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STUDY REGARDING THE STATISTICAL MODELLING OF THE URBAN TRAFFIC FLOWS

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ABSTRACT - Traffic engineering involves the collection and analysis of large amounts of experimental data for carrying out different types of studies, which require the use of mathematical statistics as a tool of analysis. Statistics helps to determine the amount of data required to achieve a certain level of confidence in the obtained results. It is impossible to observe all vehicles passing in a section of road in a spell of time, even if it is known, another data collection will not reproduce certainly the previous situation. It does not matter how many speeds are recorded, there is always much more data are not known, so the number of vehicles observed in a section of road can be considered infinite. For these reasons for the experimental studies must be observed and measured the characteristics of a sample finite number of elements.
The research paper intends to make statistical analyses of the collected data from the urban area.

THE RANDOM DISTRIBUTION OF INTERVALS BETWEEN VEHICLES

The negative exponential distribution is the distribution of random intervals of the time between vehicles arriving after a Poisson distribution of the form (6):

$$P(x) = \frac{m^x \cdot e^{-m}}{x!} \qquad [1]$$

Where:

P(x) – The probability that x vehicles arrive in a time t;

m – Average number of vehicles arriving in time t;

x – Real number of vehicles arriving in time t;

e = 2,71828;

t – Time chosen.

For x = 0, when no vehicle does not arrive within the time considered,

$$P(0) = e^{-m}. \qquad [2]$$

Expressing P (0) as the time between vehicles, if no vehicle will arrive in the interval t, the interval between vehicles is greater than t,

$$P(0) = P(h \geq t) \qquad [3]$$

$$P(h \geq t) = e^{-m} \qquad [4]$$

Average number of vehicles can be calculated with relation (6):

$$m = \left(\frac{q}{3600}\right) \cdot t \qquad [5]$$

Where:
q – Hourly traffic flow;
t – Observation interval, seconds.
Result,

$$P_{(h \geq t)} = e^{-\frac{q \cdot t}{3600}} \qquad [6]$$

Average time between vehicles can be defined by the relation:

$$\bar{t} = \frac{3600}{q} \qquad [7]$$

Considering the average time from the equation is obtained:

$$P(h \geq t) = e^{-\frac{t}{\bar{t}}} \qquad [8]$$

Knowing the average time between vehicles shall be determined probability of intervals greater than this.
It can be seen that for t = 0, is obvious that $P(h \geq t) = 1$
For values of the time $t \to \infty$, the probability $P(h \geq t) \to 0$.

Usually in experimental research regarding the traffic flows, specialists may be interested in the probability distribution $P(h \geq t)$, can calculate the probability of occurrence of intervals between specific vehicles, such as the probability of an interval between t and seconds and $t + \Delta t$ second.

This probability can be obtained by calculating the cumulative probabilities falling

$P(h \geq t)$ and $P(h \geq t + \Delta t)$, resulting:

$$P(t \leq h < t + \Delta t) = P(h \geq t) - P(h \geq t + \Delta t). \qquad [9]$$

Tabel 1.: The calculation of random distribution of intervals between vehicles (5)

t	0,2t	$P(h \geq t)$	$P(t \leq h < t + \Delta t)$	$F(t \leq h < t + \Delta t)$
0,0	0,00	1,000		
0,5	0,10	0,905	0,095	125
1.0	0,20	0,819	0,086	114
1,5	0,30	0,741	0,078	103

2,0	0,40	0,670	0,071	94
2,5	0,50	0,607	0,063	83
3,0	0,60	0,549	0,058	77
3,5	0,70	0,497	0,052	69
4,0	0,80	0,449	0,048	63
4,5	0,90	0,407	0,042	55
5,0	1,00	0,368	0,039	51
5,5	1,10	0,333	0,035	46
6,0	1,20	0,301	0,032	42
6,5	1,30	0,273	0,028	37
7,0	1,40	0,247	0,026	34
7,5	1,50	0,223	0,024	32
8,0	1,60	0,202	0,021	28
8,5	1,70	0,183	0,019	25
9,0	1,80	0,165	0,018	24
9,5	1,90	0,150	0,015	20
			0,150	198
Total intervals				1320

Average time for the lowest level of traffic intensity is 5 seconds, and the distribution of time intervals corresponds to a choice of 0.5 seconds.

Using equation (3) and replacing $\bar{t} = 5$ seconds, resulting:

$$P(h \geq t) = e^{-0,2 \cdot t} \qquad [10]$$

The microscopic analysis of traffic flows consist to calculate probabilities for each of the intervals between the vehicles using the equation (2.83), taking into account different values of real time interval, t, followed by the registration table (Table 1 and Table 2) and (Figure 1).

