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TRAFFIC COUNTS METHODOLOGIES FOR VARIOUS TYPE OF ROAD TRAFFIC APPLICATIONS

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ABSTRACT – Traffic data collection programs have to identify the changes over the time of the traffic flows patterns in order to establish the appropriate monitoring process for estimation of the traffic conditions on the road network. Continuously traffic data acquisition provides the information required to identify seasonal and daily traffic volumes. The continuously measurements are very expensive since they are performed by automatic traffic recorders but the statistics of data allow to estimate a large number of representative values as: annual average daily traffic (AADT – English, MZAT- Romanian) and annual average traffic (respectively ADT or MZT), seasonal correction factors, day of week correction factors, the 30^{th} highest annual hourly volume and the 100^{th} highest annual hourly volume, lane distribution factors and also the growth trends for a specific location.
The statistical indicators can be calculated based on the correction factors and the short time count data that describe only the traffic conditions at the moment and location of data acquisition. The selection of count locations have to be randomly selected for a better accuracy related to the road segments.

1 INTRODUCTION

Traffic engineering, as science, is based on measurements regarding all road users: vehicles, passengers, pedestrians and others. These measurements are needed for ascertaining some types of important data categories: volumes, flow rate, capacity and demand [1].

Volume is defined as the number of vehicles or persons passing through a point during a specified interval of time. This interval can be an hour, but also other period (for example, 15 minutes). The volume defines “what is” in a given location.

The flow rate represents the equivalent hourly rate at which the vehicles or person pass through a point on a lane, roadway or other types of road computed as the number of vehicles or persons passing through the point, divided by the specified time interval (usually less than one hour) in which they pass, expressed as vehicles or persons per hour [1]. Flow ratio is the ratio of actual flow rate to the saturation flow rate for a lane group in an intersection.

Capacity is defined as the maximum sustainable flow rate at which vehicles or persons are expected to pass through a point or uniform segment of a lane or roadway during a specified time interval under given roadway, geometric, traffic, environmental and control conditions, expressed as vehicles or persons per hour [3]. The capacity defines the physical limits of “what is possible” in a given location.

Demand defined that the number of users desiring service on the highway system usually expressed as vehicles per hour or passenger car per hour. The demand is frequently higher than actual volumes when the road is congested. The demand expresses “what the drivers like to be” in a given location. The demand includes the actual volume and the vehicles of drivers that wish to pass through the given location or the actual volume and the vehicles waiting in

the downstream queues to pass through the analyzed location or the drivers that use others alternative routes to avoid the congestion in adjacent road.

2 METHODS USED FOR TRAFFIC COUNTS

Traffic data collection program have to identify the changes of the traffic flows patterns in time, in order to identify the appropriate monitoring process for better estimation of the traffic conditions on the road network. Continuously traffic data acquisition provides the information needed to identify seasonal and daily traffic volumes. For these types of applications can be used a wide variety of techniques and equipment like volume recorder using satellites versus manual count techniques. When the traffic studies are related to specific values like the peak hour volumes in some days, the installation and calibration of automatic equipment are not justified, so the manual counts are recommended.

2.1 MANUAL METHODS

The manual methodology used for traffic counts is a less expensive one, appropriate for short periods of time, but require a qualified and coordinated team to produce accurate observation.

Sometimes, the manual counts can be assisted by equipment, for example, mechanical hand-counters used for single hand counter and four board-mounted counters or portable traffic classifiers. These techniques permit to classify volumes by vehicles type or record lane or direction volumes individually.

For manual counts, are commonly used 5, 15 or 60 minutes. With portable traffic recorders is possible to record data for long period of time.

