

# Analysis of the level of satisfaction of road network users - case review of road section Koprivna – Modriča (r-465)

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**Abstract:** The paper conducts a survey of satisfaction level of users of two lane road in regards to constructional-geometrical factors influencing unimpeded traffic and influence of human element during its maintenance. Establishing the satisfaction level of users of existing road network is the primary goal of the paper, through the definition of Level of Service of relevance for the analysis of traffic of inter-urban road network. The survey was conducted on the road section Koprivna – Modriča, regional road R-465 (Bušletić- Modriča). Using a questionnaire, the values of influence to the level of users' satisfaction were established. Traffic infrastructure and elements of horizontal road signs have been identified as two main indicators giving negative grade to the level of satisfaction. The end of paper gives a review of measures for the improvement of existing conditions.

**Keywords:** Level of Service (LOS), road network, road section.

## INTRODUCTION

Basic parameter of analysis of traffic and traffic infrastructure characteristics has been given through the analysis of capacities and Level of Service using calculations of practical capacities. Capacity or permeability of functional parts of road networks, in its broadest definition means a maximum number of vehicle flow that can be reached on observed functional section of road network in a time frame and in conditions of technical-exploitation, traffic, regulations and environment.

The HCM-2000 and HCM-2010 [1, 2] manuals represent quantitative values of Level of Service. Term Quality of Service is noted as a new change in approach to methodology for appropriate elements of the system.

According to HCM-2010 [2] Quality of Service means an indicator of satisfaction of users with completed travel (movement). Manuals [1, 2] provide basic functional interdependence of Quality and Level of Service with perception – users' satisfaction that Quality of Service is based upon.

The second chapter provides theoretical view of the analysis of capacities and Level of Service on two lane road with emphasis on final outputs of this analysis. The third chapter is methodology of research and discussion on the most significant results. The final chapter of this

paper shows a set of measures for the improvement, results of which should be verified by increase in the Level of Service on observed road section.

## THEORETICAL FOUNDATION FOR ANALYSIS OF CAPACITY AND LEVEL OF SERVICE ON TWO LANE ROADS

Analysis of the capacities and Level of Service are based on three levels [3]:

- operational analysis,
- design analysis and
- planning analysis.

Operational analysis establishes the practical capacity and Level of Service on the existing two-lane roads in achieved sizes and characteristics of traffic, as well as the calculations of practical capacity and Level of Service on existing or planned - designed roads in future sizes and characteristics of traffic. These analyses are separately conducted in segments of average road and terrain conditions and separately for segments of specific longitudinal slopes.

Design analysis of capacity can also be used for establishment of influence of design elements to both the capacity and Level of Service, such as the number of lanes and visibility, curve diameters and other. Detailed data of the expected traffic and conditions are necessary along with standard geometrical measures used in de-

sign of lane width, side interference, calculation speed and horizontal and vertical curves. Design of road sign plan can also be established with the help of analysis of the capacity and Level of Service.

Analysis of traffic conditions in planning of new roads help road planners to determine value of PGDS (Annual Average Daily Traffic (abbr. AADT)) accepted by a two-lane road for different Level of Service and terrain conditions. Considering that number of lanes when planning a two-lane road is already determined, the improvement of traffic conditions or increase of AADT on a planned road is possible through improvement of design elements, decrease of road ascents as well as additions on ascending sections.

HCM-2000 and HCM-2010 manuals give a new, multi-mode approach to analysis of capacity and level of service. Research will often use, according to these two manuals, the Level of Service and Quality of Service (QS) as two cornerstone indicators. Quality of Service is an indicator of satisfaction of users with travel (movement). Level of Service is a qualitative measure describing traffic conditions with the help of indicators such as speed and time of travel, traffic distractions, freedom of maneuvering and comfort [3]. Level of Service is a qualitative measure of network traffic. Level of Service means a qualitative measure of traffic conditions. Descriptions of individual Levels of Service define these conditions with the help of indicators such as speed and time of travel, traffic distractions, freedom of maneuvering and comfort. [1, 2]

Roads (segments) with two lanes are methodologically based on traffic operations measuring along the sections (segments) of the road, based on terrain, geometric elements and traffic conditions. This methodology is typical for sections of two-lane roads with segment length of 3 km. The data received must be applied for methodology of two lane road including hourly frequency in both directions, peak hourly frequency (PHF) and direct distribution of traffic. [4] Also, additional research needs to be conducted when establishing the capacity of two-lane roads. The research needs to include the influence of effects which decrease traffic flow such as overtaking zones, horizontal/vertical road lane, and influence of existence of capacity in access to roads. [5]

The conditions are quite different because of expectations of drivers and operative characteristics in categories of two lane roads, and therefore it is difficult to use single definition of travel conditions per each Level of Service (LOS). [2, 3, 6]

Wider analysis area is a combination of connected transportation objects. The analysis systems include combination of objects and order in the region. These levels of analysis are usually used in models of travel search and other networks of wider analysis. [5, 7]