Figure 1: Graphical representation of the distribution of intervals between vehicles (5)

The final stage of analysis is the conversion probability of each interval of time between groups of vehicles in frequency intervals. This can be achieved with the following equation.

$$F(t \le h < t + \Delta t) = N[P(t \le h \le t + \Delta t)] \quad [11]$$

where:

N – Total number of intervals observed in every group;

$F(t \le h < t + \Delta t)$ - Estimated number of h intervals, from the group $(t \le h \le t + \Delta t)$.

Tabel 2 Calculation of distribution ranges for the analysed case study(5)

t	f(t)	0.2*t	P(h≥t)	P(h≥t+Δt)	F(t)
0	0	0	1		
2	0.329738	0.4	0.67032	0.330	655
4	0.22103	0.8	0.449329	0.221	439
6	0.148161	1.2	0.301194	0.148	294
8	0.099315	1.6	0.201897	0.099	197
10	0.066573	2	0.135335	0.067	132
12	0.044625	2.4	0.090718	0.045	89
14	0.029913	2.8	0.06081	0.030	59
16	0.020051	3.2	0.040762	0.020	40
18	0.013441	3.6	0.027324	0.013	27
20	0.00901	4	0.018316	0.009	18
22	0.006039	4.4	0.012277	0.006	12
24	0.004048	4.8	0.00823	0.004	8
26	0.002714	5.2	0.005517	0.003	5
28	0.001819	5.6	0.003698	0.002	4
30	0.00151	6	0.002479	0.001	3
32	0.001007	6.4	0.001662	0.001	2
34	0.001007	6.8	0.001114	0.001	2
				0.999	1987

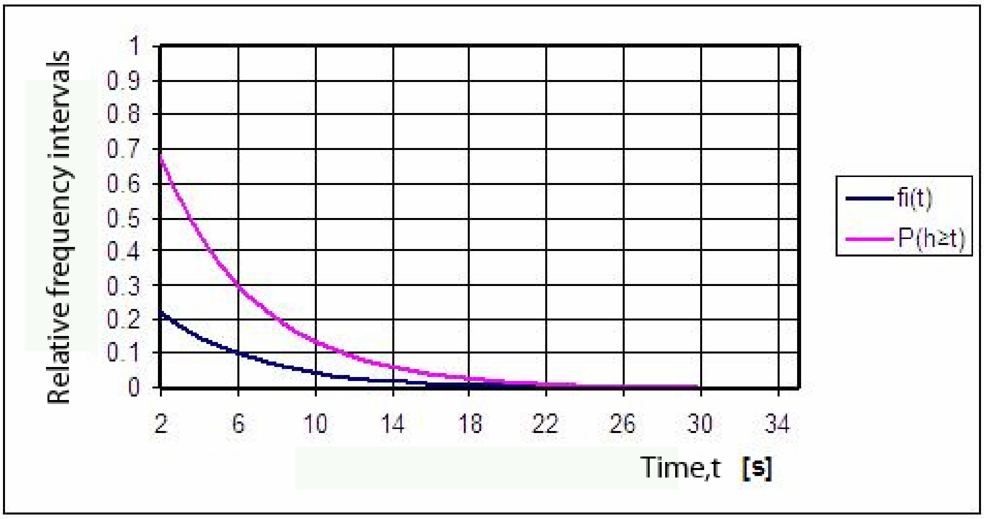

Figure 2 Graphical representation of the cumulative frequency distribution of intervals and decreasing for example the city of Calarasi road flow (5)

Microscopic method presented can be used for all experimental distributions.

CONCLUSIONS

For microscopic analysis presented in the intervals between vehicles (Table 2) and (Figure 2) can be listed the following observations:

- Exponential distribution of intervals between vehicles and feature is the smallest intervals that have maximum probability of occurrence, the probabilities decrease as the intervals between vehicles increases;
- The two distributions, empirical (experimental) and theoretical are totally different especially for the highest levels of traffic; it is recommended to compare the distributions only for low traffic flows;
- If major traffic roads or the highway, the two distributions has different values for the intervals between vehicles less than one second. Theoretical probability is higher for intervals between vehicles of less than 1 second and low for intervals ranging from 1.5 to 4.5 seconds;
- The standard deviation for the experimental distributions is often lower than the corresponding theoretical model, but seems to approach to low traffic intensity.

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