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Original scientific paper

Effects of Eco-Driving Training: A Pilot Program in Belgrade Public Transport

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Abstract: This paper shows an eco-driving pilot program that has been implemented in the public transport company "JGSP Belgrade", Serbia, in order to assess the possibilities of using eco-driving for an entire car fleet of the assessed company in the future. Eco-driving training and education of thirteen drivers were conducted in real driving conditions on the route length of 14 km and consisted of three phases. The results of eco-driving training of thirteen bus drivers confirm the findings of the previous researches that eco-driving has got many benefits. After the training, all drivers saw fuel consumption reduced by 8.61% on average, and consequently the average CO_2 emission reduced by 8.61%. The implementation of eco-driving training in the assessed company and the attained fuel economy, leads to significant annual savings. However, some driving parameters were not significantly improved after training indicating a driver's slow adaptation and application of new driving techniques.

Keywords: bus drivers; CO_2 emissions; eco-driving; fuel economy; operating parameters

1 INTRODUCTION

Road transport has a negative impact on fuel economy and ecology. In order to identify the factors that influence fuel consumption and CO_2 emissions, researchers around the world have developed methods for fuel consumption estimation [1, 2] and CO_2 emissions estimation in road transport [3]. However, many researchers believe that driver behaviour has a great influence on fuel-use and CO_2 emissions [5-7]. Eco-driving program seems like a promising strategy that can positively change the driver's behaviour and improve driving fuel efficiency. In several European countries, eco-driving is applied as a manner to promote economic driver behaviour. In practice, eco-driving has attracted attention among automakers, policy makers, and researchers because its implementation is not expensive and can be cost-effective.

Eco-driving advices are well defined and comprehensible for drivers. They include the following: avoiding harsh stops and starts; anticipating traffic situations, smooth acceleration, using the engine braking, maintaining steady speed, eliminating excessive idling, driving at or below the speed limit. Besides, Barkenbus [8] noted that some eco-driving adherents involve automobile maintenance measures. The recommendation is a monthly tyre pressure checking and regular changing of air filters.

This paper shows ecological and economical advantages of eco-driving dealing solely with driving behaviour. This eco-driving training pilot program for bus drivers is a preliminary step to, possibly, future implementation of eco-driving training program for all drivers in the public transport company "JGSP Belgrade", Serbia. This pilot program should assess the possibility of using eco-driving training in the aforementioned company and its 841 vehicles in the future.

1.1 Advantages of Eco-Driving Program

There are numerous advantages of using the eco-driving programs. Primarily, these programs can be connected to safety driving training for existing drivers. Furthermore, the programs can be applied to any vehicle on the road regardless of its age, size and type. The results of eco-driving are visible shortly after their implementation for the entire car fleet. Savings in fuel consumption and reduction of emissions are visible from day one [8].

A study for the bus drivers conducted in Greece showed the potential fuel savings of 10-15% [9]. Basarić et al. [10] also indicated the positive fuel economy effects of eco-driving on bus drivers. They established it was possible to achieve savings in fuel consumption and CO_2 emission by approximately 11,71%. In addition, Ho, Wong and Chang [11] have shown that the eco-driving training had the potential to reduce fuel consumption and CO_2 emission by 10%. Rutty, Matthews, Andrey and Del Matto [12] showed the favourable results on the impact of eco-driving training on CO_2 emissions in the period immediately after the training, comparing with CO_2 emission one month before training. Analysing the vehicle operating parameters such as idling, idle fuel consumption, CO_2 emission and harsh acceleration, they determined a reduction in CO_2 emission by 1,7 kg per vehicle per day. In addition, some papers indicated the safety benefits. Namely, Haworth and Symmons [13] in their report indicated a reduction of traffic accidents by 35% using eco-driving training. SenterNovem [14] showed that the accident damage rate decreased by 40% after eco-driving training in Germany. Beusen et al. [15] have defined the key safe driving behaviours which represent the basis of eco-driving.

