

Effects of traffic safety measures on motoray traffic

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1. ABSTRACT SUMMARY

Heavy goods vehicle overtaking ban is used in many European countries in order to satisfy road safety requirements on the motorway network. Due to the introduction of static control, some of the safety risks have been decreased, but new safety problems have been appeared. The authors have conducted a research that identifies new problems and analyses user experiences and acceptance.

2. INTRODUCTION

The overtaking ban is a traffic technique action. According to the type of the ban on the concerned section, certain vehicles cannot overtake each other. Introduction of the overtaking ban primarily serves safety, efficiency and capacity aims on the motorway network. Ban is applied on pre-defined sections and it is used for heavy goods vehicles. Several solutions can be distinguished by spatial and temporal coverage:

STATIC CONTROL (controlled by traditional traffic signs):

- Permanent (0-24h control regulation);
- Periodic (concerns to a time period indicated by additional signs, e.g. it is in force between 6-22h);

DYNAMIC CONTROL: It depends on the current traffic and weather conditions; real-time data or a predictable peak time period can be used for the control process; variable message signs can be used for information dissemination.

Both solutions can be used for each heavy goods vehicles or it is possible to distinguish vehicle according to the maximum gross weight. Table I. shows the advantages and disadvantages of different controls.

Several causes justify the introduction of Heavy Goods Vehicle (HGV) overtaking ban. Some examples:

- lack of adequate visibility due to the alignment of the road;
- safety critical parts (curves, bridges and tunnels);
- significant uphill or downhill;
- sections with high traffic load.

Primary purposes of restriction:

- maintaining continuous flow of traffic;
- increasing road safety;
- reducing stress effect caused by truck drivers;
- reducing environmental impact.

Type of control		Advantages	Disadvantages
Static	Permanent	<ul style="list-style-type: none"> - Simple and it can be implemented by ordinary traffic signs; - Cheap 	<ul style="list-style-type: none"> - It does not take into consideration the actual traffic situation; - It can detain the traffic gratuitously
	Periodic	<ul style="list-style-type: none"> - It can adjust to the general traffic load; - Simple and it can be implemented by ordinary traffic signs; - Cheap 	<ul style="list-style-type: none"> - It does not take into consideration the actual traffic situation; - It can detain the traffic gratuitously
Dynamic		<ul style="list-style-type: none"> - It takes into consideration the actual traffic situation and weather conditions; - It has a bigger user acceptance. 	<ul style="list-style-type: none"> - It has a higher development and installation cost; - Information is more complex (it does not language independent, multi-language display is needed)

Advantages and disadvantages of different controls

Use of the restriction on longer sections (few kilometres) causes that the number of trucks in the fast lane is reducing on two and three lane sections -

because travelling in the fast lane is restricted - and it effects that the traffic deceleration impact is reducing. It causes increase of motorway capacity and allows better traffic flow, especially during rush hours and between cities on high-traffic load sections.

Truck drivers can cause delay and traffic jams by overtaking manoeuvres. During these manoeuvres, speed difference is only 1-2 km/h and it causes that drivers hold up traffic unreasonably for several minutes. Travel speed will reduce and travel time will increase. Furthermore, it includes serious traffic safety risks: if the foregoing truck changes lane suddenly, the other vehicle travelling in the fast lane have to break, which causes tail back effect. It increases the risk of rear-end collisions. The extra stress on vehicle drivers also effects negative safety consequence.

In EasyWay project, researches have shown that network efficiency significantly increased by HGV overtaking ban, where the number of heavy goods vehicles is high or their ratio exceeds 10% [1].

Overall experiences of HGV overtaking bans:

- velocity of the vehicle flow getting smoother;
- when traffic load is lower the average traffic speed is increasing (<2000 vehicle/hour in 2 lanes);
- at dense traffic the speed of light goods vehicles is increasing (>2000 vehicle/hour in 2 lanes);
- decrease the number of queuing in peak periods can reduce CO₂ emission even by 500 tonnes yearly.

In those countries where dynamic control is used (adapted to the actual traffic conditions), achieved results are better, particularly in peak periods. User satisfaction has reached 90% and approximately 99% of drivers obey the regulations [1].

