Re-evaluation of the Level of Service in a Road Segment, the Basis for Traffic Management and Road Maintenance Planning. Case Study of the Tirana-Elbasan Highway

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Abstract - One component to the deterioration of LOS (Level of Service) on road networks worldwide is traffic congestion. Due to population growth, economic growth and increasing motorization rate, increasing traffic requirements and consequently increasing traffic volumes may exceed the accommodation capacity of the road especially during peak periods, which causes congestion. This road congestion reduces the speed of movement, increases the fuel consumption of vehicles, causes noise and air pollution, delays and accidents. Consequently, there is a need for periodic mid-term and long-term re-evaluation of LOS of roads. Through the analysis, and recalculation of the level of service for the highway under study, we are oriented towards ways and methodologies to improve the level of service. The purpose of this research is to maintain or improve LOS. of the Tirana-Elbasan highway giving different solutions to current problems. [1, 3]

Keywords: Traffic congestion, level of service, traffic volume studies, traffic management, AADT (Annual Average Daily Traffic), ADT (Average Daily Traffic)

I. Introduction

Transport as a system and especially road transport, which is one of the basic components of the community services sector, therefore it is an important concern for traffic engineers and planners to understand and evaluate the quality of service provided by transport facilities. The Highway Capacity Manual (HCM 2010) quantified the capacity concept for a transport facility and laid the foundations for service level assessment. [6]

The Highway Capacity Manual (HCM) is a pioneer in managing and evaluating the capacity and quality of service of various highway facilities, arterial roads, roundabouts, signaling and unmarked intersections, urban highways, pedestrians, and bicycles. The road chosen for the study has a great socio-economic and cultural importance not only nationally as it connects the center of Albania with the South-Eastern area, but also of international importance as it connects Tirana with Northern Macedonia and Greece. It is also part of Corridor VIII "The Trans-European Transport Network (TEN-T)" [20]

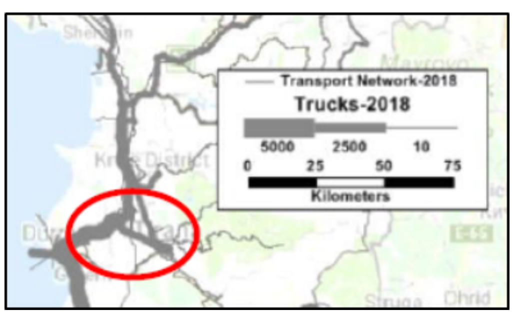

Figure 1. Source; Transport Network 2018; Trucks-2018 ANTP 3, 2019

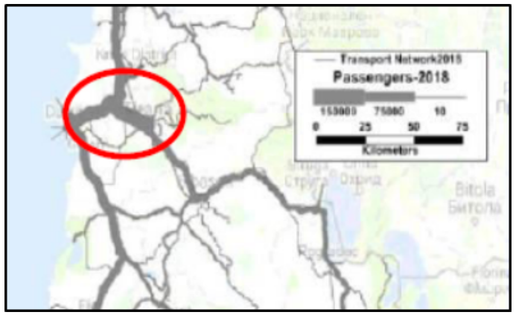

Figure 2. Source; Transport Network 2018; Passengers-2018; ANTP 3, 2019.

Using the updated 2010 Highway Capacity Manual as a methodology for the analysis procedure for two-lane two-way highways. This paper deals with the analysis, re-evaluation of LOS and recommendations for the maintenance and improvement of LOS on the Tirana-Elbasan highway. The research study was conducted on the two-lane highway Tirana-Elbasan. Traffic data were collected from the ARA database at the Ministry of Infrastructure and Energy. [1, 2]

With the development of cities, the demand for transport services in both passenger and freight increases, as a result not only will the volumes of urban and interurban traffic increase but the traffic becomes more and more complex. The interurban traffic network has continuous dynamics and offers daily services to the ever-increasing demands of transport users according to their goals. This paper presents a guide to maintain and improve LOS which aims to minimize total transportation costs, increase road safety and reduce environmental pollution from vehicle gases.