1.2 Difficulties in Adaptation and Application of Eco-Driving

For over 15 years, eco-driving has been an initiative with a widespread adoption, but the level of accomplished results and its long-term usage depend on certain limitations. Insufficient exposure of drivers to eco-driving information affects their behaviour and sustainability of the changed driving style over a longer period of time. Barkenbus [8] confirmed that there was a need for more initiatives on eco-driving in order to show positive application results, and to persuade the drivers that they should change their habits and driving style.

Before the implementation of eco-driving, the gaps in the public's limited comprehension of the nature of eco-driving and deeply rooted driving behaviour, should be filled. The researches show that the drivers have a tendency to forget the given instructions during their training, and that they fall back to their driving habits. Beusen et al. [15] showed that the majority of drivers made the immediate improvements in fuel consumption after the training, and some drivers had a tendency to return their old driving habits. S. Siero, Boon, Kok and F. Siero [16] noted a decline in positive attitude of the post-office drivers six months after the fuel economy training. However, it should be noted that the driving habits formed through experience are hard to break. Dogan, Steg and Delhomme [17] showed that the eco-driving style could hardly become a driving habit because it depended on certain factors, such as: traffic conditions, environment and personal motives.

Cultural and educational barriers slow the rate of adoption and sustainability of eco-driving from occurring. A study in France, that included 1200 car drivers, showed that despite an intense motivation to reduce fuel consumption, majority of drivers ignored the eco-driving instructions [18]. However, implementation of eco-driving feedback devices in the vehicles could be a good practice that would help the drivers to make a decision when driving. Yang, Li and Zheng [19] showed that these devices have a great role in reduction of CO_2 emission and fuel consumption. When utilising these devices, one must take into account the type, complexity, contents and presentation of information from the perspective of ergonomy.

The bus drivers have a difficulty in maintaining a balance among the goals to be achieved. They have to adhere to the bus timetable, on the other hand, need to drive economically. Dogan et al. [17] has shown that performances in fuel economy decline when the drivers have to balance the reduction of fuel consumption and travel time.

Some researchers proposed their solution for the aforementioned problems. Barkenbus [8] believes that the eco-driving should become a norm and suggests the measures, such as regulation, training, education, feedback devices, fiscal stimulus and strengthening of social norms that can be used to influence the driving behaviour of individuals. Sullman, Dorn, and Niemi [20] believe that in order to motivate the drivers to apply the eco-driving principles and improve their driving performances, the transport company should pair up the eco-driving training with the behavioural change techniques. Some researchers suggest that the eco-driving program should be included in the national climate change strategies [21, 22]. Van den Hoed et al. [21] claim that encouraging professional, individual drivers and fleet owners through eco-drive program to drive in a more ecological way can lead to reduction of CO_2 emissions in the transport sector. Also, several IEA countries have included the eco-driving activities as part of their CO_2 emission reduction strategies and national climate change programs [22].

2 RESEARCH METHODOLOGY

2.1 Participants

Eco-driving training was conducted on July 5th, 6th, 12th and 13th, 2016 in the public transport company "JGSP Belgrade", operating in Belgrade, Serbia, and included thirteen bus drivers who voluntarily agreed to be monitored for a period of time. The average age of the participants was 42, with a standard deviation of 2,62. The average driving experience was 12 years (*SD* = 2,19). The study participants were selected using purposive sampling.

2.2 Test Route and Test Vehicle

In order to eliminate the difference in road conditions for the drivers, training was conducted on the same predetermined route, from the public transport company "JGSP Belgrade" depot in Novi Beograd to the bus 85 last stop in Banovo Brdo. Total length of the route in both directions was around 14 km.

The same bus, MAN SG313 with automatic transmission, was used for each day of testing so that the drivers could drive the same bus each time. It was equipped with a Controller Area Network (CAN) bus enabling the reading of driving parameters. In case of each measurement, the test vehicle parameters that affect fuel consumption were approximately the same.

