ECO-DRIVING AWARENESS AND BEHAVIOUR OF COMMERCIAL DRIVERS

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Abstract: *Unwanted driving routines (harsh acceleration, harsh breaking and sudden steering) are among the key issues for increased fuel consumption, maintenance cost, air pollution and greenhouse gas emissions reduction. This paper focuses on commercial vehicle drivers' awareness about eco-driving impacts on environment and costs, their current driving behaviour and application of eco-driving measures by companies in transportation and logistics sector. Eco-driving in developing countries is highly desirable and reasonable due to its low costs and almost permanent effects in comparison with other costly and time-consuming measures (fleet renewal with hybrid and electric vehicles, environmental impact strategies and green logistics concepts). For the research purpose, a questionnaire survey is conducted to collect data on eco-driving skills and strategies on in logistics and transportation sector in Serbia.*

Keywords*: Eco-driving, Fuel consumption, Green logistics, Serbia*

1. INTRODUCTION

Eco-driving programs attempt to change a driver's behaviour through general advice, such as: do not drive too fast; do not accelerate too quickly; shift gears sooner to keep engine speed lower; maintain steady speeds; and keep the vehicle in good maintenance (e.g. check for proper tyre pressure frequently) (Barth & Boriboonsomsin, 2009). Some of these actions drivers do applicate without knowing what eco-driving means. However, not all drivers are aware of all of the techniques of eco-driving. Awareness of eco-driving is the first step towards this concept implementation and further development. The aim of this paper is to estimate a level of eco-driving awareness in transportation and logistics sector and level of (un)conscious application of eco-driving techniques on roads in Serbia.

This paper is organised as follows. After a brief introduction, an insight into the eco-driving principles and benefits, as well as a brief overview of the recent eco-driving initiatives and projects are given in Section 2. The research methodology, main results and discussion are presented in Sections 3, 4 and 5, respectively. Final remarks and conclusions are given in the last section.

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2. RESEARCH BACKGROUND

Eco-driving is a term used to describe the energy efficient use of vehicles, and refers to the set of rules, techniques and behaviour that drivers can employ in order to reduce their fuel usage, emissions of CO_2 and other pollutants. Vehicle efficiency is not constant and changing driver behaviour can significantly reduce fuel consumption. Such behaviour is often described as eco-driving (Mensing et al., 2013). We have identified a few terms in use - rational driving, modern driving, smarter driving, etc. - all referring to similar actions. Additionally, "energy efficient driving" or "environmentally friendly driving" are the terms often associated with "slowing down" which is counterproductive, rather than supportive for changing driving behaviour (Schulte, 2012a). Therefore, we decided to use term "eco-driving" to describe such behaviour.

Numerous possible benefits of eco-driving are divided into four groups: environmental (reduced greenhouse gas emissions, local air pollutants and noise), financial (reduced fuel, vehicle maintenance, and costs of accidents), social (more responsible driving, less stress while driving, higher comfort for drivers), and safety (improved road safety, enhanced driving skills) (ECOWILL project, 2010-2013). The essence of eco-driving is to reduce fuel consumption and studies showed that savings are 5-10% on average in long-term period (Barkenbus, 2010).

In transportation and logistics sector, eco-driving also contributes to avoid situations when driver of the vehicle with company logo shows too aggressive driving style, which harm the reputation of the company. In order to achieve listed benefits, driving behaviour and driving techniques should be adapted to traffic conditions and to the type of vehicle. In general, there is a range of rules, tips and tricks about eco-driving that drivers should know. However, five basic ("golden") rules of eco-driving for drivers to follow are identified (Schulte, 2012b):

I Anticipate traffic flow;
II Maintain a steady speed at low rpm;
III Shift up early;
IV Check tyre pressures frequently;
V Consider any extra energy required costs fuel and money.

