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**ESTIMATION OF TRAFFIC VOLUME AND FUEL CONSUMPTION
IN LATVIA**

Transmitted by the Road Traffic Safety Directorate

Note: The document, reproduced below, was submitted to the secretariat by the delegation from Latvia.

Introduction

Since Latvia regained independence the nature of traffic has changed. There are many more vehicles than before and in the middle of the 1990s this raised questions on how large the traffic volume is and how to estimate it. In 1995, the Road Traffic Safety Directorate, in collaboration with the Faculty of Building and Civil Engineering of Riga Technical University, developed general guidelines and ways for estimation of traffic volume:

- by using fuel consumption;
- by using vehicle counting on roads;
- by using speedometer's indicators of vehicles in technical inspection.

The main conclusion was that the best method of all was the one using speedometer's indicators of vehicles. But at that time, it was impossible because there were not data of speedometer's indicators. Since 1996, the Road Traffic Safety Directorate began to accumulate data of speedometer's indicators at the moment when vehicle was passing annual technical inspection.

“Method of estimation of traffic volume and fuel consumption in Latvia” was developed in 2001 by the Road Traffic Safety Directorate and it is used for estimation of traffic volume and fuel consumption up to now. The method is based on statistical data from Vehicles’ register of Road Traffic Safety Directorate. Statistical data are input in EXCEL sheets and all calculations are performed by EXCEL functions, so it is easy and friendly for users.

General steps of estimation of traffic volume and fuel consumption

1. **Step.** Estimation of average traffic volume during vehicle’s technical inspection by speedometer’s indicator in each group of vehicles;
2. **Step.** Estimation of traffic volume in total and in each group of vehicles by type of engine and for vehicles which have passed technical inspection and are allowed to operate in Latvia;
3. **Step.** Estimation of average fuel consumption per 100 km in each group of vehicles by questionnaire of drivers who have passed technical inspection;
4. **Step.** Estimation of fuel consumption in each group of vehicles and in total in Latvia.

Grouping of vehicles

The main problem is how to divide vehicles in groups. If the groups of vehicles are too numerous, it makes the estimation much more difficult. If groups of vehicles are too small, the estimation is rather inaccurate. As a compromise settlement, Latvia took the decision to group vehicles by type, by gross weight, by age, by region and by type of engine by fuel (see Table 1). For the years 2001 until 2003, all vehicles were divided into two groups - Riga and Riga’s region and other regions. But it was too complicated and from 2004 there was no more grouping by region.

Type of vehicle	Vehicle group_k, where k between 1 and 12	Age_j, where j between 1 and 3	Engine_q, where q between 1 and 3
	Group_k	Group_kj	Group_kjq
Cars	Group_1. Gross weight up to 1500 kg	up to 5 years	Petrol
			Diesel
			Petrol&gas
		from 6 and 10 years	
		over 10 years	
		Group_2. Gross weight between 1500 and 1799 kg	
Trucks	Group_3. Gross weight between 1800 and 2099 kg		
	Group_4. Gross weight between 2100 and 2599 kg		
	Group_5. Gross weight between 2600 and 3500 kg		
	Group_6. Gross weight up to 3501 kg		
	Group_7. Gross weight between 3501 and 7500 kg		
Buses	Group_8. Gross weight between 7501 and 12000 kg		
	Group_9. Gross weight between 12001 and 16000 kg		
	Group_10. Gross weight over 16000 kg		
	Group_11. Gross weight up to 5000 kg		
	Group_12. Gross weight over 5000 kg		

Table 1. Grouping of vehicle

1. Step. Estimation of average traffic volume

Estimation of average traffic volume in each group of vehicles, without subdividing by type of engine is:

$$Q_{av}(kj) = (\text{SUM}(N_{i,200x} - N_{i,200x-1})) / n_{kj}$$

Where,

$Q_{av}(kj)$ – average traffic volume in the group_kj, (km);

$N_{i,200x}$; $N_{i,200x-1}$ - speedometer's indicator of vehicle_i in years 200x and 200x-1;

n_{kj} - number of vehicles in the group_kj.

Data are aggregated in EXEL sheet, example for vehicle group_1j is shown in Table 2.

1.step			
Age of vehicles	Number of vehicles, n_{kj}	Volume by spidometer, $\text{SUM}(N_{i,200x} - N_{i,200x-1})$	Average volume per vehicle, $Q_{av}(kj)$
years	number	km	km
up to 5	1105	23441151	21214
6 to 10	3484	58391133	16760
over 10	72340	933388121	12903

Table 2. Estimation of average traffic volume in the group_1j in 2004

2. Step. Estimation of traffic volume in total and in each group of vehicles

Traffic volumes estimated for vehicles which have passed technical inspections and are allowed to operate in Latvia on 01.01.200x.