2.3 Procedure

The study was conducted between 9 a.m. and 4 p.m. As an initial hypothesis, approximately the same number of vehicles and network conditions were selected in order to characterise the time periods and the driving behaviour in the tested interval.

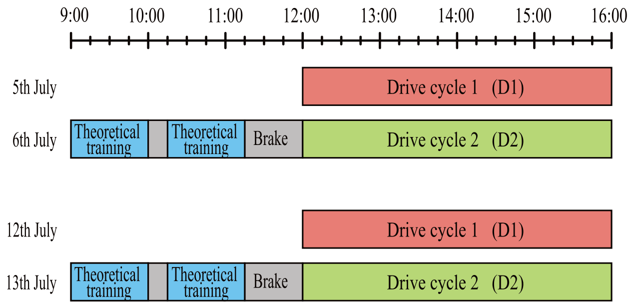

Figure 1 The pilot program time period

The test drive was taken twice by each driver: first before eco-driving training (normal driving) and second after eco-driving training with the professional eco-driving instructions. Eco-driving training has two sessions; a theoretical approach and a practical driving under instructor. The whole pilot program included three stages (in Fig. 1):

- Before eco–driving training - D1 (Drive cycle 1) – This drive was completed by all the participants in the study so that the driving style could be recorded before the implementation of eco-driving tips. The first seven drivers (driver 1 – driver 7) conducted the initial drive (D1) on 5th July 2016 and the other six drivers (driver 8 – driver 13) on 12th July 2016 between 12 a.m. and 4 p.m. This serves as the control point in comparison to drive cycle 2 (D2) so that the potential fuel economy, advancement in driving and vehicle parameters achieved with eco-driving, can be assessed.
- Classroom training session – Theoretical eco–driving training was undertaken by the licensed instructors from RICo Training Centre (Accredited Training Institute of the World's Road Transport Organisation – IRU from Geneva) in duration of 120 minutes. Classroom training session took place on 6th July 2016 (driver 1 – driver 7) and 13th

July 2016 (driver 8 – driver 13) before drive cycle 2. The training program was a static approach which aimed at urging drivers to apply eco-driving techniques after learning. Some of the advices given to the drivers include: driving at the speed limit, slow motion, decelerate smoothly, anticipate traffic flow, maintain a steady speed at low RPM (revolutions per minute) etc.

- Practical driver training - D2 (Drive cycle 2) – Drive cycle 2 combines the techniques learnt during the classroom teachings, as well as the real-time guidance from the instructor during the drive cycles. This drive cycle was conducted on 6th July 2016 (driver 1 – driver 7) and on 13th July 2016 (driver 8 – driver 13) between 12 a.m. and 4 p.m. After the completion of drive cycle 2, the obtained results were presented to drivers in order to evaluate the effects and identify the key needs for future development. The logged parameters are as shown in Tab. 1.

Table 1 List of parameters logged for both drive cycles 1 and 2

Parameter	Unit	Description
Duration	hh:mm:ss	From start to end of the drive
Distance	km	Distance covered
Average speed	km/h	Vehicle speed for the distance travelled in a given period of time
Average speed – on the move	km/h	Vehicle speed for the distance travelled in a given period of time when the vehicle is in motion
Fuel consumption – on the move	L(litre)	Amount of fuel used while the vehicle is in motion
Total fuel consumption	L(litre)	Amount of fuel used during a specific drive
Average fuel consumption	L/100 km	Average amount of fuel used during a specific drive
Average CO_2 emission	kg/100 km	Corresponding average CO_2 emission for a specific drive
Average accelerator pedal position	%	Average accelerator pedal position ranges between 0% (not touching) and 100% (fully pushed)
Driving without accelerator pedal – moving time	mm:ss	Vehicle drive time when driving without using accelerator pedal
Brake time	mm:ss	Total duration of brake time per drive
Driving without accelerator pedal - total distance	km	Total distance when driving without accelerator pedal
Brake usage – total distance	km	Total distance with brake pedal usage per drive
Brake count	-	Total number of braking occurrences per drive
Stopping events count	-	Total number of events that affect the vehicle stop
Idling time	mm:ss	Total duration when vehicle's engine is running and the vehicle is not in motion
Gearshift count	-	Total number of gearshifts according to driving style
Average engine speed	rpm	Number of revolutions per minute at which the engine crankshaft turns

