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THE EFFECTS OF MOTORWAY NETWORK DEVELOPMENT ON TRAFFIC ACCIDENT COSTS IN CROATIA

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SUMMARY: The basic objective of this research is to explore the contribution of motorway network development in minimizing accident costs. Results of the study are based on Croatian experience. The likelihood of a statistically negative correlation between the total motorway length and traffic accident costs will be investigated through observation of variations in the total length of motorways and the number and type of accidents that occurred. The results are based on statistical methods of regression and correlation analysis. The analysis spans the period between 2000 and 2013. The conducted regression analysis has confirmed that one newly constructed kilometre of motorways results in a decrease of social accident costs by 761,488 €. The gathered data suggest that the expected effects of further construction of Croatian motorway network on traffic safety are lessening, so in order to increase traffic safety further measures to improve traffic culture of all traffic participants should be implemented with more vigour.

Key words: *motorways, road safety, accidents, social accident costs, Croatian experience*

INTRODUCTION

Traffic accidents are a major issue in transport policies around the world. For example, traffic accidents reap more than 30 000 fatalities per year in the European Union. It is estimated that for each death on European roads, there are 4 permanently disabling injuries, such as damage to the brain or spinal cord, 8 serious injuries and 50 minor injuries *(Mobility and transport, 2016).* The number of non-fatal accidents is much higher. There is an estimate of 1,2 million road traffic deaths per year on world roads, and about 50 million injured *(World report on Road Traffic Injury Prevention, 2004)* most of them (90%) in low and middle income countries *(Nantulya, Reich, 2002).* Rapid urbanization and motorization in low and middle income countries will account for much of the increase in the number of crash fatalities. Over the past few decades, there has been a decrease in the number of traffic accident casualties, in spite of the substantial increase in the transport volume *(Blaeij et al., 2003).* Similar trends can be perceived in Croatia as well. Road fatalities in EU in 2012 have fallen by 63,1% since 1991, in Croatia by 51,49%. Accidents involving personal injury have fallen by 25% in EU since 1991, in Croatia by 27,2% since 2001. Perhaps this relative increase in road safety is due to implementation of a broad range of safety enhancing measures in vehicles and infrastructure, and to better traffic behaviour. Safety problems and the occurrence of accidents are a feature of transport, in particular of road transport. In European rail, air and water transport accidents in general occur less frequently than in road transport.

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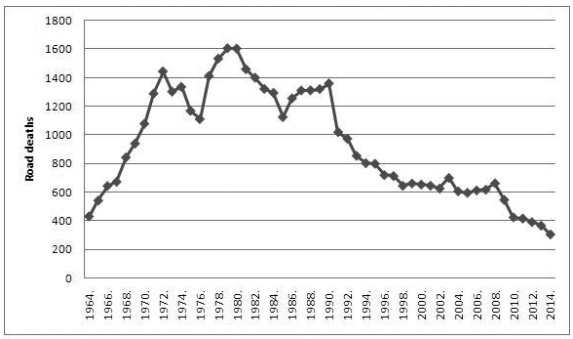
These accidents have an enormous cost. Since 2000, the length of motorway network in Croatia has increased three times. Accordingly, the basic premise of this study is that the enhancement of Croatian roads measured in length of motorway network has contributed to reduce number of traffic accidents, their consequences and costs. But to achieve the main goal of the National Road Traffic Safety Programme, and that is, reducing the number of fatalities to 213 by the year 2020, solely through improvement of road infrastructure, will not be enough. Consequently, the task of this study is to determine the exact contribution of additional length of motorways to reduction of road accident costs in Croatia. Also we'd like to point how important length of motorway network is regarding social costs. This approach, however, by no means seeks to either diminish or jeopardize the Law on Road Traffic Safety or the Croatian National Road Traffic Safety Programme.

The application of the method of abstraction, and an emphasis on road quality as the main factor in reduction of road accident costs, acknowledges the necessity of including these effects in discussion about total transport costs, or construction costs of modern motorways. The resulting knowlegde may be of help to traffic authorities, both on micro and macro levels.

