – 105 are located on the intersection of roads of the first and second category with the border of General Urban Plan of Kragujevac.

2.1. Surveys

For the needs of the study, the following surveys were conducted:

1. Traffic counting on the road and street network

Traffic counting on the street network of the city of Kragujevac was conducted at totally 27 positions, out of which there are 20 intersections, 1 interchange and 6 sections. Traffic at the intersections was counted in the period 06:00-09:00 and 14:00-17:00, and at the sections in the continuity from 06:00 to 18:00.

2. Survey in households

Surveys in households were conducted in local communities on the territory of General Urban Plan of Kragujevac. It had been planned that the survey is carried out on the sample of 1% of the households in 38 local communities, that is, in totally around 500 households..

3. Determining basic demographic and economic characteristics

4. Survey on the external cordon

5. Velocity measuring on the basic road and street network of Kragujevac

2.2. Travel characteristics

For the needs of the analysis of the current state and travel characteristics, the analysis of exploitation characteristics of the existing network in peak hours was carried out. Analyzing the capacity and the level of service at intersections where the traffic counting was carried out, the following data were obtained.

Travel with original and target zones within the borders of the general plan represent the so called inner-city travel. The travel within the city territory, depending on the motive, the distance, that is travel time, can be carried out by all traffic means existing in the given conditions, including walking.

The average mobility of inhabitants of Kragujevac determined in the survey in the households is 2.21 units of travel a day by all transport means, which, if applied to the number of residents in Kragujevac, which is around 152,400 residents, results in 336,750 units of travel a day.

Table 1. Peak hour LOS

Intersection	LOS	Intersection	LOS
R1	C	R11	F
R2	C	R12	C
R3	F	R13	F
R4	D	R14	D
R5	F	R15	F
R6	E	R16	E
R7	D	R17	C
R8	C	R18	F
R9	C	R19	D
R10	F	R21	C

Table 2. Modal split

Method	On foot	Bicycle	Private car driver	Private car passenger	Private car	JPP	Other	total
Travel number	138,070	6,060	86,210	31,650	117,860	70,380	4,380	336,750
(%)	41.0	1.8	25.6	9.4	35.0	20.9	1.3	100.0

Table 3. Travel by purpose

purpose motive	Going to work	schooling	shopping	Returning to flat/house	Other	total
Travel number	55,227	24,583	42,767	153,221	60,950	336,750
(%)	16.4	7.3	12.7	45.5	18.1	100.0

Table 5. Traffic on the external cordon

Road name and label	Traffic zone	Target traffic	Original traffic.	totally I-C	Transit	total	Transit (%)
Kragujevac-Batočina IB 24	101	3,204	3,207	6,411	557	6,968	8.0
Kragujevac-Topola IB 25	102	3,163	2,937	6,100	272	6,372	4.3
Kragujevac- G. Milanovac IIA 177	103	2,672	2,418	5,090	216	5,306	4.0
Kragujevac-Kraljevo IB 24	104	2,712	2,310	5,022	514	5,536	9.3
Kragujevac-Rekovac II A 183	105	1,282	1,098	2,380	122	2,502	4.9
total		13,033	11,970	25,003	1,681	26,684	6.3

2.3. Calibration of transport model

Calibration of the model was carried out on the level of vehicles counting at the most important intersections and sections, which has been shown in the following figure:

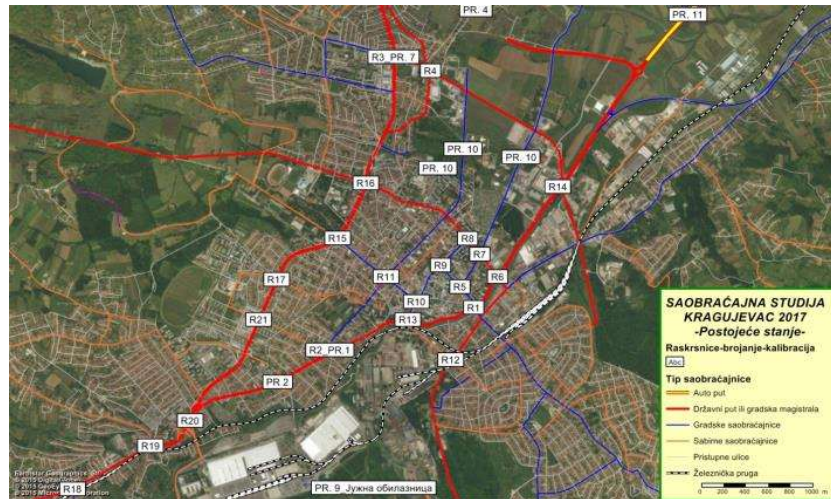


Figure 1. Counting positions for traffic counting and model calibration

The model was calibrated on the base year 2017 with totally 96 links. Mean relative mistake of 7% and correlation coefficient R^2 of 0.97 were achieved with the calibration, as shown in the following figure.

Based on the above, it can be seen that the estimated (e.g. modeled) flows correspond to the observed flows (counted). This implies that the model corresponds to the purpose and it can be freely used in the development of traffic forecasts in Kragujevac, as it can be seen in the following figure:

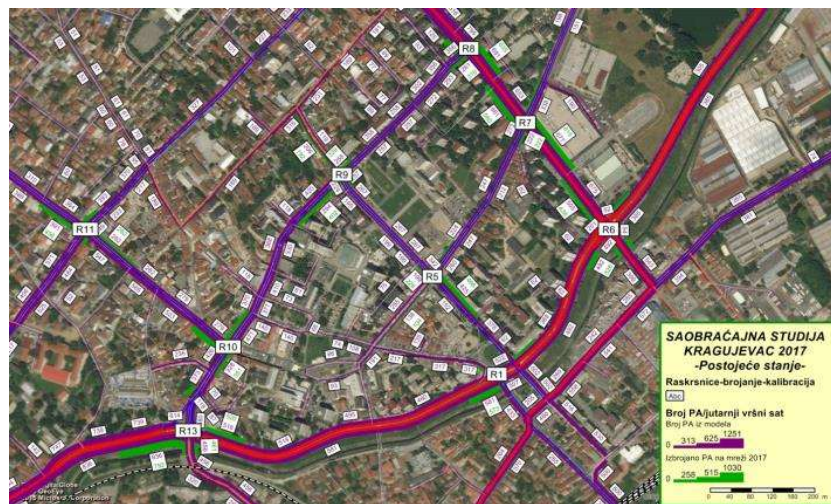


Figure 2. Calibrated model

3. PROPOSED MEASURES AND ACTION PLAN

Within the proposed measures for the improvement of traffic flow conditions on the territory of the city of Kragujevac, altogether 12 proposed measures have been analyzed, further explained:

- Small scale intersection with a roundabout.
- The end of the street Braće Petković on the section from Interchange Centralna Radionica to Kneza Mihaila Street
- The construction of Pozorišna Street from Daničićeva Street to Lepenički Boulevard
- The completion of the construction of Petrovačka highway to the road for Topola.
- The completion of the construction of the second roadway lane of Kneza Miloša Street from Male Vaga to Grad Sirena Street and further to Petrovačka highway
- The completion of construction of Dragojla Dudića Street to the intersection with Gornji Milanovac Road, as to connect the direction to Gornji Milanovac and Kraljevo
- Analysis of validity (from the aspect of service level) of the roundabout construction at the intersection number 3 “Crva na Aerodromu” (“Worms at the Airport”)
- The construction of 4 lanes in the street Miodraga Vlajića Šuke from Save Kovačevića Street to Beogradska Street.
- Simulation of transit with the completion of the first phase of the construction of the south bypass to the interchange “Korićani”
- The construction of the street Đure Pucara Starog and Dragana Panića Street from Save Kovačevića Street to Milentija Popovića Street (Direction of the state road towards Topola)
- Simulation of the transit with the completion of the first phase of the north bypass construction from the intersection Petrovački highway and the road towards Topola and state road to Kraljevo
- Roundabout at the intersection number number 16 at Medical School.