2.4 Data Collection

Data was collected after connecting CAN network with the software Key Driving Training System produced by Belgian company Key Driving Competence, using the diagnostic cable SAE J1939. Using two interfaces (Kvaser and Squarell) the data was translated into computable and readable data that could be used on a PC.

The data collected were statistically evaluated to measure the effectiveness of the Eco-driving training program. Statistical evaluation of the driving parameters was investigated using paired t-test (at 5% significance level) in statistical program MINITAB 17. Paired t-test was used to compare whether the results of driving parameters after the eco-driving training were significantly improved to the results before training.

3 RESULTS AND DISCUSSION

Analysis of the driving quality parameters before (D1) and after eco-driving training (D2) as per Tab. 2 show an average speed deceleration of nine drivers between range of 2,92% - 14,67% while four drivers increased the average speed after training between range of 0,73% – 23,70%. Similar values were obtained in the analysis of the average speed while the vehicle was in motion. The results among thirteen drivers revealed that there was no significant effect of the eco-driving training in both parameters, p = 0,756 and p = 0,548, respectively.

After completing the second Drive cycle (D2), and when compared to the test drive before the training (D1), almost all drivers reduced the fuel consumption while the vehicle was still in motion. Driver 2 achieved the least savings in fuel consumption (0,99%), whereas Driver 11 achieved the most (20,95%). Driver 12 only achieved an increase of 0,30%. Also, a lower overall fuel consumption was determined for all the drivers after the training, with an average saving in fuel consumption by 8,61%. The results showed that eco-driving techniques contributed to reducing parameters FCM (fuel consumption – on the move), TFC (total fuel consumption) and AFC (average fuel consumption) considerably and values of these parameters before training were significantly greater than those after training, p = 0,000, p = 0,001 and p = 0,001, respectively. There are previous evidences which have also reported eco-driving training to result in an increase in fuel savings for bus drivers [9, 10, 23, 24, 25]. These researchers showed that eco-driving could increase the fuel economy up to 27%.

Consequently, the average CO_2 emission in tested drivers was reduced from 0,13% to 19,95% in relation to the emission before training. Average reduction in CO_2 emission for all thirteen drivers was 8,61%. Results showed that Eco-driving program significantly affected the reduction of average CO_2 emission after training, p = 0,001. Barić, Zovak and Periša [26] showed it was possible to achieve even higher emission reduction, of up to 32%.

Result analysis after the eco-driving training in tested drivers (in Tab. 3) showed that nine drivers reduced the parameter APGP (the average accelerator pedal position) avoiding strong accelerations indicating that eco-driving training affected a significant improvement of this parameter after training, p = 0,009. Pushing the throttle not more than 50% can be beneficial for fuel economy [27]. After eco-driving training, nine drivers increased the time of driving without throttle while the vehicle was in motion.

The improvements are between range of 0,32% - 49,49% while four drivers decreased between range of 3,38% - 38,13%. Post-training improvements were no statistically significant, p = 0,155. In addition, there was no significant effect of the eco-driving training on increasing total distance with driving without throttle, p = 0,479.