PROBLEM AND STATISTICAL DATA

After the world's first automobile-related fatality, which occurred in London in 1896, the coroner said: "This must never happen again." Little did he know that from then on, some 25 million people would have died in vehicle-related accidents, according to the World Health Organization (WHO). This number is expected to rise by 65 percent by the year 2020, according to a report by WHO and the World Bank. Fatalities are predicted to increase by more than 80 percent in low and middle-income countries, but will decrease by nearly 30 percent in high-income countries *(Kopits, Cropper, 2003)*. From 1964 to 2013 there were 2,557,613 traffic accidents on Croatian roads. The number of traffic accidents with casualties is 628 393. Of these, 47,206 people were killed and 871,356 injured. Over the last fifty years Croatia has lost the population of the size of the city of Varaždin in traffic accidents only.



Source: prepared by the author according to Bulletin of Road Traffic Safety, 2014.

Chart 1. Road traffic fatalities in Croatia since 1964

Slika 1. Smrtnost u prometu u Hrvatskoj od 1964.

Since Haddon introduced his famous "Haddon matrix model" (Table 1) *(Haddon, 1980),* in which he considered three sets of interactive factors, namely human, vehicle and environment, before, during and after a collision, a large number of studies have shown that some of the most important factors associated with traffic accident incidence and injuries/fatalities are driving behaviour such as distracted drivers, driver fatigue, drunk driving, speeding, aggressive driving. Ironically, the greatest threat to drivers seem to be the drivers themselves.

Haddon described road transport as an ill-designed "manmachine" system in need of comprehensive systemic treatment. Each phase – pre-crash, crash and post-crash – can be analysed systematically for human, vehicle, road and environmental factors. The Haddon matrix is an analytical tool to help in identifying all factors associated with a crash.

The four main factors associated with traffic violations and injury severity, are *(Zhang et al., 2013.)*: 1) human factors – driver's gender, driver's age, driver's driving experience, driver's education, income and social status, driver's occupation; 2) vehicle factors – vehicle type, vehicle safety status, vehicle overload condition, whether the vehicle had any compulsory third party insurance, whether the vehicle is a commercial vehicle; 3) road factors – types of

Table 1. Haddon matrix model

Tablica 1. Model Haddonove matrice

Phase		Factors		
		Human	**Vehicles and equipment**	**Environment**
Pre-crash	Crash prevention	Information Attitudes Impairment Police enforcement	Roadworthiness Lighting Braking Handling Speed management	Road design and road layout Speed limits Pedestrian facilities
Crash	Injury prevention during the crash	Use of restraints Impairment	Occupant restraints Other safety devices Crash protective design	Crash-protective roadside objects
Post-crash	Life sustaining	First-aid skill Access to medics	Ease of access Fire risk	Rescue facilities Congestion

traffic lanes, road type; 4) environment factors – street-light condition, weather condition, visibility level, whether it was a weekend, a public holiday, a particular time, a season, a year. Numerous studies suggested that human factors account between 80 to 95% of the factors that cause accidents.

Over the last ten years, the percent of traffic accidents caused by human factor is moving between 92 and 95%. In 2013, the main cause of traffic accidents on Croatian roads is speeding in unfavourable conditions with 22.3%; of those, 40.9% were fatal, while 31.2% ended with casualties. Among accidents caused by driver errors, there is contempt of advantage with 12.8%, improper reverse driving with 8,5%, insufficient distance between vehicles with 7.2% and irregular traffic engagement with 4.9%. From 2003 to 2013, the highest number of traffic accidents happened on Fridays. The most critical months are July and August, which is understandable when you consider that Croatia is a tourist country, and so annually visited by about 12.5 million tourists, and that about 91% of tourists are visiting by car. Men are involved in more accidents and there are more male casualties than female. The highest number of traffic accidents in Croatia during 2013 occurred on other roads within settlements (72.5%) and on state roads outside the settlements (9%). Likewise, the highest number of fatalities in all categories occurred on other roads within settlements (141 people) and state roads outside the settlements (80 people). In the motorway network, the most critical are motorway A1 Zagreb-Split with 34,5% traffic accidents and A3 Bregana-Zagreb-Lipovac with 37,8%. Of 42 fatalities on Croatian motorways in 2013, 34 or 80,95% were killed on A1 (16 people) and A3 (18 people).

