Journal of Environmental Protection, Safety, Education and Management

2015, Number 6, Volume 3, date of issue 28th November 2015 ISSN 1339-5270

IMPACT OF ROAD INFRASTRUCTURE CHARGING ON THE PLANNING OF TRANSPORT

Miloš POLIAK - Stefánia SEMANOVÁ - Michaela MRNÍKOVÁ

ABSTRACT

The paper deals with an issue of the impact of road infrastructure charging on the planning of transport. In Europe, the amount of fees for using the road network is determined based on the costs of construction and maintenance of the road network. These fees for using the road network do not motivate road carriers to use toll roads of the higher category. The carriers often bypass toll roads and use the roads of the lower category. Beside toll costs, fuel costs and time savings in travel time are mainly related to the use of toll roads. The output of the paper is a proposal for a methodology of determination of fees for using the road network. The methodology is based on the requirement for keeping vehicles on the higher category roads. The fee amount is determined as the difference of the value of time savings of a carrier while using toll roads and the toll costs increased by the difference of fuel consumption costs while comparing possible routes of carriage.

KEY WORDS

Transport, toll, financing, factor, impact, decision-making.

1. Introduction

Method of road charging is significantly changing in Europe in recent years. It has a significant influence on the decision-making process of hauliers in route choice. Most states have substituted the method of road charging in the form of vignettes for the performance-based method of road charging. In the case of performance-based method of road charging, the fee amount does not depend on time validity of vignettes but it depends on actual distance travelled within toll road infrastructure [1]. Since 2005, the method of road network charging has been changed, for example, in Germany, Austria, the Czech Republic, the Slovak Republic, and Hungary. Changes in the system of road charging can be also observed in non-EU states (e.g., Belarus). Under the performance-based method of road charging, a haulier usually bears higher costs for using toll road network, and he can also consider a possibility to use non-tolled road infrastructure when planning transportation or to use roads with lower fees [2]. Amount of fees for using road infrastructure is regulated by Directive 1999/62/EC [3] in the European Union. The Directive provides a methodology for calculating the fee for using road infrastructure without taking into account the possibility of using a parallel non-tolled road by haulier [4]. When charging road infrastructure, there are also approaches that take into account a decision-making process from the position of haulier. Such approaches are addressed by several authors as Vadali, et al. [5]. The objective of this paper is to identify the factors affecting decision-making process of hauliers in route choice in case that there are several possibilities for transport routing.

2. Factors Affecting a Route Choice

A route choice in road freight transport is a result of various factors that were addressed by several authors. These factors include, for example, route attributes, level of congestion, toll fees, fuel costs, time of carriage (travel time), speed, and vehicle operating costs. Table 1 summarizes the results of studies which deal with the factors affecting a route choice.

Based on the results of processed studies, it can be stated that the most important factors are

- Travel time—congestion and maximum speed for individual roads are also related to the travel time;
- Fuel costs;
- Toll.

Travel time is the most important factor while deciding on a transport route, particularly because legislation stipulates the maximum driving time of drivers within a given period. Table 2 provides a comparison of the stipulated working hours of drivers in individual countries. Maximum daily driving time in individual countries is regulated in the interval from 9 hours in the EU to 15 hours in Canada (northern part of the country, maximum daily driving time in southern part of the country is 13 hours). Similarly, maximum weekly driving time or maximum driving time within two consecutive weeks is also

2015, Number 6, Volume 3, date of issue 28th November 2015 ISSN 1339-5270

regulated. Moreover, minimum daily and weekly rest period are stipulated in the analysed countries. Drivers cannot drive during mentioned rest periods and vehicle must be stationary if a driver draws the rest period in the vehicle.

Table 1 – Factors affecting a route choice made by hauliers [5-10].

Authors of studies	Ref. [6]	Ref. [7]	Ref. [8]	Ref. [9]	Ref. [10]	Ref. [5]
Region	USA	Los Angles (USA)	International experience	Japan	India, South Africa	USA
Driver's decision						
Manager's decision						
Driver wage/income						
Route attributes						
Congestion						
Toll						
Fuel costs						
Speed						
Travel time (reliability/uncertainty)						
Vehicle operating costs						

Table 2 – Regulation of driving time and rest period in individual analysed countries [12-16].