Table 2 Driving quality parameters before (D1) and after eco-driving training (D2)

		Parameters							
		D	Dis	AS	ASM	FCM	TFC	AFC	ACO_2
		hh:mm:ss	km	km/h	km/h	L(litre)	L(litre)	L/100 km	kg/100 km
Driver 1	D1	0:25:00	14,34	34,42	37,08	7,89	8,13	56,7	150,7
	D2	0:25:50	14,35	33,33	35,85	7,81	8,12	56,63	150,5
	%	3,33	0,07	-3,17	-3,31	-1,01	-0,12	-0,12	-0,13
Driver 2	D1	0:25:52	14,39	33,38	35,09	8,04	8,25	57,3	152,5
	D2	0:30:19	14,39	28,48	30,25	7,96	8,23	57,16	152,2
	%	17,20	0,00	-14,67	-13,8	-0,99	-0,24	-0,24	-0,19
Driver 3	D1	0:26:55	14,34	31,98	35,01	7,9	8,28	57,7	153,6
	D2	0:29:27	14,34	29,21	32,1	7,58	7,81	57,43	144,9
	%	9,41	0,00	-8,66	-8,31	-4,05	-5,67	-0,47	-5,66
Driver 4	D1	0:28:46	14,38	30,00	32,35	8,82	9,09	63,2	168,1
	D2	0:26:42	14,33	32,19	33,11	7,42	7,53	52,36	139,7
	%	-7,18	-0,35	7,30	2,35	-15,87	-17,16	-17,16	-16,89
Driver 5	D1	0:27:18	14,35	31,53	33,57	7,92	8,16	56,9	151,3
	D2	0:28:39	14,33	30,00	32,88	7,33	7,73	53,9	143,5
	%	4,97	-0,11	-4,84	-2,03	-7,48	-5,31	-5,20	-5,20
Driver 6	D1	0:30:02	14,27	28,51	30,49	7,5	7,84	54,94	145,1
	D2	0:30:43	14,18	27,7	29,32	6,42	6,72	47,4	126,1
	%	2,30	-0,63	-2,92	-3,84	-14,39	-14,20	-15,91	-15,07
Driver 7	D1	0:27:47	14,54	31,41	33,80	6,61	6,78	46,6	124,0
	D2	0:27:35	14,55	31,64	32,81	6,47	6,57	45,2	120,2
	%	-0,54	0,03	0,73	-2,95	-2,25	-3,05	-3,08	-3,08
Driver 8	D1	0:31:26	14,33	27,36	29,11	8,44	8,70	60,7	161,4
	D2	0:25:27	14,36	33,85	36,14	7,25	7,37	51,3	136,5
	%	-19,03	0,20	23,70	24,18	-14,07	-15,23	-15,40	-15,40
Driver 9	D1	0:27:13	14,16	31,21	33,25	7,69	7,96	56,2	149,5
	D2	0:22:26	14,28	38,19	39,26	7,12	7,22	50,5	134,4
	%	-17,54	0,91	22,37	18,07	-7,40	-9,29	-10,14	-10,11
Driver 10	D1	0:24:17	14,40	35,57	37,84	8,91	9,09	63,1	167,9
	D2	0:25:49	14,40	33,47	35,10	7,43	7,63	53,0	141,0
	%	6,29	0,00	-5,90	-7,23	-16,66	-15,98	-15,99	-16,02
Driver 11	D1	0:24:40	14,37	34,95	36,06	9,30	9,39	65,4	173,8
	D2	0:27:33	14,33	31,21	32,21	7,35	7,50	52,3	139,2
	%	11,68	-0,29	-10,72	-10,68	-20,95	-20,18	-19,95	-19,95
Driver 12	D1	0:25:31	14,26	33,54	36,69	7,32	7,60	53,3	141,7
	D2	0:26:44	14,26	32,01	34,24	7,34	7,56	53,0	141,0
	%	4,78	0,00	-4,55	-6,68	0,30	-0,47	-0,48	-0,49
Driver 13	D1	0:33:15	14,29	25,79	28,95	8,43	8,81	61,7	164,1
	D2	0:35:19	14,29	24,27	28,24	7,82	8,36	58,5	155,6
	%	6,22	0,00	-5,87	-2,45	-7,25	-5,18	-5,16	-5,16