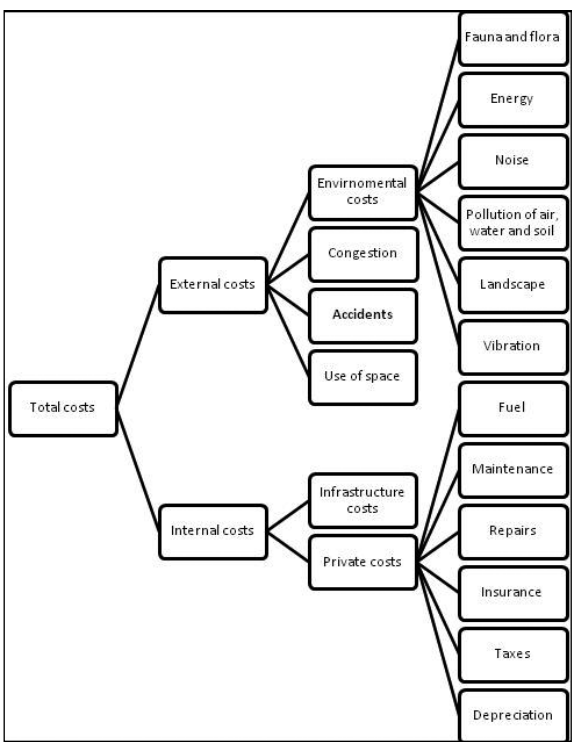
Once the multiple factors associated with a crash are identified and analysed, countermeasures can be developed and prioritized for implementation over short-term and long-term periods. Measures that should reduce the number of deaths on Croatian roads to 213 by 2020 will be implemented in the following fields of action: 1) change of behaviour of traffic participants; 2) better road infrastructure; 3) safer vehicles; 4) efficient medical care in treating traffic casualties and 5) other fields of action.

One of the main factors contributing to the increase in global road crash injuries is the growing number of motor vehicles. The problem is not just the growth in numbers and increase in exposure to the risk but also ensuring that appropriate road safety measures accompany this growth. The motor vehicle, along with the subsequent growth in the number of motor vehicles and in road infrastructure, has brought social benefit but it has also led to social cost, to which road traffic injury contributes significantly.

Scheme 1, based on *(Greene et al., 1997),* provides a schematic outline of different types of cost involved in transport.

Transport authorities on micro and macro levels are obliged to be acquainted with transport costs. However, not only do they need to have an insight in the amount of costs, but also in the cost function, which shows that costs vary in relation

to various parameters *(Quinet, Vickerman, 2008)*. More developed transport systems tend to have lower transport costs since they are more reliable, safer and able to cope with high frequency traffic. In addition, mortality from road traffic injuries has tremendously increased in low and middle income countries; since the 1970s, mortality from road traffic injuries increased by 384% in Botswana, 243% in China, 273% in Columbia and 79% in India *(Mock et al., 2005)*. Deaths due to road traffic accidents have become one of the top three reasons of death for population aged 5 to 44 years, and the direct economic loss has accounted for approximately 1–3% of China's annual gross domestic product *(Global Status Report on Safety: Time for Action, 2009).*



Scheme 1. Structure of transport costs

Shema 1. Struktura troškova prijevoza

The total external costs of transport in the EU plus Norway and Switzerland in 2008 amount to more than € 500 billion, or 4% of the total GDP. About 77% of the costs are caused by passenger transport and 23% by freight. Road transport modes have by far the largest share in these costs (93%). This can be explained by the large share of road transport in the overall transport output, as well as higher average external costs per passenger/km or tonne/km *(External Cost of Transport in Europe, 2008).* Accident costs, comprising both fatal and non-fatal damage costs, form an important part of external transport costs. In 2004, the estimated annual costs of traffic injuries both direct and indirect in the EU-15 countries exceeded 180 billion € *(Social and Economic..., 2007)*. Real costs in terms of deaths, injuries and social and economic consequences exceed these estimates by far. According to the lowest estimates of insurance experts and economic analysts, Croatia suffers a direct loss of social values in the amount of at least two percent of GDP due to traffic accidents, while indirect losses are manifold. The EU Directive 2008/96/EC on road safety requires Member States to carry out the calculation of average social accident costs (*a+b+c*). The costs (*a+b+c*) cover all social costs of the accident, with *a* representing the cost of death or injury to the exposed individual and *b* representing the cost for relatives and friends of the exposed individual. Parameter *c* represents the costs for the rest of society. This includes various direct and indirect economic costs and is assumed to be in the order of 10% of value of safety *per se* (i.e., of the value of life for a fatality).