3. HEAVY GOODS VEHICLE OVERTAKING BANS IN THE EUROPEAN UNION AND THEIR EFFECTS

Periodic overtaking ban was introduced first on the motorways of the Netherlands, because of the capacity problems due to the dense transit traffic. Nowadays, different types of restrictions are used successfully in several countries of the European Union. Various types of overtaking bans that used in the countries of European Union are shown in Table II, [2], [3], [4]. The results of the measures are summarized in Table III.

Country	United Kingdom	Germany	Netherlands	France	Denmark
Affected area	A1, A14, A20, M11, M42	Bavaria and Baden-Württemberg	more than 50% of motorway network	A4, RN83, French - Spanish border, A7	nationwide
Length	2.4-5 km motorway sections	~1500 km	1150 km	~175 km	~230 km
Type of overtaking ban	intermittent	static and dynamic	dynamic	static	intermittent
Affected HGV	over 7.5t	3.5t or over 7.5t	over 7.5 t	3.5t, 12t, or over 19t	over 3.5t

HGV overtaking bans in the EU

Impacts of the HGV overtaking ban	Positive effects +	Negative effects -
Consequences on traffic	Better flow, speed homogeneity in each lane	Speed of all heavy vehicles adjusted
Speed	Average speed increased	In case of dense traffic (flow > 2000 veh/h one way, on both lanes) speed of lorries decreased
% of lorries in the fast lane	Decreased to reach approximately 2%	Increase in case of dense traffic flow
Compliance with the interdiction	Good compliance in general	Progress margin (2% of lorries use the fast lane despite the interdiction)
		Less compliance in case of increase in the % of lorries in the traffic
Reception from users	Measure seen beneficial by private vehicle drivers	Measure sometimes seen as a penalty by lorry drivers
Safety	Safety improved on sections where accidents related to lorry traffic have occurred	Appearance of queues of "lorry walls" on the right lane which impedes the entry/exit of vehicles
	Reduction of traffic on related sections	Out of regulated areas, lorries start overtaking again
Environment	Reduction of CO ₂ emission	-

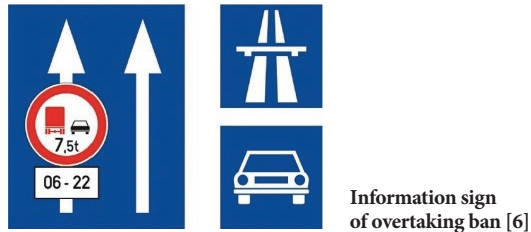
The impacts of HGV overtaking ban [1]

According to the presented results, it is clearly stated that traffic management has greatly improved in the whole area and the ban has positive effects on the traffic of heavy goods vehicles. Furthermore, according to the analysis, better results could be achieved with dynamic overtaking ban, so it is proposed for domestic use, where the infrastructural facilities permit. The evaluation of European examples has shown that for the purpose of driver's cooperation, the length of affected motorway section should be

between 5 and 20 km. Over 20 km, the drivers of heavy goods vehicles do not respect the restriction. Because of the current static control used in Hungary, the observance of the guideline cannot be respected [1], [5].

4. HGV OVERTAKING BAN IN HUNGARY

On the Hungarian motorway network there is a permanent overtaking ban since 2008 on certain two-lane sections - mainly near Budapest - that is compulsory for every vehicle over 3.5 tonnes. In 1st January 2011 the legislation was completed: for every heavy goods vehicle over 7.5 tonnes, it is forbidden to overtake another HGV on all the two-lane sections between 6AM and 10PM. (Fig. 1. illustrates a static traffic sign that indicates the prohibition of overtaking)



In addition, within the scope of the overtaking ban, vehicles must keep 70 meters safety distance that is enough at least for one HGV to get between them in safety.

Introduction of overtaking ban was explained with the increasing number of rear-end collisions and the increase of traffic jams caused by overtaking trucks that have low speed difference. According to the Ministry of National Development - that has developed the measure - the applied measures increases safety, reduces travel times, increases travel speed in the fast lane and reduces the risk of potential accidents.