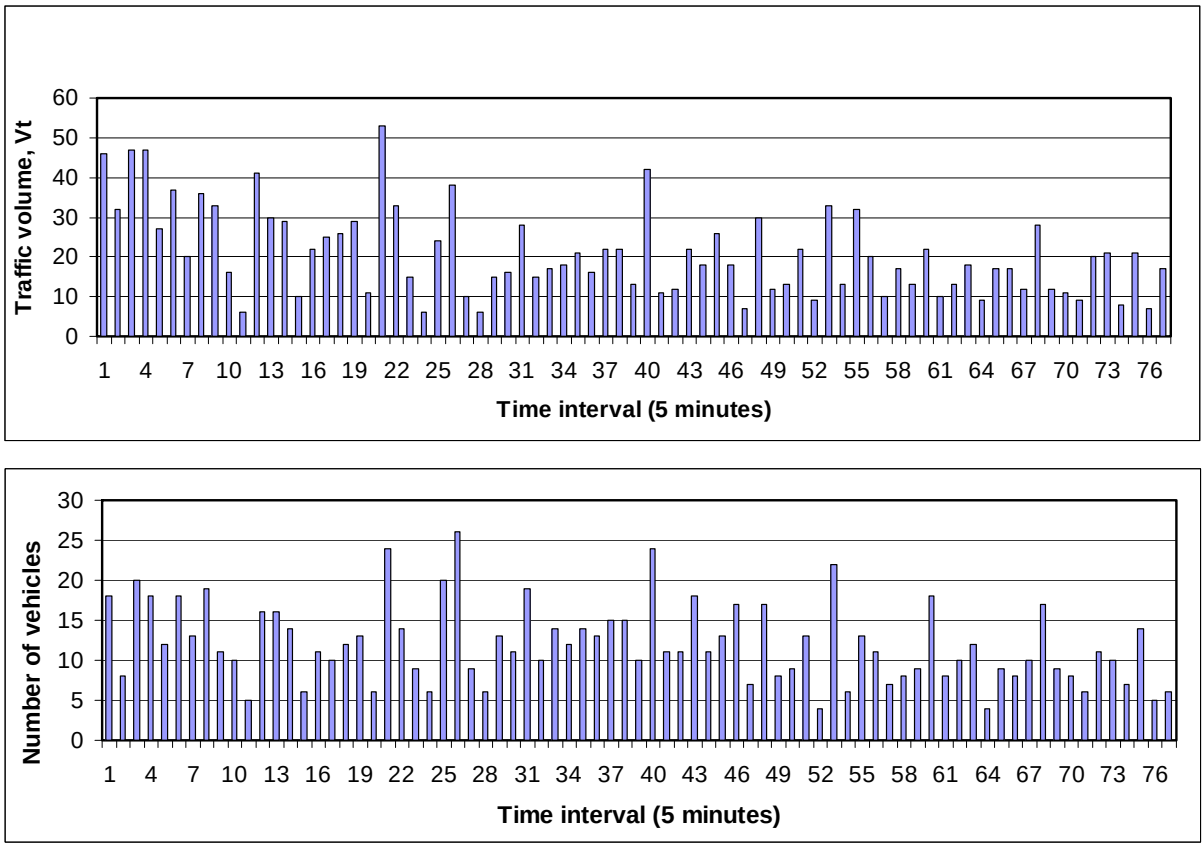

Figure 1: Variation of traffic volumes for 5 minutes intervals (unitary and physical vehicles)