Note: D – Duration; DIS – Distance; AS - Average speed; ASM - Average speed – on the move; FCM - Fuel consumption – on the move; TFC - Total fuel consumption; AFC - Average fuel consumption; ACO_2 - Average CO_2 emission

After applying advices on reducing the risky traffic situations the drivers were given during their training, ten drivers reduced their brake time during driving after eco-driving training from 3,53% to 70,15%. After the training these ten drivers used the brake less between range of 36,84% – 86,60% which consequently led to an increased fuel economy. Eco-driving program was effective in these two parameters, BT (brake time) and BC (brake count), so it was statistically shown that their values before training were greater than those of after training, p = 0,004 and p = 0,003, respectively. These findings were justified by previous researches [5, 28], claiming that a large number of sudden breakings could be responsible for the increase of the fuel consumption by around 30-44% in comparison to vehicles that were driving smoothly and moderately.

After eco-driving training, the stopping events count reduced, as statistically demonstrated, p = 0,007. When faced with situations where the drivers had to stop (e.g. at intersections), these drivers anticipated the traffic situations enabling a more comfortable and safer drive without sudden braking.

Table 3 Analysis of results of the tested drivers before (D1) and after eco-driving training (D2)

		Parameters									
		APGP	DWTM	BT	DWTTD	BUTD	BC	SEC	IT	GC	AES
		%	mm:ss	mm:ss	km	km	#	#	mm:ss	#	rpm
Driver 1	D1	30,00	05:09	01:07	3,13	0,17	20	6	01:48	88	1077
	D2	26,00	05:10	01:51	2,85	0,13	20	8	01:49	89	1021
	%	-13,13	0,32	41,12	-8,94	-23,53	0,00	33,33	0,92	1,14	-5,19
Driver 2	D1	30,00	04:30	01:18	2,56	0,19	26	2	01:16	95	1072
	D2	25,00	06:18	01:49	3,28	0,15	34	3	01:46	104	1045
	%	-16,67	40,00	26,27	28,12	-21,05	30,77	50,00	39,47	9,47	-2,52
Driver 3	D1	28,00	04:13	03:18	2,36	0,22	19	9	02:20	96	1034
	D2	25,00	06:14	03:11	3,25	0,07	12	7	02:39	99	1015
	%	-10,71	47,83	-3,53	37,71	-68,18	-36,84	-22,22	13,57	3,12	-1,84
Driver 4	D1	28,00	07:39	03:21	4,5	0,17	26	9	02:05	144	1054
	D2	28,00	04:44	01:00	2,57	0,04	9	4	00:44	68	1046
	%	0,00	-38,13	-70,15	-42,89	-76,47	-65,38	-55,55	-64,80	-52,78	-0,76
Driver 5	D1	28,00	06:04	02:45	3,41	0,19	24	9	01:39	102	1038
	D2	25,00	05:17	02:06	2,77	0,13	14	6	02:31	71	1025
	%	-9,09	-12,91	-23,74	-18,79	-32,87	-43,75	-33,33	51,70	-30,39	-1,22
Driver 6	D1	23,00	08:56	02:01	5,32	0,28	51	11	01:57	125	1021
	D2	21,00	08:24	01:30	4,22	0,20	24	4	01:42	95	1002
	%	-9,73	-6,00	-25,38	-20,70	-29,01	-52,48	-63,64	-12,94	-24,00	-1,84
Driver 7	D1	24,00	05:04	01:09	2,74	0,10	13	6	01:58	86	1014
	D2	24,00	06:20	01:16	3,63	0,11	18	3	00:59	100	1014
	%	0,00	24,79	9,07	32,52	15,82	38,46	-50,00	-50,10	16,28	0,00
Driver 8	D1	26,00	04:45	02:57	2,39	0,18	28	10	01:53	130	1013
	D2	28,00	04:54	01:08	2,86	0,09	10	3	01:37	76	1056
	%	8,45	3,14	-61,48	19,86	-49,10	-64,29	-70,00	-14,07	-41,54	4,25
Driver 9	D1	27,00	04:26	02:04	2,56	0,05	10	6	01:40	76	1032
	D2	30,00	04:58	00:57	3,06	0,07	6	2	00:37	65	1088
	%	9,57	12,00	-53,55	19,79	43,82	-40,00	-66,67	-63,35	-14,47	5,39
Driver 10	D1	36,00	06:45	02:50	4,52	0,48	49	6	01:27	101	1116
	D2	29,00	06:32	01:24	3,68	0,02	7	3	01:12	86	1069
	%	-19,98	-3,38	-50,77	-18,57	-94,99	-86,60	-50,00	-17,59	-14,85	-4,16
Driver 11	D1	36,00	07:14	02:07	4,72	0,26	25	5	00:45	106	1109
	D2	26,00	07:21	00:45	3,97	0,03	4	3	00:51	84	1056
	%	-27,93	1,76	-64,46	-16,00	-88,78	-85,71	-40,00	13,37	-20,75	-4,73
Driver 12	D1	28,00	04:23	02:24	2,53	0,12	27	4	02:12	82	1036
	D2	25,00	06:33	01:58	3,70	0,12	16	7	01:44	104	1041
	%	-8,62	49,49	-17,91	46,12	0,00	-39,62	75,00	-20,66	26,83	0,49
Driver 13	D1	24,00	04:47	05:30	2,26	0,25	48	13	03:38	113	1005
	D2	21,00	06:06	04:19	3,35	0,07	19	11	04:58	106	954
	%	-13,60	27,84	-21,60	48,27	-72,76	-60,00	-15,38	36,60	-6,19	-5,05