Eco-driving initiatives in transportation and logistics sector can be differed by levels of application: *Policy level* – creating a unified platform in order to stimulate eco-driving; *Company strategic level* – enhanced route planning and decision making; and *Company operational level* – driver education, trainings and motivation, as well as vehicle equipment and maintenance. Only the last one is considered in this paper. Also, different types of eco-driving activities can be distinguished, but the optimal scenario is a blend of these activities (SenterNovem, 2005): 1. Awareness raising; 2. Dissemination and distribution of information; 3. Training programs. We considered the awareness of commercial vehicle drivers about eco-driving as the first and necessary step towards other measures and activities.

There have been some actions in the past to stimulate eco-driving in Europe, from the legislative (Directive 2003/59/EC, 2003), to the implementation and education area. Target groups of a large number of initiatives were mainly the drivers of private (passenger) cars. Greater attention to eco-driving in freight transportation is paid in several projects (ECOEFFECT project, 2011-2013; ECOSTARS Europe project, 2011-2014; RECODRIVE project, 2007-2010). The results of those projects showed environmental, financial, social and safety benefits. The positive effects are particularly related with emission reductions, fuel consumption and costs savings.

The first steps of eco-driving in Serbia were made under the UNDP project "Support to Sustainable Transportation System in the City of Belgrade", 2011-2015 (Plevnik, 2013). However, only five truck drivers were involved into program. Training and testing of truck drivers resulted with about 7% savings of the average fuel consumption (Vuković and Đorđević, 2014). To include other positive effects and obtain more reliable conclusions, it is necessary to continue the research.

3. METHODOLOGY

A short structured interview (2-3 minutes) is used for data collection. The survey was carried out in the first week of March 2015. The drivers of all commercial vehicle types were included into the survey. The interview was conducted at two level crossings with the barriers in the surrounding of the city of Novi Sad, in periods when the barriers were closed. Once the traffic flow is stopped, random drivers were asked by trained interviewers to participate the survey. If they agreed, the interviewers asked the questions from the questionnaire, explained them, if necessary, and filled in the obtained answers fast "in situ". The interview sample size accounts the total number of 113 drivers. This method allowed the highest level of response. Only 3 questionnaires were not finished due to the opening of the barriers in the middle of interview and they are excluded from further research, so the total number of analysed answers are 110.

The questionnaire consisted of three sets of questions. At the beginning, drivers were asked about their age, driving experience, vehicle and route basic data. Further questions addressed driving behaviour, habits and skills, implementation of eco-driving measures by companies and what measures drivers prefer. Finally, drivers were asked to assess driving skills of commercial drivers in Serbia and whether they are familiar with the term “eco-driving”. The possibility that drivers could give desirable/expected answers from the viewpoint of their company is minimized, because the survey was not conducted in firms. The interviewers have also conducted a brief visual inspect of the vehicle equipment related with aerodynamic design. This was considered as an indirect supporting indicator of an overall approach of respondents' companies to environmental issues.

4. MAIN RESULTS

The survey intended to collect the data on eco-driving awareness and behaviour of commercial vehicle drivers. The basic information about drivers and vehicles is shown in Figure 1. A wide range of drivers is covered by the survey with different levels of experience – young, old, more or less experienced. About 62% of drivers has more than 10 years of driving experience and more than 68% of drivers are older than 35. A significantly high percentage of old vehicles can also be noticed. About a quarter of respondents usually drive on the long-haul routes.