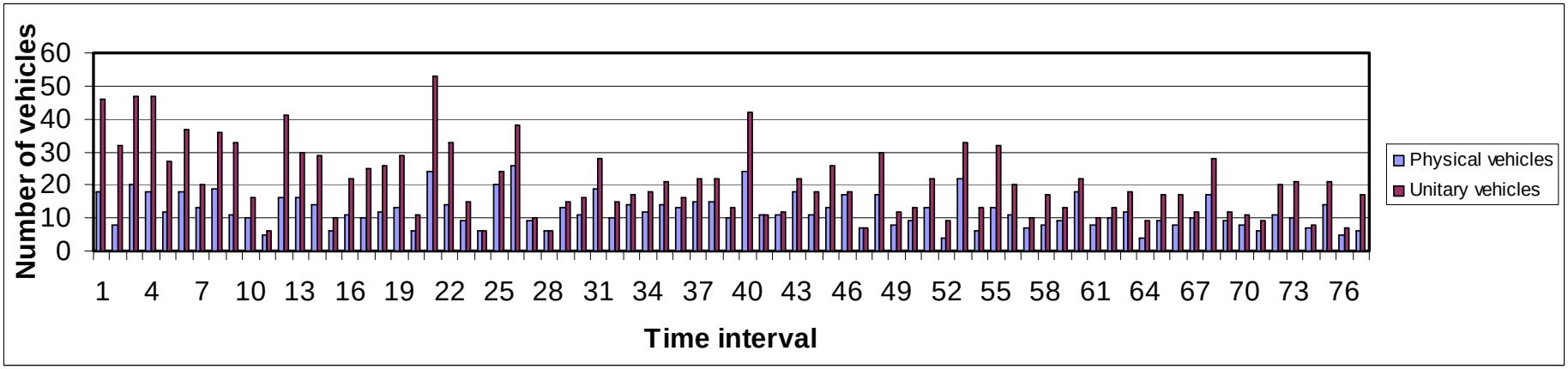

Figure 2: Comparative analysis for traffic volumes (5-minutes intervals)