HUNGARIAN ROAD SAFETY CAMPAIGN ABOUT HGV OVERTAKING BAN AND MINIMUM SAFETY DISTANCE

Before the implementation of the regulation, the Ministry of National Development, - who has elaborated the rules and regulation - and the National Committee on Accident Prevention - department of the National Police Headquarters - have started a national road safety campaign [7]. Road users have been informed about the modifications of Highway Code and billboards

have been installed with road safety messages along motorways. In line with the installations, the Committee and the largest motorway operator company published multi-language leaflets (Hungarian, English, German, Italian, Romanian, Serbian, Croatian, and Turkish) about the new regulations and its background. Issues could be available at rest areas, at petrol stations, at vignette vending locations and at external - non-Schengen - border crossing points [8].

After the regulation came into force, multilingual road safety information have been given about the new regulation through roadside variable messages signs (VMS) on main motorways by the State Motorway Management Ltd. New signs are still displayed and are in operation [9].

Following figures show the implemented solutions for road safety messages.



Safety message on billboards [7]



Safety messages on VMSs [9]

IDENTIFICATION OF PROBLEMS

The Hungarian national motorway network is in a central position of the European transport network due to its function and it implies that the road operator has to prepare for the presence of various goods vehicles travelling towards the main transit directions. Outworn vehicles travelling with low speed may create significant traffic congestions, and they may delay HGV traffic and max increase travel time that may cause increased stress and labour costs. Long lorry walls can cause increased safety risk as drivers do not obey following distance and it means significant problems for merging traffic.

5. EXPERIENCES OF THE HUNGARIAN PERMANENT HGV OVERTAKING BAN

During the research, authors have investigated several aspects like user aspects, motorway operator aspects, expert aspects and authority aspects. Due to content reasons, in the followings only road safety results and observations can be read.

USER EXPERIENCES ABOUT THE HGV OVERTAKING BAN

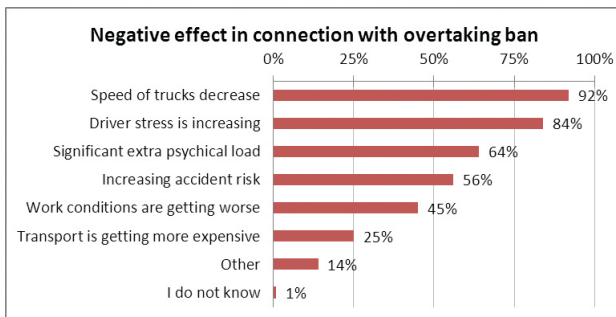
Authors have used a web-based questionnaire to determine user views, which was delivered to the main logistics and transportation companies. The applied method was appropriate for collecting user experiences. The research is not representative because it was available only in Hungarian language, and the respondents were Hungarian road users. More than 250 users filled the questionnaire.

Although the pattern is small, the applied method and results can give input data for further research and in Hungary it is a unique research in the field of HGV overtaking ban.

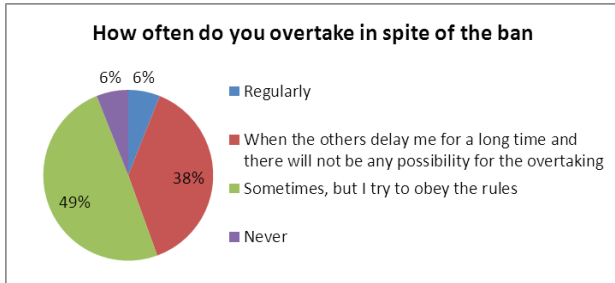
Results have shown a general overview of the current regulation and it represents the general opinions of the Hungarian transporters and logistics sector.