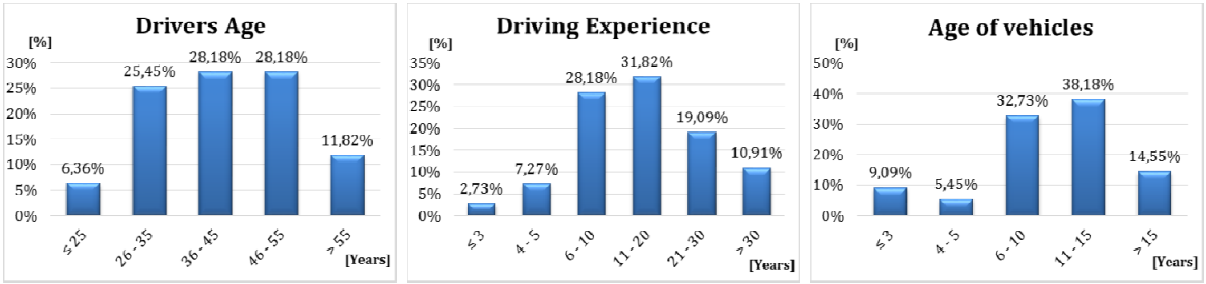

Figure 1. Basic data on drivers and vehicles included in survey

We have investigated at what amount of revolutions per minute (rpm) commercial vehicle drivers usually perform gear shifting, depending on the type of vehicle they drive (Figure 2). Drivers of vehicles equipped with tachometer (around 74%) answered about the engine speeds they usually shift gears. Twenty three percent of total number of respondents drive vehicles with automatic transmission system and a few vehicles with manual transmission are not equipped with tachometer. The two thirds of the light commercial vehicle (LCV) drivers shift gear between 2000 and 2500 rpm. Drivers of vehicles with load capacity more than 3.5 tons (middle and heavy commercial vehicles – MCV and HCV) mostly shifts between 1250 and 1500 rpm. When maintaining a steady speed drivers act different: 40% tend to maintain speed at low

rpm, other 40% maintain a certain rpm (the most at 1250, but there were answers up to 3000 rpm) and 20% maintain desired speed regardless amount of rpm.

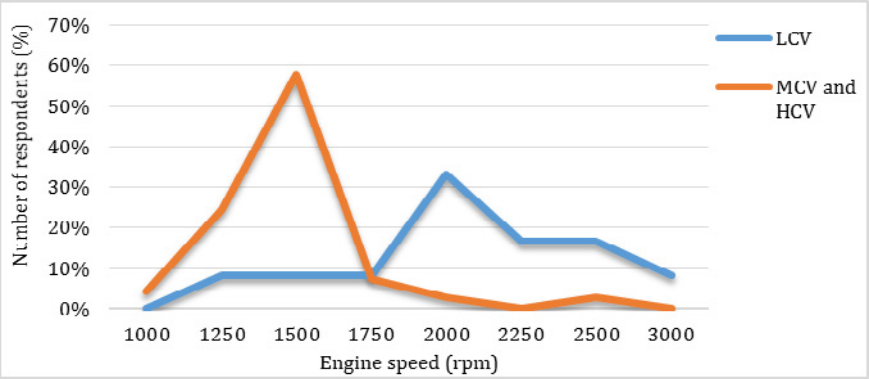

Figure 2. Drivers' opinion about preferred engine speed for gear shifting

Electrical energy is converted from extra fuel burned in a combustion engine, so electrical equipment costs extra energy. Air conditioning is basic electrical device that significantly impact fuel consumption. Drivers were asked how often they use the air conditioner – 60% never or rarely use it, 28% sometimes and 12% often or constantly.

Drivers were asked to rate driving behaviour of other professional drivers in Serbia on a scale from 1-poor to 5-excellent. The rough assessment of driving behaviour resulted with 72% of answers with average and above average rates. Also, a little more than 60% of drivers said they had heard of the term eco-driving, but only 20% of those had a good explanation of what it involves.

At the end, we have investigated level of eco-driving implementation by companies. Even 75% of drivers answered that their company do not implement any of the measures. However, 50% said that implementation of eco-driver recognition and rewarding system is highly desirable. The investment into the air drag reduction aids additionally indicate that the company care about environmental impact. Around 30% of vehicles were not equipped with air drag reduction aids at all. Roof deflectors were on 97% and side extenders on 39% of vehicles equipped with any aid. When it comes to tyre pressure checking, research results shows that 35% of drivers perform frequent checks and around 40% do it occasionally. In few cases, another person in company was responsible for vehicle operational maintenance, so drivers were not obligated to check tyre pressure.

Air drag reduction aids (roof deflectors, side extenders, side tank fairings and end fairings) and recommended tyre pressure reduce fuel consumption, especially on a long-haul routes due to higher driving speeds. Roof deflectors and side extenders are in most cases added in a vehicle production process and are not necessary a result of companies paying attention on air drag reduction. The side tank fairings had only 1% of vehicles and that there was no vehicle with end fairings attached.