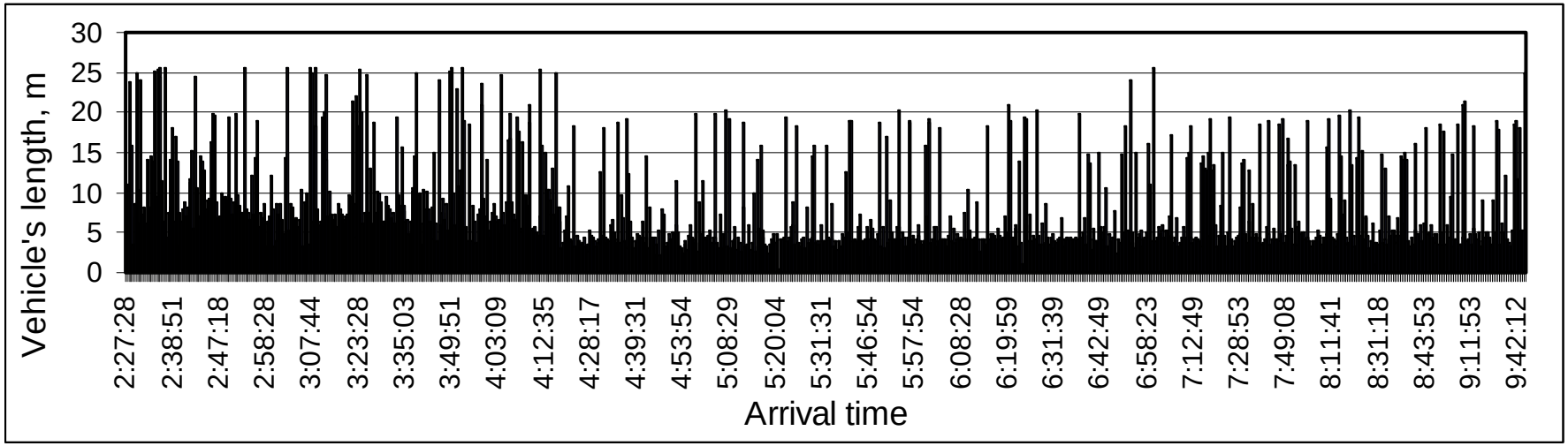

Figure 3: Representation of arrival of different types of vehicles in time

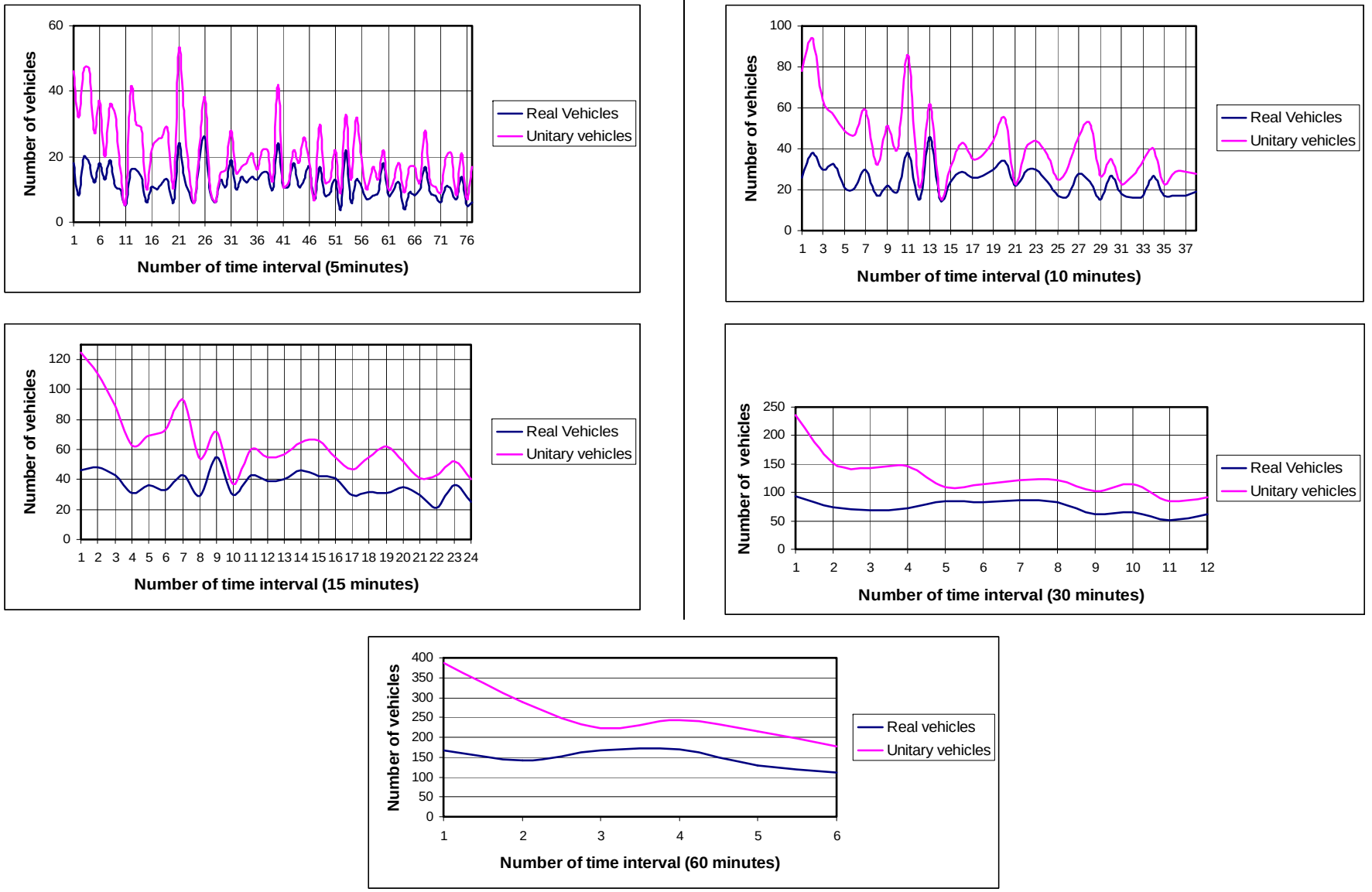

Figure 4: Variation of traffic volumes depending of time interval

In *Figure 4* are presented the results of data processing regarding the variation of traffic volumes for a section of a national road. The data were grouped for the beginning in the 5 minutes time intervals, and then it was analysed the influence of interval extent on the volumes' profile. The recording was made in June, on Monday, and the 7 hours data collection process was started at 14:27:00 PM. The equipment allows also recording the length of passing vehicles, and the transformation in unitary vehicles (Vt), according to the manufacturer recommendation [4]. By this transformation the difference calculated is 56.18%.