Traffic volume in group_kjq is:

$$Q(kjq) = Q_{av}(kj) * n_{kjq}$$

Where,

$Q(kjq)$ – traffic volume in group_kjq (km);

$Q_{av}(kj)$ – average traffic volume in group_kj, (km);

n_{kjq} - number of vehicles which have passed technical inspection in group_kjq.

Total traffic volume in the group_kq is:

$$Q(kq) = \text{SUM}(Q(kjq))$$

Where,

Q (kq) – traffic volume in the group_kq (km);

Q (kjq) – traffic volume in the group_kjq (km).

Data are aggregated in EXCEL sheet, example is shown in Table 3.

2. step				
Age of vehicles	Average volume per vehicle, Qav(kj)	Type of engine	Number of vehicles in the group_kjq*	Traffic volume in the group_kjq, Q (kjq)
years	km		number	km
up to 5 years	21214	petrol	2107	44697898
		diesel	64	1357696
		petrol&gas	7	148498
from 6 and 10 years	16760	petrol	4569	76576440
		diesel	134	2245840
		petrol&gas	80	1340800
over 10 years	12903	petrol	85744	1106354832
		diesel	11107	143313621
		petrol&gas	2365	30515595
Total in group_1q	....	petrol	....	1227629170
		diesel		146917157
		petrol&gas		32004893
* number of vehicles which have passed technical inspection and are allowed to operate in Latvia				

Table 3. Traffic volume in the group_1jq and total in the group_1q in 2004

Total traffic volume by type of engine and type of vehicle are aggregated in EXCEL sheet, example is shown in Table 4.

Year_2004	Cars (group_1 ... group_5)	Trucks (group_6 ... group_10)	Buses (group_11 ... group_12)	Total (km*10 ⁶)
petrol	5351762860	196348523	26580261	5574.7
diesel	1856720621	1506274985	223772714	3586.8
petrol&gas	277778598	48244476	6942614	333.0
Total (km*10⁶)	7486.3	1750.9	257.3	9494.4

Table 4. Traffic volume in 2004

Distribution of traffic volume is collected in Table 5.

Distribution of traffic volume in Latvia										
Year	Cars			Trucks			Buses			Total
	Number of registered on the end of the year	Volume km*10 ⁶	Average per vehicle	Number of registered on the end of the year	Volume km*10 ⁶	Average per vehicle	Number of registered on the end of the year	Volume km*10 ⁶	Average per vehicle	Volume km*10 ⁶
2000	556771	5731.0	10293	97081	1575.7	16231	11501	270.7	23537	7577.4
2001	586209	6392.0	10904	99708	1745.0	17501	11294	255.8	22649	8392.8
2002	619081	6268.0	10125	102734	1495.0	14552	11164	266.6	23880	8029.6
2003	648901	6809.3	10494	104626	1583.1	15131	10983	273.9	24939	8666.3
2004	686128	7486.3	10911	107553	1750.9	16279	10740	257.3	23957	9494.5

Table 5. Distribution of traffic volume in Latvia

3. Step. Estimation of average fuel consumption per 100 km

It is the most difficult step in the estimation of fuel consumption. The age of vehicles is so different in Latvia from very old to span-new. Results are gained from questionnaire of drivers in technical inspection from 26.03.- 31.03.2001. 6000 drivers gave answers about fuel consumption for their own vehicle. Data were wrap up and estimation of average fuel consumption per 100 km in each vehicle group_kq was made.

The fuel consumption per 100 km for group_1q is aggregated in EXCEL sheet, example is shown in Table 6.

3.step		
Type of fuel	Respondent drivers in group_1q	Average fuel consumption per 100km
	number	liters
petrol	170	8.
diesel	20	6.
petrol&gas	3	8.

Table 6. Fuel consumption per 100 km for the group_1q.

From 01.01.2002 certification of replacement parts was introduced in Latvia banning sales of non-certified parts. Thenceforward data of fuel consumption per 100 km for new vehicles are collected in a vehicles' register. It makes it easy to calculate fuel consumption per 100 km further on.

4. Step. Estimation of fuel consumption

Estimation of total fuel consumption in the group_kq of vehicles is:

$$F(kq) = f_{av}(kq) * Q(kq)/100$$

Where,

F(kq) – fuel consumption in the group_kq of vehicles, litres;

$f_{av}(\mathbf{kq})$ - average fuel consumption per 100km in the group_kq of vehicles, litres;

$Q(\mathbf{kq})$ - total traffic volume in the group_kq km.