Road traffic crashes cause death, disability and economic loss all over the world. Traffic accident cost depends on the numbers of fatalities and injuries, and there is also a monetary value which can be placed on human life and injury. Assessing this value is a controversial and sensitive issue. The EU Directive 2008/96/EC on road safety requires Member States to carry out the calculation of average social accident costs (cf. table 2) *(Update of the Handbook..., 2014)*.

Table 2. Average social transport costs, at market prices (PPP) in € 2010

Tablica 2. Prosječni društveni trošak prijevoza prema tržišnim cijenama u € u 2010.

Country	Fatality	Severe injury	Slight injury
Austria	2395000	327000	25800
Belgium	2178000	330400	21300
Bulgaria	984000	127900	9800
Croatia	**1333000**	**173300**	**13300**
Cyprus	1234000	163100	11900
Czech Republic	1446000	194300	14100
Denmark	2364000	292600	22900
Estonia	1163000	155800	11200
Finland	2213000	294300	22000
France	2070000	289200	21600
Germany	2220000	307100	24800
Greece	1518000	198400	15100
Hungary	1225000	164400	11900
Ireland	2412000	305600	23300
Italy	1916000	246200	18800
Latvia	1034000	140000	10000
Lithuania	1061000	144900	10500
Luxemburg	3223000	517700	31200
Malta	2122000	269500	20100
Netherlands	2388000	316400	25500
Poland	1168000	156700	11300
Portugal	1505000	201100	13800
Romania	1048000	136200	10400
Slovakia	1593000	219700	15700
Slovenia	1989000	258300	18900
Spain	1913000	237600	17900
Sweden	2240000	328700	23500
Great Britain	2170000	280300	22200

As seen in Table 2, there is a significant difference in average social accident costs between countries. These costs in Croatia are considerably lower than the EU average (cf. Table 3).

The immanent approach to development of road networks consists of phase one - investment in the length of the road network up to a certain, optimal level of development, followed by phase two – investment in the quality of the road network. Improvement in quality of the road network through increase of 1) the percentage of length of motorways in the total length of road network, 2) the length of motorways per 1000 km^2, 3) the length of motorways per 1 million inhabitants, considerably affect traffic safety and thus reduce external transport costs, notably accident costs. To prove this hypothesis in scientific terms and to investigate and elaborate on Croatian experience in the period between 2000 and 2013, the following statistical data was used as a starting point (cf. Table 4) *(Bulletin on Road Traffic Safety, 2014).*

This 13-year period was chosen specifically because Croatian transport policy since 1999 has been exclusively focused on infrastructure *(Pupavac, 2009)*. Namely, the length of motorways in 2013 increased 3,34 times compared to 1999, while in the same period, the number of traffic accidents was almost two times lower. Construction and launching of new motorways directly and significantly affected redirection of traffic flows on high level service roads, thus improving road safety.

Table 3. Descriptive statistics for social transport costs in EU-28 in € 2010

Tablica 3. Deskriptivna statistika društvenog troška prijevoza u EU-28 u € u 2010.

Variable	Descriptive Statistics (Spreadsheet 1)					
	Mean	Std. Dev	Minimum	Maximum	N	No. cases Missing
Fatality	1790179	572413,2	984000,0	3223000	28	0
Severy injury	242025	87028,9	127900,0	517700	28	0
Slight injury	17814	5968,3	9800,0	31200	28	0

Table 4. Number and type of traffic accidents and the length of motorways in Croatia from 2000 to 2013

Tablica 4. Broj i vrsta prometnih nesreća i duljina autocesta u Hrvatskoj od 2000. do 2013.

Year	Number of recorded accidents	Fatality	Severe injury	Slight injury	Length of motorways, km
2000.	73387	655	4497	19004	411
2001.	81911	647	4604	17489	429
2002.	86611	627	4481	19442	455
2003.	92102	701	4878	21275	554
2004.	76540	608	4395	19876	742
2005.	58132	597	4178	17595	792
2006.	58283	614	4308	18828	877
2007.	61020	619	4544	20548	959
2008.	53496	664	4029	18366	1043
2009.	50388	548	3905	18018	1097
2010.	44394	426	3182	15151	1126
2011.	42443	418	3409	14656	1254
2012.	37065	393	3049	12961	1254
2013.	34021	368	2831	12443	1279

RESEARCH RESULTS AND DISCUSSION

Using statistical data from Table 4, Pearson's coefficient of correlation has been calculated to determine if there is a correlation between the number and type of accidents and the length of motorways (cf. Table 5).