The classification by vehicle type presents some interesting data: 61.32 % passenger cars and, the difference of 38.67 % were heavy traffic including trucks, buses and others long vehicles.

Depending on time interval extent the data collected using manual methodology can offer the detail variations of the traffic volumes. This fact can be observed from the series of graphical representation in *Figure 4* for real physical vehicles and also for unitary vehicles variation, depending of classification time interval.

2.2 AUTOMATED TRAFFIC DATA COLLECTION

Automated traffic data collection is very important for establishing of a number of indicators with generalisation characteristics to be used in a wide range of applications, like acoustic modelling, atmospheric chemical pollutants dispersion or traffic forecasts.

Automated systems must ensure the continuous recording of traffic flows and to be able to storage the data in an appropriate format to facilitate the statistical analysis.

The simple use of video recording does not allow analysing the data, unless the equipment provides images that can be processed using image processing software.

Continuous recording of road traffic flows allows monitoring the evolution of traffic parameters in time. The researches in this area [1] based on a huge volume of data, covering years, revealed the specific day of week volumes and the seasonal variations. So, it was realised a classification of the traffic volumes magnitude and a hierarchy (in decreasing order) of these parameters was established. An interesting conclusion that approach different urban, rural and suburban areas, from the traffic volumes point of view, is to take the peak hour volumes into consideration. The peak hour volume may represent 10-15 % of the total volume in a day [1].

When the analysis is focused on an hour, it can be observed a pattern of the hourly volume variation, which highlight the two peak hours, in the morning and in the afternoon (or evening in some areas). The existence of these peak intervals is predictible and repeatable for the working days of the week. Obviously, the situation may be different for other road categories, outside the urban areas. The data records during one year allows to establish the hourly volume variation day by day in a year, to identify the spreading of values and to ascertain the variation interval with a confidence level of 95 %.

The traffic engineers have the role to identify statistical parameters capable to reflect any of the particular cases and that can be used for planning, design and operation. A well known parameter is the *annual average daily traffic* – AADT, used as reference for defining the highest hourly volumes. It is known the use of the 30^{th} highest hour for rural planning, design and operation in USA methodologies. The reason to adopt this value is primarily that the target demand would be exceeded only 29 times per years. The second argument is that the 30^{th} peak hour marks a point where the peak hours have similar volumes [1].

The use of one hour as interval for analysis requires to consider the peak hour, when appear also traffic flow peaks. In particular, the analysis of signalised intersections is based on these

parameters and also on the variation, inside the peak hour, of the corresponding volumes for the four quarter intervals. Thus it is possible to ascertain, for each driving direction form any intersection entry, the peak hour factor as a ratio of the total volume for the driving direction (peak hourly volume) and the maximum flow rate obtained considering that during one hour the traffic flow has a rate that corresponds to the maximum quarter (number of interval x peak interval volume).

$$F = \frac{Peak\ hourly\ volume}{Number\ of\ interval \bullet Peak\ interval\ volume} \leq 1$$

The standard interval of 15 minutes is used in many traffic engineering applications, being considered as the lowest interval over which flow rates are statistical stable. For scientific reasons the analysis may be more accurate, considering also time intervals lower than 5 minutes. Statistically stable implies that logical relationship can be calibrated between the traffic parameters as flow rate, speed and density.