The fuel consumption in the group_kq of vehicles is aggregated in EXCEL sheet, example of the year 2004 is shown in Table 7.

4.step			
Type of engine	Total traffic volume in the group_1q	Average fuel consumption per 100km	Total fuel consumption in the group_1q
	km	liters	liters
petrol	1227629170	8.1	99396970
diesel	146917157	6.0	8878906
petrol&gas	32004893	8.7	2795094

Table 7. Total fuel consumption in the group_1q.

Fuel consumption by type of fuel and type of vehicle is:

$$F(\mathbf{q}) = \text{SUM}(F(\mathbf{kq}))$$

Where

$F(\mathbf{q})$ – total fuel consumption by type of fuel, liters;

$F(\mathbf{kq})$ – fuel consumption in the group_kq of vehicles, liters;

$Q(\mathbf{kq})$ - total traffic volume in the group_kq km.

Total fuel consumption by type of fuel and type of vehicle is aggregated in EXCEL sheet, example for the year 2004 is shown in Table 8.

Year_2004	Cars (group_1 ... group_5)	Trucks (group_6 ... group_10)	Buses (group_11 ... group_12)	Total (liters*10 ⁶)
petrol	504184526	34541852	6115461.0	544.8
diesel	147654112	356276463	55349585.4	559.3
petrol&gas	30153260	9395454	1826792.6	41.4

Table 8. Fuel consumption by type of fuel and type of vehicle in 2004

Distribution of fuel consumption in Latvia is collected in Table 9.

	2000 liters*10 ⁶	2001 liters*10 ⁶	2002 liters*10 ⁶	2003 liters*10 ⁶	2004 liters*10 ⁶
petrol	522.4	569.2	521.7	529.3	544.8
diesel	374.7	416.1	438.7	492.5	559.3
petrol&gas	17.7	23.2	28.2	36.0	41.4

Table 9. Distribution of fuel consumption in Latvia

SUMMARY

Summary of all above written steps is collected in table 10. Gray colored cells are output data from one step and input data for the next step.

1.step			
Age of vehicles	Number of vehicles, n_{kj}	Volume by spidometer, $\text{SUM}(N_{i,200x} - N_{i,200x-1})$	Average volume per vehicle, $Q_{av}(kj)$
years	number	km	km
up to 5	1105	23441151	21214
6 to 10	3484	58391133	16760
over 10	72340	933388121	12903

2. step				
Age of vehicles	Average volume per vehicle, $Q_{av}(kj)$	Type of engine	Number of vehicles in the group_kjq*	Traffic volume in the group_kjq, $Q(kjq)$
years	km		number	km
up to 5 years	21214	petrol	2107	44697898
		diesel	64	1357696
		petrol&gas	7	148498
from 6 and 10 years	16760	petrol	4569	76576440
		diesel	134	2245840
		petrol&gas	80	1340800
over 10 years	12903	petrol	85744	1106354832
		diesel	11107	143313621
		petrol&gas	2365	30515595
Total in group_1q	....	petrol	....	1227629170
		diesel	....	146917157
		petrol&gas	....	32004893

* number of vehicles which have passed technical inspection and are allowed to operate in Latvia

3.step		
Type of engine	Respondent drivers in the group_1q	Average fuel consumption per 100km
	number	liters
petrol	1707	8.1
diesel	207	6.0
petrol&gas	30	8.7

4.step			
Type of engine	Total traffic volume in the group_1q	Average fuel consumption per 100km	Total fuel consumption in the group_1q
	km	liters	liters
petrol	1227629170	8.1	99396970
diesel	146917157	6.0	8878906
petrol&gas	32004893	8.7	2795094

Table10. Summary of all steps in the group_1 of vehicles

Comments

Firstly, traffic volume must be increased by 10-15% due to the following reasons:

- The estimation does not include vehicles which have not passed technical inspection but operate in traffic flow illegally;
- The estimation does not include motorcycles, tricycles and mopeds;
- The estimation does not include transit vehicles from other countries.

On the other hand, the estimation includes all traffic volume which the vehicles of Latvia have driven in other countries far away from Latvia. This traffic volume compensates the lack of estimation in the above mentioned groups.

Conclusion

The result of the developed method is annual estimation of traffic volume and fuel consumption by type of vehicle, by age, by gross weight and by type of fuel as well as in total for all vehicles.

Additionally, besides main goals, the method provides a large amount of statistical information which is useful for solving other problems concerning traffic, for example - estimation of traffic impact on environment.

Finally, it would be of great advantage great if all European countries might be able to use a single harmonized generally accepted method for estimation of traffic volume as well as for estimation of fuel consumption.