With the economic growth and the increase of incomes in the region of Tirana-Elbasan, the volume of traffic will continue to increase dynamically. On the other hand, road maintenance and traffic management is an ongoing activity, with relatively small operations which can and should contribute to the preservation of LOS, traffic safety and more environmentally friendly. The Tirana-Elbasan highway started its operation in 2013. In recent years, the increase in the number of vehicles has led to a decrease in the level of service and quality performance in this road segment. [1, 2,7]

This road is a very important element in the systems of the national road network of Albania. It is one of the main arteries of the national road network for the geographical position where it lies but also for the economic weight of the area where it crosses, it is used for a number of functions, and consequently it has large traffic volumes.

Table 1. ADTs for the Tirana-Durres, Fushe Kruje-Milot and Tirana-Elbasan highway for one direction 2018-2020.

Road Segment.	**ADT**	**in %**
TIRANE-DURRES	**43871**	**59**
FUSHE KRUJE-MILOT	**20948**	**28**
TIRANE-ELBASAN	**9524**	**13**

II. Study Methodology.

2.1. Collection and Analysis of Traffic Data.

The new and updated version of the service level assessment methodology for two-lane highways according to HCM 2010, helps in the assessment of traffic and environmental effects on the highway, where this methodology is used to analyze and use capacity, lane requirements, impact of traffic in capacity and design of facilities for uninterrupted flow of traffic. The analysis in this case study was conducted using HCS 2010 for existing, short-term and medium-term conditions for the Tirana-Elbasan highway. The data collected by ARA are given in the table below. [6]

To arrive at the AADT assessment we need ADT and AADT data for three years. For this purpose, below we are giving the data received from ARA for the years 2018-2020. [1]

Table 2 ADTs by months for the Tirana-Elbasan highway for one direction and AADT for the years 2018-2020. Source ARA.

Month/ year	2018	2019	2020
January	7844	8180	8944
February	7602	7946	8446
March	8670	8330	9030
April	8865	8700	9300
May	8860	9200	9600
June	9060	9400	9900
July	9422	9827	10127
August	10405	11000	11415
September	10175	10571	11071
October	10272	10612	11012
November	9253	9785	10285
December	9652	10005	10545
AADT	9173	9467	9973

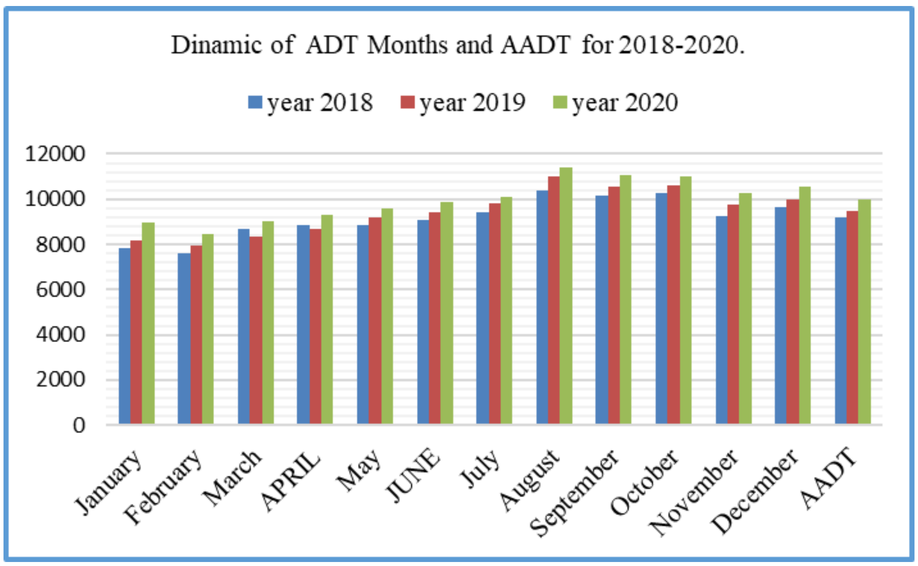

Figure 3. Dynamics of ADT by months and AADT for 2018-2020.

To calculate future traffic we will use the calculation formula of 1. (According to HCM 2010). [6, 8]. The calculation of the daily average of normal traffic in year (y) will be done as follows:

$$AADT_y = AADT_{actual} \cdot \left[1 + \frac{p}{100} \cdot (y-1) \right] \quad (1)$$

Where: AADTy = average daily annual traffic for year (y).