As seen in Table 5, it is clear that there is a statistically significant negative correlation between the length of motorways measured in kilometers and the number of accidents ($r=-0,93$; $p < 0,05$), between the length of motorways and the number of fatal accidents ($r=-0,80$; $p < 0,05$), between the length of motorways and the number of severe injury accidents ($r=-0,84$; $p < 0,05$), between the length of motorways and the number of slight injury accidents ($r=-0,70$; $p < 0,05$).

The method of correlation analysis indisputably established a strong negative correlation between the number and type of traffic accidents and the length of motorways measured by number of constructed kilometers, so what follows is an investigation of connection between social accident costs and the length of motorways. In order to do that, and to set an appropriate econometric model for Croatia, accident costs were derived from average data for certain types of accidents from Table 2, ie average cost of accidents resulting in fatalities was 1,333,000 €, average cost for serious injuries 173,000 € and for minor injuries 13,000 € (cf. Table 6).

Table 5. Correlation between the number and type of accidents and the length of motorways

Tablica 5. Korelacija između broja i vrste nesreća i duljine autocesta

Correlations (Safety.sta) Marked correlations are significant at p < ,05000 N=14 (Casewise deletion of missing data)							
	Means	**Std.Dev.**	**Number of accidents**	**Fatality**	**Severe injury**	**Slight injury**	**Length of motorways**
Number of accidents	60699,50	18728,01	1,000000	0,838860	0,903822	0,814361	-0,934895
Fatality	563,21	112,57	0,838860	1,000000	0,957382	0,922702	-0,803650
Severe injury	4020,71	649,60	0,903822	0,957382	1,000000	0,941559	-0,849706
Slight injury	17546,57	2742,29	0,814361	0,922702	0,941559	1,000000	-0,701316
Length of motorways	876,54	318,15	-0,934895	-0,803650	-0,849706	-0,701316	1,000000

Table 6. Annual losses due to road traffic accidents in Croatia from 2000 to 2013

Tablica 6. Godišnji gubici uzrokovani cestovnim prometnim nesrećama od 2000. do 2013.

Year	**Fatality**	**Severe injury**	**Slight injury**	**Total Average social accident costs**	**Length of motorways, km**
2000.	873115000	779330100	252753200	1905198300	411
2001.	862451000	797873200	232603700	1892927900	429
2002.	835791000	776557300	258578600	1870926900	455
2003.	934433000	845357400	282957500	2062747900	554
2004.	810464000	761653500	264350800	1836468300	742
2005.	795801000	724047400	234013500	1753861900	792
2006.	818462000	746576400	250412400	1815450800	877
2007.	825127000	787475200	273288400	1885890600	959
2008.	885112000	698225700	244267800	1827605500	1043
2009.	730484000	676736500	239639400	1646859900	1097
2010.	567858000	551440600	201508300	1320806900	1126
2011.	557194000	590779700	194924800	1342898500	1254
2012.	523869000	528391700	172381300	1224642000	1254
2013.	490544000	489763000	161759000	1142066000	1279

Source: Author's calculation

When total average accident costs in this period are considered, significant oscillations with prominent tendency of decrease could be observed ((M=1,68 billion €; SD=0,295 billion €; min= 1,14 billion €, max=2,06 billion €). After conducting correlation analysis (cf. Table 5), we decided on a one-dimensional model of linear regression in the following form:

$$Y = a + bX + u \quad [1]$$

Where:

X – independent variable – length of motorways (LM),

Y – dependent variable – average social accident costs (SAC),

u – deviation from the functional relation,

a, b – parameters.

In assessing the value of parameters in function [1] the method of regression analysis was applied, while the numerical computation was performed by *Statistica* software (cf. Table 7).

Regression analysis of the correlation between average social accident costs and the length of motorways gives the following model of simple linear regression:

$$SAC = 2\,348\,068\,000 - 761\,488\,LM \quad [2]$$

Results of regression analysis (cf. Table 7) indicate that there is a statistically significant correlation between total average social accident costs and the length of motorways (R=0,82; F(1,12=24,819; p<0,01). Correlation between the total average social accident costs and the length of motorways is negative, indicating that the decrease in social accident costs is linked with an increase in the length of motorways. An increase in the length of motorways of 1 km leads to decrease in social accident costs about 761 488 € in the first year (B=-761488; SE=152851; p<0,01). Decrease in social accident costs with 67,4% of variance can be explained by the length of motorways.