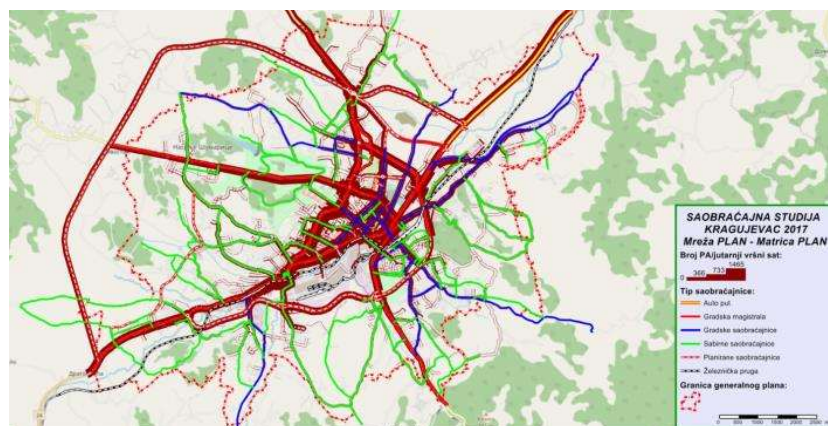


Figure 3. Traffic volumes with proposed measures

On the basis of the analysis of the proposed measures, from a traffic point of view, the following has been concluded:

- The proposal number 12, i.e., the roundabout at the intersection number 16 at Medical School has no validity since the land use of the roundabout planned in this way is over 109%.
- The proposal number 11 (Northern bypass) has no validity since there is going to be less than 250 PA/h in the peak hour by one downstream and the capacity utilization is going to be less than 20%,
- The proposal 10 (Direction of the state road towards Topola) has no validity since there is going to be less than 250 PA/h in the peak hour in one downstream and the utilization is going to be less than 20%,
- The proposal 6 (Dragojla Dudića - Connection Gornji Milanovac - Kraljevo) also has no validity since there is going to be less than 250 PA/h in the peak hour in one downstream and the capacity utilization is going to be less than 20%.

On the other hand, the measures which are justified and which are to be implemented as soon as possible are:

- Proposal number 1 should be realized as soon as possible, that is, the existing intersection "Mala vaga" should be reconstructed into a roundabout,
- Proposal 7 (to reconstruct the intersection number 3),
- Proposal 8 (Miodraga Vlajića Šuke Street),
- Proposal 4 (Petrovačka highway)
- Proposal 5 (Kneza Miloša Street)
- Proposal 9 (the first phase of the southern bypass - Kraljevačkog Bataljona Street)
- Proposal 2 (Braće Petković)
- Proposal 3 (Pozorišna Street).

4. CONCLUSIONS

The research study of traffic in Kragujevac has been carried out as an analytical and graphical basis for General Urban Plan "Kragujevac 2025." This research study was preceded by corresponding research and documentation collecting which were the basis for the analysis of the current state and for the proposed measures for interventions in the short-termed period. The forecast of the expected traffic has been done by models based on indicators of the current state and the expected demographic and economic development of Kragujevac, and based on the data from the documentation and specialist studies made for the needs of General Urban Plan. In the study there are proposed measures for the improvement of the conditions of passenger traffic by enlarging pedestrian zones in the centre and the reduction of street and surface parking by constructing public garages, as well as the recommendations for the development of cycling traffic, as an element of the concept of sustainable urban mobility. These measures mean building cycling infrastructure in the city and suburban territory of the city of Kragujevac.

Apart from that, the recommendations were given that alongside the plan and project documentation, by priorities previously stated, there should be a research study related to the validity of northern and southern bypass, which will take into consideration not only the traffic -economic effects, but also the benefits which will be achieved in ecological and social plan, with the removal of the transit and freight traffic from the centre to the peripheral parts of the city area.

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