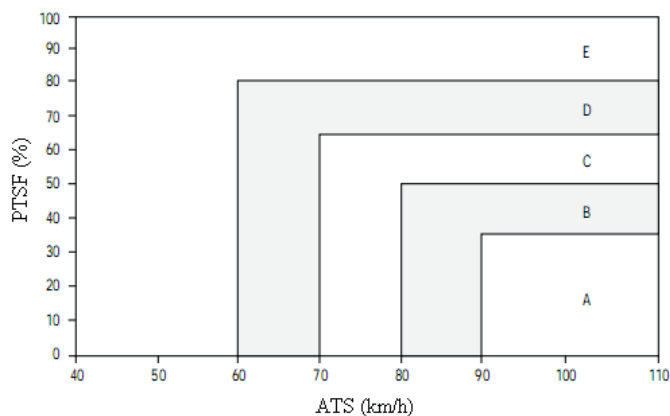


Figure 1. Criteria of Level of Service (graphic) for two lane roads [1]

Very important indicators are established through analysis of capacity and Level of Service [6]:

1. "Bottlenecks" on the existing network and basic cause of bottlenecks in comparison to achieved and expected traffic.
2. Technical measure necessary for the removal of bottlenecks on the existing network (through increase in capacity and/or improvement in Level of Service) through new construction, renovation and/or regulation measures.
3. Ability of designed technical solutions to intake projected traffic on a satisfactory Level of Service.
4. Indicators on traffic conditions in access to intersections in level (relation traffic/capacity through access and loss of time) are necessary for optimization of direction measures which improve traffic conditions in intersections in the level.
5. Indicators on conditions of movement of vehicles in the network, that is, the input data for:
  - Analysis of costs of usage of motor vehicle (fuel, lubricants, tires, spare parts and other),
  - Analysis of loss of time drivers and goods experience on the road as well as and
  - Analysis of gas emissions and noise in the network (both existing and improved).

## RESEARCH RESULTS AND DISCUSSION

A research has been conducted using a questionnaire on 100 people where data on the Level of Satisfaction of the given road section has been acquired.

### Research methodology and basic hypothesis

The observed section is on regional road R-465 (Bušletić- Modriča 2). The regional road connects to main road M-17 Doboje- Šamac. The regional road R-465 is 31,782 km in length, and connects in Modriča to the aforementioned main road M-17 (Doboje- Modriča-Šamac). The observed section is 17.71 km in length and

goes through inhabited places. AADT value of road section Koprivna – Modriča have in the past ten years moved from 1331 to 1174 (veh/day), and is in mild decline.

The survey was anonymous with 100 people on observed section Koprivna – Modriča, 17.71 km in length and it was aimed at establishing level of satisfaction of user with existing regional road network Koprivna – Modriča. Subject of the analysis was the Level of Satisfaction of users of regional asphalt road. Persons under the age of 18 were not surveyed, but drivers only, in order to determine research and positive and negative remarks to existing road section. Tables 3.1. and 3.2. show the number of surveyed people as well as questionnaire questions.

This paper aims at the establishment of adequate indicators influencing the decrease of quality of service given to users by this road section through the research conducted on a two-lane road.

### Analysis of research results

The research produced results shown in tables 3.1. i 3.2. The first table shows gender and age structure, as well as purpose of travel on the road section.

**Table 1.** Structure of surveyed people

| Structure of surveyed people: |                           |    |     |
|-------------------------------|---------------------------|----|-----|
| Gender                        | Male                      | 70 | 70% |
|                               | Female                    | 30 | 30% |
| Age                           | 18-30                     | 30 | 30% |
|                               | 31-40                     | 12 | 12% |
|                               | 41-50                     | 23 | 23% |
|                               | 51-60                     | 21 | 21% |
|                               | Over 60                   | 14 | 14% |
| Purpose of travel             | Work                      | 35 | 35% |
|                               | Returning home            | 2  | 2%  |
|                               | Education                 | 0  | 0%  |
|                               | Healthcare                | 20 | 20% |
|                               | Entertainment/ recreation | 7  | 7%  |
|                               | Shopping                  | 26 | 26% |
|                               | Other                     | 10 | 10% |

Observing the structure of surveyed people, demographically speaking it can be seen that male presence is significantly higher (70%) than female (30%). Furthermore, observing the age range of surveyed people, most people come from age group from 18 to 30 years, 30%. The next most represented age group is 41 to 50 years of age (23%) and the age group from 51 to 60 years of age is represented in the percentage of 21%.