Chart 2 shows a comparison between the observed and model predicted values of the dependent variable. Chart 2 also shows a satisfactory adaptation of the model to the real data.

Table 7. Regression analysis

Tablica 7. Regresijska analiza

Regression Summary for Dependent Variable: Social accident costs (Safety.sta) R= ,82102539 R2= ,67408269 Adjusted R2= ,64692291 F(1,12)=24,819 p						
	Beta	**Std.Err. - of Beta**	**B**	**Std.Err. - of B**	**t(12)**	**p-level**
Intercept			2,348068E+09	141938432	16,54286	0,000000
Length of motorways	-0,821025	0,164802	-7,614880E+05	152851	-4,98188	0,000319

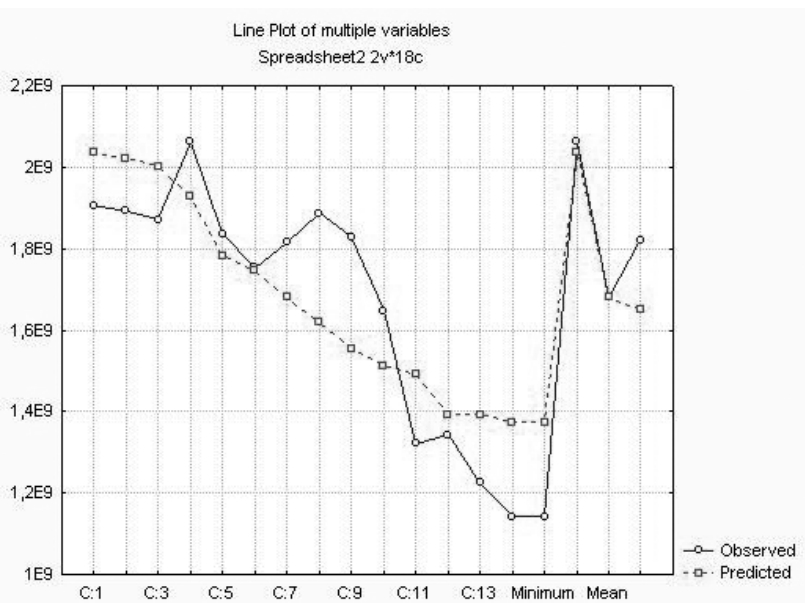


Chart 2. Comparison between the econometric model and the real data for the total social accident costs in Croatia from 2000 to 2013

Slika 2. Usporedba ekonometrijskog modela i stvarnih podataka ukupnog društvenog troška nesreća u Hrvatskoj od 2000. do 2013.

Applying the model (2), and assuming the entire construction of Croatian motorway network with a total length of 1 745.5 km, total losses due to traffic accidents would amount to € 1,015,510,000, or € 123,556,000 less than in 2013. From 2000 to 2013 the structure of casualties is stabilized, so in 2013 the share of fatalities is 2.35% (2.53% on average), 18.09% of the seriously injured (an average of 18.17%) and 79.55% of minor injuries (an average of 79.3%). In this period the structure of losses caused by traffic accidents is also stabilized, so in 2013 the share of losses by fatalities in total losses is 42.95% (an average of 44.47%), of serious injuries 42.88% (an average of 41.58%) and of minor injuries 14.16% (an average of 13.93%).

If the structure of the victims would remain the same, assuming the total construction of Croatian motorway network, the structure of casualties in total amount would be as following: the number of fatalities would be 340 or 8,23% less than in 2013, the number of seriously injured would be 2448 or 15,64% less than in 2013, and the number of minor injuries would be 10 915 or 22,1% less than in 2013. The data obtained suggest that the effects of further construction of Croatian motorway network on traffic safety are reduced and that to improve traffic safety other measures should be implemented, in particular measures to improve traffic culture of all traffic users.

CONCLUSION

Problems of safety and the occurrence of accidents is a feature of traffic, particularly of road traffic. Human behaviour factors are the principal cause of road traffic accidents. One of the consequences of these accidents is an immense cost, a cost which depends on the numbers of fatalities and injuries and the monetary value which can be placed on human life or injury. Economic damages from road traffic accidents are estimated in hundreds of millions of euros, noting that more developed transport systems tend to have lower transport costs.