5. DISCUSSION

The variety of respondents in terms of age, driving experience, company they work for and routes they usually drive gives strength to this research. Different shifting techniques for light and heavy commercial vehicles (see Figure 2) are consequence of different power sources and different designs of transmission system – HCV are mostly powered with big diesel engines with narrow power band and a lot of LCV are powered by gasoline engines with wider power band. Although the results about preferred engine speed for gear shifting are not output of testing and measurement, but the personal opinions of drivers, we can conclude that drivers of commercial

vehicles perform (or tend to perform) gear shifting in eco-driving manner. The same conclusion can be made about maintaining a steady speed. The most of the drivers which aim to maintain certain engine speed cited low number of rpm. Based on those results, we can conclude that almost 80% of drivers (of both vehicle load capacities - less and more than 3.5 tons) act with regard to eco-driving rule "low rpm at steady speeds".

A high percent of answers about never or rarely use of air conditioner (60%) indicate its use in the eco-driving manner. This is partly influenced by a high number of vehicles without air conditioner installed. It should also be noticed that survey was conducted in winter days, which might have subconscious influence on answers or question misunderstanding. Further, a purpose of commercial vehicle sometimes requires additional (special) electrical equipment. This research questionnaire was not designed to collect specific data about equipment usage of such dedicated vehicles (concrete mixers, refrigeration, waste collection, etc.).

Average and above average assessment of other drivers' behaviour leads to conclusion that professional drivers generally think their driving behaviour is good, but that there is still a room for improvements. Little familiarity with eco-driving indicates that education and dissemination of eco-driving concept should be carried out. This can be achieved in different ways: presentations, press and media, current and new driver trainings in driving schools, etc. The drivers' interesting for this matter encourages the consideration of these measures.

The average age of vehicles indicate a high level of emissions and therefore, a greater importance of the question how they are exploited. While the fleet renewal is crucially significant for environmental impact, it is in the same time the most expensive measure, hardly extensively applicable by majority of Serbian carriers. Hence, the importance of eco-driving gets an additional significance in such challenging economic environment.

The adoption of eco-driving techniques by drivers may be stimulated by their belief that company policy is eco-oriented. A systematic implementation of eco-driving initiatives and programs by companies in transportation and logistics sector in Serbia is on a low level, from drivers' point of view. However, respondents mostly agreed that company should implement some measures. Eco-driver recognition and rewarding scheme is the most wanted measure by drivers, so it is likely that this measure will be well accepted. A low level of application of added air drag reduction aids may indicate low willingness of companies to invest into the environmentally friendly measures, even if they support reduction of fuel consumption.

This research also has a set of limitations. The survey method always indicate a subjective viewpoints of respondents. Further, traffic flow anticipation minimizes harsh acceleration and harsh braking, but this aspect could not be analysed by the qualitative research. Therefore, in further research ECU or accelerometer readings should be included into the analysis to obtain a more comprehensive picture of eco-driving behaviour and obtain more exact results. Additional research could be conducted about eco-driving activities on company strategic level and national level. Dedicated vehicles should be analysed in order to assess additional electrical equipment usage and impact on fuel consumption.

6. CONCLUSION

Eco-driving reduces fuel and maintenance costs, as well as the traffic accidents costs due to a safer way of driving. Consequently, rising the eco-driving awareness contribute to the business performance improvement of companies. Due to its social and environmental significance, we have conducted a research on eco-driving awareness of commercial drivers in Serbia. The general conclusion is that drivers are not familiar with eco-driving concept, but they often use to apply one or more eco-driving techniques.

While majority of environmental measures in transportation and logistics require additional costs and efforts, eco-driving is among the rare ones which have mostly coupled cost-effective

and environmental positive effects. This point may be of crucial importance for wider involving companies into the eco-driving actions. An increasing awareness about environmental effects of eco-driving might additionally increase the motivation for wider implementation of techniques in full range from driver, to company and wider level. This is particularly important for developing countries, with weak economies, where transport and logistics industry face numerous challenges. Therefore, eco-driving concept should be disseminated in all possible ways and it should also be a part of training in driving schools.

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