$AADT_{actual}$ = average daily annual traffic for the year the measurements were made. (In one direction)

p_{year} = annual increase expressed as a percentage; (calculated on the basis of the database)

We calculate the annual growth (p), for the years 2017, 2018, 2019

So for 2018;

$$p_{18} = \frac{AADT_{2018} - AADT_{2017}}{AADT_{2017}} \cdot 100\% = \frac{9173 - 8761}{8761} \cdot 100\% = 4.7\% \qquad (2)$$

Table 3 Estimation of the annual increase of traffic volume "p"

AADT	**Year 2017**	**Year 2018**	**Year 2019**	**Year 2020**
	8761	**9173**	**9467**	**9973**
	Average growth in years %	**4.70%**	**3.20%**	**5.30%**
	p= 4.42 % The average three-year growth of AADT.			

To calculate AADT until 2030 we apply formula 1. From the application of the formative we have obtained table 3.

Table 4 AADT forecast.

Years	**AADT**
Year 2021	**10413**
Year 2022	**10871**
Year 2023	**11350**
Year 2024	**11849**
Year 2025	**12370**
Year 2026	**12915**
Year 2027	**13483**
Year 2028	**14076**
Year 2029	**14695**
Year 2030	**15342**

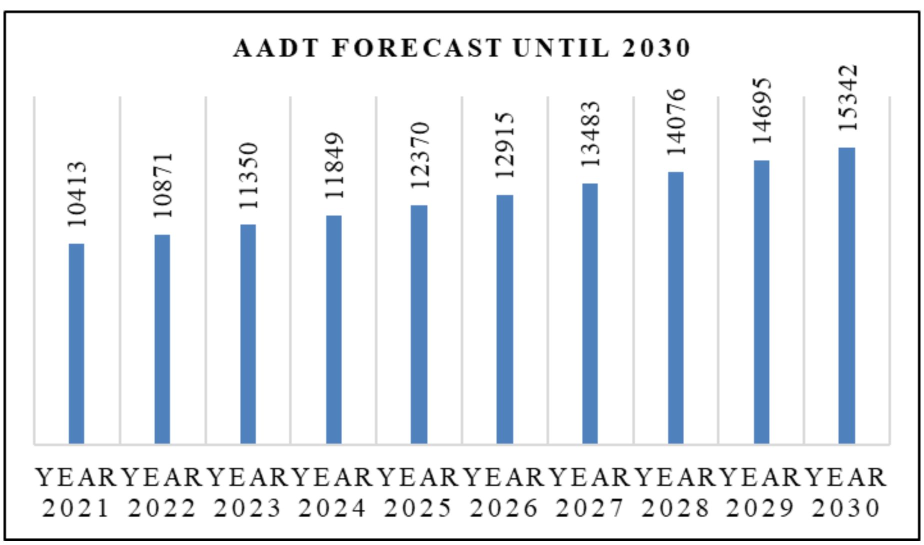

Figure 4. AADT forecast for the years 2021-2031.

III. Analysis and Results

3.1 Calculating the Service Level for the next 10 years.

The purpose of reassessing the forecast of service level dynamics is to develop strategies in road maintenance, traffic management and, if necessary, in their reconstruction. Thus, to improve traffic conditions, it is necessary to improve the level of service. The level of service provides the qualitative measure of traffic facilities. The topic addressed deals with a key aspect of traffic engineering that of improving road traffic performance. [3, 6, 8]

Capacity analysis helps evaluate LOS. Capacity is a quantitative assessment of the ability of a traffic facility to accommodate the vehicles for which it is designed. While service level analysis is essentially a qualitative analysis. Capacities and Level of Services are thus analyzes closely related to a traffic facility. Level of Service (LOS) of a traffic facility is a concept introduced to link the quality of traffic service with a certain flow rate. HCM proposes LOS as a paper defining a set of operating conditions in a particular type of facility. The six categories of LOS are defined by HCM, namely A, B, C, D, E and F, where A indicates the best quality of service and F marks the worst. [6, 8]

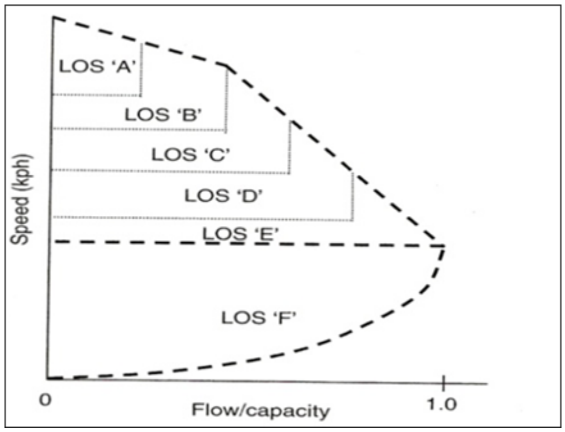

Figure 5. Source HCM 2010.