This study has proven the statistically significant negative correlation between social accident costs and the length of motorway network in Croatia over the last decade. The conducted regression analysis has confirmed that a newly constructed kilometer of a motorway results in decrease of social accident costs in the amount of €761 488. The construction of a full motorway network would contribute to the lessening of social accident costs for 123.5 mil. € compared to 2013, yet it would not guarantee that the number of fatalities would diminish to 213 by 2020.

Since the human factor is the main cause of traffic accidents in Croatia (95%), in order to further improve road safety, besides rehabilitation of dangerous road section and solving the problem of non-insured vehicles the emphasis should be aimed at changing the behaviour of traffic users, ie improving traffic culture of all traffic users. The final outcome should be road traffic system structured to eliminate fatalities and injuries that undermine the sustainability of road traffic networks and communities they serve.

REFERENCES

Bulletin on Road Traffic Safety (in croatian: Bilten o sigurnosti cestovnog prometa), Croatian Ministry of Internal Affairs, Zagreb, 2014.

Blaeij, A. et al.: The Value of Statistical Life in Road Safety: A Meta-Analysis, *Accident Analysis and Prevention*, 35, 2003, 6, 973-986.

External Cost of Transport in Europe, Update Study for 2008, CE Delft, September 2011.

Greene, D., Jones, D., Dulucchi, M.: *The Full Social Costs and Benefits of Transportation,* Springer-Verlag, Berlin, 1997.

Global Status Report on Safety: Time for Action, WHO - World Health Organization, Geneve, 2009.

Haddon, W.: Advances in the epidemiology of injuries as a basis for public policy, *Public Health Report,* 95, 1980, 411–421.

Kopits, E., Cropper, M.: *Traffic Fatalities and Economic Growth. Policy Research Working Paper Number 3035.* The World Bank, Washington, 2003.

Mobility and transport, available at: www.ec.europa.eu/transport, access: May 12, 2015.

Mock, C. et al.: Human resources for the control of road traffic injury, *Bull World Health Organ,* 83, 2005, 4, 294-300.

Nantulya, VM., Reich, MR.: The neglected epidemic: road traffic injuries in developing countries, *BMJ,* 324, 2002, 7346, 1139-41

Pupavac, D.: *Principles of Transport Economics, (in croatian: Načela ekonomike prometa),* Polytehnics of Rijeka, Rijeka, 2009.

Quinet, E., Vickerman, R.: *Principles of Transport Economics,* Edward Elgar Publishing, Inc., Massachusetts, USA, 2008.

Social and Economic Consequences of Road Traffic Injury in Europe, European Transport Safety Council, Brussels, 2007.

Update of the Handbook on External Costs of Transport, Report for the European Commission, Ricardo-AEA, 2014.

World Report on Road Traffic Injury prevention, WHO - World Health Organization, Geneve, 2004.

Zhang, G., Yau, K., Chen, G.: Risk factors associated with traffic violations and accident, *Accident Analysis and Prevention,* 59, 2013, 18-25.

UTJECAJ RAZVOJA MREŽE AUTOCESTA NA TROŠAK PROMETNIH NESREĆA U HRVATSKOJ

SAŽETAK: Temeljni cilj studije je istražiti doprinos razvoja mreže autocesta u smanjenju troška nesreća. Rezultati odražavaju iskustva iz Hrvatske. Moguća negativna korelacija između duljine autoceste i troška prometnih nesreća istražit će se promatranjem različitih duljina autocesta te broja i vrste nesreća koje su se dogodile. Rezultati se temelje na statističkim metodama regresijske i korelacijske analize. Analizirano je razdoblje od 2000. do 2013. Provedena regresijska analiza potvrđuje da svaki novi kilometar izgrađene autoceste ima za posljedicu smanjenje troškova nesreća, i to za 761 488 €. Dobiveni podaci također govore da očekivani učinci daljnje izgradnje mreže autocesta u Hrvatskoj opadaju. Stoga, kako bi se povećala sigurnost u prometu potrebno je provesti odlučne mjere za poboljšanje prometne kulture svih sudionika u prometu.

Ključne riječi: *autoceste, sigurnost na cesti, nesreće, društveni trošak nesreća, hrvatsko iskustvo*

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