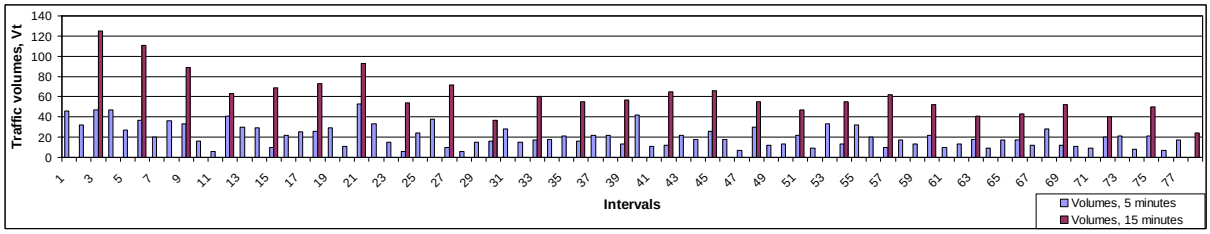

Figure 5: Comparative representation of traffic volumes for 5 and 15 minutes intervals

In order to highlight the differences that may arise in the assessment of traffic volumes, the data provided by the previously mentioned record are referred again. In this example, a variation of traffic volumes is shown in *Figure 5*, where can be observed that the peak hour is the same with the start recording hour, having a volume of 388 Vt/h/lane. The goal of this analysis is to prove the importance of the time interval.

Table 1: Analysis of peak hour volumes

Time interval, min	60	15				5											
Traffic volume, V_t	388	125	111	89	63	46	32	47	47	27	37	20	36	33	16	6	41
Hourly volumes, V_t	388	388				388											
Highest rate of flow, V_t/h	388	500				564											
Peak hour factor	-	0,776				0,6879											

In *Table 1*, the peak hourly volume is 388 V_t. The highest 15 minutes flow rate is 500 V_t and the corresponding peak hour factor is 0.776. For a 5 minutes interval, the highest flow rate is 564 V_t/h and the peak hour factor is 0.6879.

When selecting a 15 minutes base period for design and analysis, the demand flow rate is 500 V_t/h per lane. This value is 11.35% lower than the peak 5 minute flow rate and 28.87% higher than the peak hourly volume.

In real planning and design these differences could be translated into a road design with one or more or fewer lanes, or other geometric and control elements.

The solution of the actual problems related to road traffic data production for different applications can be given at a national level by the correct ascertainment of the two AADT and ADT indicators, and of the mean values corresponding to the days of week, for the calculation of the daily variation factor and for calibrating the monthly variation factor.

The literature [1] recommends the following equation for the calculation of the AADT indicator, considering *i* days and *j* months in one year:

$$AADT = V_{24ij} * DF_i * MF_j \text{, [Vt/day]}$$

where:

V_{24ij} - 24 hour volume for *i* day and *j* month, Vt;

DF_i - daily adjustment factor for *i* day;

MF_j - monthly adjustment factor for *j* month.

The methods of calibration are based on the statistical processing of a high volume of data, for each recording point. Having more data collecting stations, the final values of the average daily factor represent also an average of the respective daily factors. The procedure is repeated also for the average monthly factor.

Having the 24 hour count at a location in which are known the daily variation factor established with a group of control stations, it is easy to calculate AADT for that location.

3 CONCLUSIONS

One of the most important challenges for traffic engineers is that they are continuously planning and design on demand. The question is if the selection the peak flow rate within a peak hour on a peak day during a peak season represents the appropriate solution. In this case is sure that the new facilities are underutilized most of the time.

It can be concluded that depending by the size of the analysed interval can be generated traffic data that differ considerably.

Obtaining of accurate data is an expensive activity that requires qualified personnel. The use of incorrect data for certain studies and applications that are based on traffic data, can lead to wrong models (like, for example, in noise mapping) or using non realistic scenarios for reorganising the road traffic. This may lead to high cost and low safety for the road users.

4 REFERENCES

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