Safety related and psychological user experiences (main results):

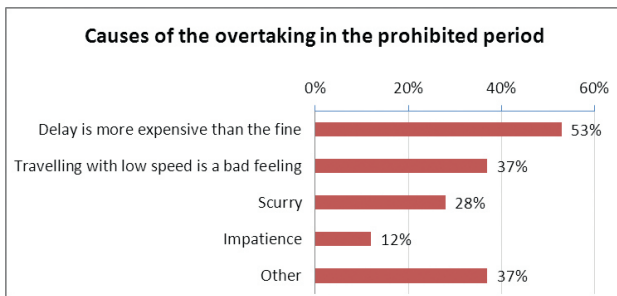
- More than 80% of the respondents think that the applied regulation is not efficient because disadvantages are dominating and the restriction is significantly impairing the work conditions.
- Lot of negative experiences have been indicated. Following diagram shows the percentage of respondents indicated the disadvantages:



- Due to the regulations, irregular overtaking in the prohibited period have decreased. Compare to the previous period the decrease is generally 70-80%. (It may vary by region and section)
- 94% of the representatives have reported that they have already overtaken in the prohibited period. Most of the drivers try to obey the rules but they start the overtaking if they have been being delayed for a long time.

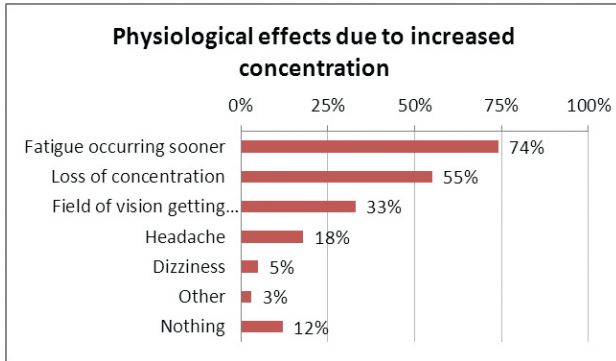


- All respondents have experienced that slower vehicle unnecessarily delayed the traffic due to the ban. (More than 80% say it happens regularly)
- Drivers have indicated the compulsory fulfil of delivery deadline and predefined route as reasons of the irregular overtaking. It is a specific situation in Hungary that overtaking fines are lower than cost of delays. (Details are shown on the following diagram) Users who have marked 'other' they have reported maximal driving time and profit-orientated company attitude as a reason of irregular overtaking. In most cases they cannot use their full work time because of a slower truck.



- 65% of the representatives are refrained from overtaking in the prohibited period due to the fine, and ~25% of the representatives are refrained from overtaking and the rest are not refrained from overtaking.

- More 70% of the drivers try to observe the minimum safety distance, but it is very difficult. When drivers do not comply it, it has mainly traffic reasons.
- Most of the representatives have reported a new type of fatigue (mental stress). Following diagram shows the distribution of most common symptoms.



- A lot of drivers feel that due to the regulation they are limited and it makes them more frustrated, they become more aggressive which have a negative effect on driving thus on the traffic safety.
- 80% of the representatives suppose that the current regulation is justified just on certain sections and in specific period when the traffic load is high.
- Almost every representative agrees to have a more modern regulation. 80% of them prefer dynamic HGV overtaking ban.

EXPERIENCES OF ROAD OPERATORS

The analysis is based on the date of automatic traffic counting stations. Several periods were compared during the analyses: before and after the implementation. Different two-lane cross-sections were chosen on the M0 motorway. The average traffic flow and the proportion of freight traffic are different at each cross section. This allows modelling the Hungarian transportation behaviour at various traffic loads. The analysis covered 6 months.

Since the implementation of the periodic overtaking ban, experiences are the followings:

- Accident data has not changed. However, some benefits may be discoverable, but they cannot be determined due to the lack of specific statistics.
- Average speed of trucks has been reduced by 2-3 km/h;
- During the limitation period, irregular fast-lane usage is between 1-15% of total freight traffic depending on traffic flow and time (when traffic load is low, drivers obey rules better, if traffic volume increases, the number of irregular lane users is growing). Comparing with the prevailing period - when there was no overtaking ban – it is a 65-70% reduction;
- During rush hours, a lot of users break the overtaking ban, and they are travelling at 90-100 km/h average speed, which is 10-15 km/h more than regular speed. It has psychological causes; drivers would like to finish their irregular manoeuvres as soon as possible;

Two additional safety problems have appeared because of the lack of enforcement:

- Slower trucks often use the hard shoulder gratuitously. They continue their journey slower but continuously on the hard shoulder and they wait until the 'HGV wall' overtakes them. This involves a significant security risk, because hard shoulder loses its natural function;
- When the motorway operator has to indicate a distant signal of a traffic diversion on the hard shoulder, the long 'lorry wall' can hide the signs and drivers on the fast lane cannot see them, which has an increased accident risk.