The above capacity values fall due to various "non-ideal condition", which includes changes in speed or travel time, traffic interruptions or restrictions, etc. LOS on the other hand sets qualitative levels of traffic based on the measure of performance such as speed, density, etc. To calculate the Level of Service "nsh" (in the literature is marked with LOS, (Level of Service) for the next 10 years.

The capacity of the Tirana-Elbasan highway according to the project is c = 2000 vehicles / h / lane. [7] Table 4 shows the LOS according to the classification by AASHTO/HCM.

Table 5 Classification of “nsh”. Source AASHTO.

Level of Service “nsh” LOS		Approximate limits to "nsh" LOS
A	**Free flow operation.**	**< 0.25**
B	**Free flow.**	**0.25 ÷ 0.5**
C	**Obvious maneuvers.**	**0.5 ÷ 0.7**
D	**Long maneuvers.**	**0.7 ÷ 0.9**
E	**Compressed and unstable flow.**	**÷ 1**
F	**Condensed state.**	**> 1**

Knowing the design capacity of the road, then we calculate the level of service for 2021. According to HCM for ideal conditions the maximum service flow is given;

$$SF_{\max} = C_i \cdot \left(\frac{v}{c}\right)_i \cdot N \tag{3}$$

Ci = 2000 vehicles/h/k (value for speed 110 km/h) according to Table 5.1 [8]

N = number of lanes for each direction.

Or

$$\left(\frac{v}{c}\right)_i = \frac{SF_{\max}}{C_i \cdot N} \tag{4}$$

$\left(\frac{v}{c}\right)_i$ service level

Or what we write above; $n_s = \frac{v}{c}$

where

v = SF current flow (vehicles/h/lane)

for the year "y" $n_{shy} = \frac{v_y}{c}$

v_y = SF (service flow in year y) [vehicles/h/lane]

The flow of SF service can also be calculated as a function of peak hourly volume and PHF according to HCM 2010 with the formula;

$$SF = \frac{VOP}{PHF} \tag{5}$$

VOP = peak hour volume [vehicles/h/lane]

PHF = coefficient, peak hour factor, taken 0.85-0.95 [9]

Where VOP according to HMC is given by the formula;

$$VOP = AADT \cdot K \tag{6}$$

K = 15% (coefficient for highways, main interurban roads. [9]

We note that for the highway under study we have assumed other ideal conditions and have not taken them into consideration. Since we have calculated AADT (see Table 5), based on formula 5 we estimate VOP and SF for each year according to table 5, and we get;

Table 6 AADT, VOP and SF values. For one direction (for two lanes).

Years	AADT	VOP	SF
Year 2021	**10413**	**1562**	**1838**
Year 2022	**10871**	**1631**	**1918**
Year 2023	**11350**	**1703**	**2003**
Year 2024	**11849**	**1777**	**2091**
year 2025	**12370**	**1856**	**2183**
Year 2026	**12915**	**1937**	**2279**
Year 2027	**13483**	**2022**	**2379**
Year 2028	**14076**	**2111**	**2484**
Year 2029	**14695**	**2204**	**2593**
Year 2030	**15342**	**2301**	**2707**

Now that we have evaluated VOP and SF we calculate the level of service for the next 10 years according to HMC;

$$n_{shy} = \frac{SF_y}{c} \quad (7)$$

or for the year 2030

$$n_{sh2030} = \frac{SF_{2030}}{c}$$

Table 7 VOP, SF and LOS values for 10 years, for one lane. (vehicles/h/lane)