**Table 2.** Results of the questionnaire in percentages related to questionnaire's questions

| Questions:  | Grades:    |          |                |              |     |     |
|---|------------|----------|----------------|--------------|-----|-----|
|   | 1          | 2        | 3              | 4            |     |     |
| 1. How do you grade the influence of traffic infrastructure to the quality of service in this road? | 1          | 0        | 0%             |              |     |     |
|   | 2          | 0        | 0%             |              |     |     |
|   | 3          | 15       | 15%            |              |     |     |
|   | 4          | 48       | 48%            |              |     |     |
|   | 5          | 37       | 37%            |              |     |     |
|   | 6          | 0        | 0%             |              |     |     |
| 2. How much does the longitudinal slope affect the speed of travelling in this section?             | 1          | 0        | 0%             |              |     |     |
|   | 2          | 7        | 7%             |              |     |     |
|   | 3          | 64       | 64%            |              |     |     |
|   | 4          | 29       | 29%            |              |     |     |
|   | 5          | 0        | 0%             |              |     |     |
|   | 6          | 0        | 0%             |              |     |     |
| 3. Grade your motivation to drive?  | YES        | 15       | 15%            |              |     |     |
|   | NO         | 85       | 85%            |              |     |     |
|   | Horizontal | Vertical | Horizontal (%) | Vertical (%) |     |     |
| 4. Grade the visibility of horizontal and vertical road signs?                                      | 1          | 0        | 1              | 0            | 0%  | 0%  |
|   | 2          | 4        | 2              | 0            | 4%  | 0%  |
|   | 3          | 82       | 3              | 7            | 82% | 7%  |
|   | 4          | 14       | 4              | 87           | 14% | 87% |
|   | 5          | 0        | 5              | 6            | 0%  | 6%  |
|   | 6          | 0        | 6              | 0            | 0%  | 0%  |
| 5. What grade (1-6) would you give to frequency (number of vehicles) on the road?                   | 1          | 0        | 0%             |              |     |     |
|   | 2          | 0        | 0%             |              |     |     |
|   | 3          | 1        | 1%             |              |     |     |
|   | 4          | 14       | 14%            |              |     |     |
|   | 5          | 79       | 79%            |              |     |     |
|   | 6          | 6        | 6%             |              |     |     |
| 6. Give a grade 1-6 for the maintenance of road section?  | 1          | 0        | 0%             |              |     |     |
|   | 2          | 22       | 22%            |              |     |     |
|   | 3          | 57       | 57%            |              |     |     |
|   | 4          | 21       | 21%            |              |     |     |
|   | 5          | 0        | 0%             |              |     |     |
|   | 6          | 0        | 0%             |              |     |     |
| 7. How would you grade the placement of speed limit signs on the section?                           | YES        | 43       | 43%            |              |     |     |
|   | NO         | 57       | 57%            |              |     |     |
| 8. How would you grade the traffic safety of the road?  | 1          | 0        | 0%             |              |     |     |
|   | 2          | 7        | 7%             |              |     |     |
|   | 3          | 78       | 78%            |              |     |     |
|   | 4          | 12       | 12%            |              |     |     |
|   | 5          | 3        | 3%             |              |     |     |
|   | 6          | 0        | 0%             |              |     |     |
| 9. How would you grade the occurrences of sudden curves (minimal radius) on the road?               | 1          | 0        | 0%             |              |     |     |
|   | 2          | 4        | 4%             |              |     |     |
|   | 3          | 32       | 32%            |              |     |     |
|   | 4          | 53       | 53%            |              |     |     |
|   | 5          | 11       | 11%            |              |     |     |
|   | 6          | 0        | 0%             |              |     |     |

Grades: 1-N/A, 2- very bad, 3- bad, 4- good, 5- very good, 6- excellent

It can be pointed out that 87% of people graded vertical road signs as good, and 79% of people graded the level (degree) of possible high frequency of the road section as very good. Opposite to this, the most expressed

answers, and the most negative ones in terms of level of satisfaction of users were given to the following questions:

- *Road condition grade*, where 64% of people graded the road conditions on the observed road section as bad,
- *Traffic infrastructure grade*, where 74 % of people answered that bad infrastructure has a negative impact to quality of service of the observed road section,
- *Horizontal road signs grade*, where 82% of people graded the conditions and visibility of horizontal road signs on the observed road section as very bad,
- *Maintenance of the road section grade*, where 57% of people graded the road maintenance of the observed road section as bad.

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## CONCLUSIONS WITH IMPROVEMENT MEASURES

As seen in the previous analysis and discussion, it can be concluded that the grades of road condition, traffic infrastructure, horizontal road signs and road maintenance worsen the quality of service offered to users by the observed road section.

A subjective grade of existing conditions of the observed road section, according to relevant indicators for the analysis of capacity and Level of Service which are based on aforementioned factors of traffic and road, gives the conclusion that the observed road section received a grade between B and C.

To reduce the negative factors, the following suggestion of measures can be implemented:

1. Improvement of traffic safety through Road Safety Inspection of observed road section with road geometry, longitudinal and transverse profile,
2. Improvement of road condition in certain segments of the observed road section, where needed,

3. Improvement of traffic infrastructure to prevent negative effects arising from inadequate maintenance or reconstruction of noticed existing facilities by jurisdictional authorities on the observed road section,
4. Improvement of visibility of horizontal road signs by applying a new layer of paint on several segments of the observed road section,
5. Road maintenance as a main priority, as all other negative factors directly depend on it,
6. Improvement of regulation and traffic management on the observed road section through jurisdictional organizations,
7. Placement of additional speed limit signs in inhabited areas with the speed limit of 50 km/h, and the speed limit of 30 km/h in school areas, which is not currently visible in the observed road section,
8. Placement of target improvement for road and traffic conditions, which directly influences better Level of Service (A-B).

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