Note: APGP – Average position of gas pedal; DWTM – Driving without throttle – moving time; BT – Brake time; DWTTD - Driving without throttle – total distance; BUTD – Brake usage – total distance; BC – Brake count; SEC – Stopping events count; IT – Idling time; GSC – Gearshitf count; AES – Average engine speed

A number of gear changes after the training reduced by eight drivers between range of 6,19% - 52,78% while the five drivers increased between range of 1,14% - 26,83%. After eco-driving training, smoother driving was achieved as statistically demonstrated, $p = 0,036$. Symmons, Rose & van Doorn [29] claim that a decrease in the number of gear changes and the use of brake not only has a positive effect on reduction of risky situations, but also has a positive effect on the vehicle repair and maintenance expenses. Basarić et al. [10] moreover showed that a lower number of gear changes and smoother drive reduced the vehicle's wear and tear.

Although the improvements of the average engine speed were achieved to nine drivers when compared to the drive before the training, between range of 0,76% - 5,19%, the results among thirteen drivers revealed that there was no significant effect of the eco-driving training, $p = 0,080$.

After eco-driving training seven drivers reduced the idling time from 12,94% to 64,80% while six drivers increased between range of 0,92% - 51,70%. The result among the thirteen drivers showed that there was no significant effect of the eco-driving training on reducing the vehicle's idle time, $p = 0,300$. Researchers have shown that idling time is the most inefficient use of fuel [12]. Natural Resources Canada [30] have concluded that the idling time of the vehicle of more than 10 seconds has a higher fuel consumption than turning the engine off and starting it again.

Tab. 4 summarized the outcome of the eco-driving training and it disclosed that there was a general improvement in the driver's manner of driving.