Years	VOP	SF	LOS
Year 2021	781	919	0.46
Year 2022	815	959	0.48
Year 2023	851	1001	0.50
Year 2024	889	1046	0.52
Year 2025	928	1091	0.55
Year 2026	969	1140	0.57
Year 2027	1011	1190	0.59
Year 2028	1056	1242	0.62
Year 2029	1102	1297	0.65
Year 2030	1151	1354	0.68

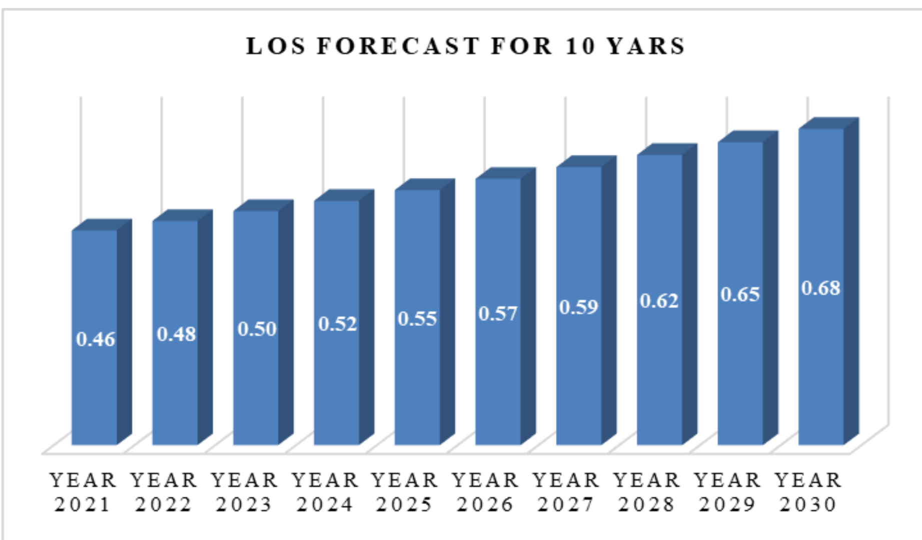

Figure 6. Dynamics of nsh (LOS) until 2030.

So the level of service for 2030 will be 0.68, or according to table 4, referring to the value, we have a level of service (LOS) C which means "Visible limitations in maneuver". Table 7 presents the dynamics of the level of service, based on the classification according to six categories A, B, C, D, E, F, and with numerical values. [6]

Table 8 Trend of LOS by categories (A, B, C, D, E, F) for the years 2020-2030.

Dynamics of Level of Service for 10 years.						
Year	**A**	**B**	**C**	**D**	**E**	**F**
	0 ÷ 0.25	**0.25 ÷ 0.5**	**0.5 ÷ 0.7**	**0.7 ÷ 0.9**	**0.9 ÷ 1**	**> 1**
2020						
2021						
2022						
2023						
2024						
2025						
2026						
2027						
2028						
2029						
2030						
2031						

IV CONCLUSIONS

Based on the results of the engineering analysis of the growth trend of AADT for a period of 10 years, we draw some conclusions;

The level of service until 2020, referring to the results, will be satisfactory, and belongs to category B. At this level we have free flow operation and we have the possibility of smooth movement and safe maneuvers of vehicles.

From 2023 to 2030 we will have a reduction of the level of service from category B to category C, values where concerns begin to appear in traffic operation, so we will have visible limitations in maneuvering during operation on this road.

So after 2027 we have a deterioration in the level of service.

In 2028, service levels with LOS values start to appear approximately 0.7, ie towards the limit of category C and we are at the initial limit of category D. Situation that should be taken into account through daily monitoring of traffic management, routine maintenance and planning of that periodically continuously. The smallest incident will cause traffic problems.

After 2030 there will be delays in movement, which will cause a decrease in speed, increase the cost of travel and the possibility of increasing the number of road accidents.

Therefore, after 2027, it is recommended to increase traffic management measures through the installation of ITS intelligent systems. (Currently only for monitoring cases of blockages, accidents or fires inside a tunnel of this road axis)

Recommendations.

It is recommended to use the HCM 2010 methodology for all interurban roads in Albania in terms of LOS analysis, maintenance planning and traffic management.

It is recommended to maintain the historical database including traffic volume data and geometric data for this road.

Traffic network management studies need to be updated from time to time in order to take care of any major changes in traffic patterns in the future.

Increase the routine and periodic maintenance measures of the infrastructure of this road segment.

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