PROFESSIONAL OPINIONS ABOUT THE CURRENT HUNGARIAN REGULATIONS

Roads safety and traffic experts know that the regulation is a must and it is needed because traffic safety reasons. However in the future it is necessary to take into consideration the extra mental and physical load of the regulation that befalls the vehicle drivers.

Traffic safety and overall traffic impacts and results of the regulation:

- Due to the regulation progress of cars has become safer. Drivers are not forced to take emergency break and steering manoeuvres because of the overtaking HGVs. Previously it was general on motorways.
- Due to the restrictions blind spots accidents can be avoid.
- Most of the truck drivers obey the overtaking ban. The retentiveness is not the safety reason goals but the fear of hard punishments. Thus, this solution can be effective on a short time period.
- Obeying the minimum following distance has a similar positive influence on road safety, it can mitigate rear-end collisions. However, the observance of this regulation needs a permanent break-stand-by that is very tiring and has an extreme exhausting effect on the driver's nervous system.
- Truck drivers feel that the regulation limits them and they cannot work effectively. They want to reach their destination as soon as possible and they use every chance to do it. In this situation, it occurs that they do not obey the rules and they start to overtake each others. (It is a general psychological observation, if people have to wait or have to go slower, they will sense that time as it would longer that actually it is. Truck drivers usually overestimate their few minutes delay and they want to make up the leeway.)

In case of heavy traffic, fast lane can be free and car drivers are able to travel by 130 km/h. In such cases it is recommended to reduce their speed to 100 km/h in the fast lane, because in the aspect of the car driver on the left side there is the guardrail and on the right side there is a dense and continuously moving truck flow that is narrowing the driver's field of vision. In case of emergency, there is no way to escape.

PSYCHOLOGICAL AND MENTAL EFFECTS

The permanent overtaking ban has many positive effects on road safety but on the aspect of truck drivers it can negatively affect the work conditions. The increased stress effects, fatigue, decrease of concentration ability can contribute to road accidents caused by trucks.

- To complying the following distance and obligate slow speed travelling behind another truck require continuous, intense concentration that leads to a new kind of mental fatigue. Truck drivers have reported that regularly they are forced to travel behind a slow moving truck and because of this, they saw the back of the foregoing truck and it has increased the monotonically effect. Truck drivers' field of vision have narrowed, they get tired more intensely, and they have to break their trip more often, but they not always have the possibility to have a rest. However, it means increased accident risk.
- International research has shown that if continuous driving time reach or exceeds 8 hours, the symptoms of fatigue become more intensive and concentration decrease. As a result of monotony caused by static control, drivers reach the same level of exhaustion faster, which means after 6-7 hours. Additionally, risk of accidents increase progressively after 8 hours of driving. According to the above-mentioned reasons, we can say that drivers need less time to feel the symptoms of fatigue.
- Continuous monotony not also has short-term effect but it has long-term physiological effects. If a driver has to work in monotone conditions even for months or years it will significantly decrease his/her performance. This affects his/her work, and it can occur that his/her nervous system cannot cope with this problem. In the questionnaire a lot of drivers have reported this kind of problems.

6. SUMMARY

Introduction of HGV overtaking ban on the Hungarian motorway network has resulted new traffic safety problems. During the research not only user reviews but professional experiences were analysed in order to explore the safety risks of the new regulation. According to the results, psychological and mental effects of monotony caused by the overtaking ban could increase the number of accidents. One of the solutions mentioned above could be to introducing dynamic overtaking ban that takes into consideration the current traffic conditions and flow. In this way, the regulation would be in operation only on those sections where it is necessary. According to foreign experiences, user acceptance of the ban would increase – mainly among truck drivers – which would be beneficial not only for the compliance but also for traffic safety.

7. REFERENCES

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