Table 4 The driving before (D1) and after eco-driving (D2) statistics

Driving Parameters	Units	Mean	SD	P-value	T-value
D (D1) - D (D2)	h	-0,0058	0,0498	0,680	-0,42
AS (D1) - AS (D2)	km/h	0,315	3,574	0,756	0,32
ASM (D1) - ASM (D2)	km/h	0,598	3,494	0,548	0,62
FCM (D1) - FCM (D2)	L(litre)	0,758	0,609	0,000**	4,49
TFC (D1) - TFC (D2)	L(litre)	0,748	0,651	0,001**	4,15
AFC (D1) - AFC (D2)	L/100 km	5,00	4,70	0,001**	3,84
ACO_2 (D1) - ACO_2 (D2)	kg/100 km	13,76	11,90	0,001**	4,17
APGP (D1) - APGP (D2)	%	2,692	3,521	0,009**	2,76
DWTM (D1) - DWTM (D2)	h	-0,00675	0,02294	0,155	-1,06
BT (D1) - BT (D2)	h	0,01327	0,01533	0,004**	3,12
DWTTD (D1) - DWTTD (D2)	km	-0,015	0,992	0,479	-0,05
BUTD (D1) - BUTD (D2)	km	0,1100	0,1294	0,005**	3,07
BC (D1) - BC (D2)	#	13,31	14,32	0,003**	3,35
SEC (D1) - SEC (D2)	#	2,462	3,072	0,007**	2,89
IT (D1) - IT (D2)	h	0,00190	0,01275	0,300	0,54
GC (D1) - GC (D2)	#	15,15	27,72	0,036**	1,97
AES (D1) - AES (D2)	rpm	14,54	35,00	0,080	1,50

Note: Driving parameters were calculated as (D1) minus (D2); **significant P-value at 5% level; SD: Standard Deviation

3.1 Eco-Driving

Assessment of the fuel economy provides the calculation of the economic benefits for the public transport company "JGSP Belgrade", from implementing eco-driving education among its drivers. In this company, the overall structure costs of 32% go to fuel expenses. Every bus consumes around 22 829 l of diesel annually, which indicates that an average fuel saving of 8,61% results in an annual saving of 1966 l of diesel fuel per bus. If an average price for 1l of diesel fuel is €0,90, than an annual saving for each bus would be €1769 amounting to €1 487 729 for the 841 bus fleet. Symmons et al. [29] established that if a car fleet consuming around 1,5 million litters of diesel fuel per year saved just 1%, it would made the savings of $15 000 per annum.

4 CONCLUSIONS

In this paper, the effectiveness of Eco-driving training in the public transport company "JGSP Belgrade", Serbia, was investigated. The results confirm the findings of the previous researches that Eco-driving training reduces fuel consumption, CO_2 emissions, and improves driver behaviour short-term. In the present pilot program fuel economy was enhanced on average by 8,61% after the training and hence the average CO_2 emission was reduced by 8,61%. Furthermore, the findings of this pilot program also demonstrated that eco-driving training has the potential to significantly reduce fuel-related costs for transport companies.

Eco-driving effects have shown a general improvement in the driver's manner of driving. However, some driving parameters (D, AS, ASM, DWTM, DWTTD, IT, AES) were not significantly improved after training indicating a driver's slow adaptation and application of new driving techniques. Therefore, eco-driving program needs to examine how the guidelines for these driving parameters could be improved.

Although our results were enticed under realistic conditions with potentially a great validity, this study had limitations that should be accepted in the context of the results. One limitation was the small sample size ($N = 13$) and it may not be possible to generalize the findings to other companies without restrictions. However, these findings can provide a preliminary access into what level of influence an eco-driving training and education can have on bus drivers' fuel efficiency. Furthermore, the primary goal of drivers is not to save fuel but to take passengers to the destination site; drivers might not react to the interventions as drivers with other primary goals in different settings. There may be other external influences outside of our control which may distract the effects.

Future researches should test if, and to what extent, these results could be sustainable over a longer period, and whether they could be transferred to other domains of energy-efficiency behaviour.

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