Requirement	EU	USA	Canada	Australia	New Zealand
Continuous driving time	4.5 h	8 h	13/15 h	5.25 h	5.5 h
Break	45 min	30 min	-	15 min	30 min
Daily driving time	9 h	11 h	13/15 h	12 h	13 h
Daily rest period	11 h	10 h	10/8 h	7 h	10 h
Weekly driving time	56 h	70 h	70/80 h	72 h	70 h
Weekly rest period	45 h	34 h	36 h	24 h	24 h
Fortnightly driving time	90 h	148 h	147 h	144 h	166 h

Southern part of Canada/Northern part of Canada.

When taking into account the mentioned restrictions, hauliers prefer the shortest travel time due to possibility to deliver the greatest number of shipments within limited period of time, and from the reason of realization of maximum vehicle performance that is possible within limited period of time. The mentioned statement was also stated by Vadali, et al. [5] and Geiselbrecht, et al. [11]. This means that a haulier will prefer a superior road infrastructure (toll roads) in terms of higher vehicle utilization and he will be willing to pay the fees for its use unless the amount of fees is higher than benefits associated with faster carriage performed on that infrastructure.
Fuel costs represent a significant cost item of the road freight transport operators-hauliers. Table 3 provides the average proportion of fuel costs for the hauliers operating in the USA compared to those operating in the EU. The proportion of fuel costs was at a comparable level of total direct costs in the USA and the EU, in 2008; while total direct costs did not contain the fees for using road infrastructure.

Table 3 – Proportion of individual costs of total costs of hauliers in % [17, 18].

Costs	USA (2008) (%)	EU (2008) (%)
Fuel	36	37
Tires	3	1
Maintenance and repairs	9	8
Wage	37	29
Depreciation	12	18
Insurance	4	7
Total	100	100

Fuel costs represent a proportion of more than one third of the total direct costs of a haulier. Two approaches arise when deciding on transport route and ensuring the operation efficiency:

- In relation to variable costs—hauliers prefer the shortest route of transport or transport route which does not lead through challenging mountain routes. If a shorter route leads through non-tolled infrastructure, hauliers will prefer to use this route.

- In relation to fixed costs—haulier prefer the fastest transport route from the reason that fixed costs per unit are lower in the case of higher performance. Hauliers prefer superior, faster, road infrastructure where the probability of congestion formation is lower.

Toll costs are also an important factor affecting the use of toll road infrastructure by a haulier during transport realization. According to Ref. [18], the average costs of toll were at the level of 1.7 cents per mile ($0.0106/km) for freight vehicles in the USA in 2011. Toll costs represented about 1% of the total direct costs in that period of time. Toll fees represent higher cost level within the EU. Table 4 provides an overview of toll rates in the EU selected states. Given that toll rates in the EU depend on the total vehicle weight, number of axles as well as engine emission class of vehicle, the comparison in Table 4 is processed for a freight vehicle with a gross weight of 40 tons, 5 axles and emission class of EURO 5. Despite the fact that Directive No 1999/62/EC determines a methodology for calculating toll rates, toll rates in the selected states are very different. For example, toll rate in Poland is at the level of €0.050/km, whereas toll rate in Austria is higher almost by €0.3/km (€0.357/km).

In the EU, costs of toll fees represent an average level of €0.15/km. Taking into account the average costs of the carriage by road freight transport—€1.2/km, costs of toll fees in the EU represent the fourth most important cost item that follows the fuel costs, costs of vehicle acquisition (depreciation) and labour costs. It is necessary to note that toll rates in the EU are higher and they also represent a larger proportion on the total costs of hauliers compared to the USA. Furthermore, it should be noted that likelihood of the use of parallel non-tolled infrastructure of lower category by hauliers is increasing with the increasing costs of toll. In the case of higher toll for using road infrastructure, a haulier is willing to endure a higher level of fuel costs (longer route) and the unit fixed costs associated with the use of a parallel non-tolled road.

Table 4 – Comparison of toll rates in selected states of the EU in euros/km (Year 2013) [19-24].

State	Toll (€/km)
Czech Republic	0.150
Hungary	0.289
Germany	0.155
Poland	0.050
Austria	0.357
Slovakia	0.189

However, the whole-society problem is that vehicle diversions from toll roads to non-tolled roads causes increased costs relating to congestion and traffic accidents which are growing in proportion with the increase of traffic intensity on non-tolled infrastructure. In times of economic recession in the USA in 2010, the fees for using road infrastructure decreased significantly. The objective was to motivate hauliers to use toll roads because they had tendency to avoid the toll roads in order to reduce their own costs. Decline in the fees represented 43 % compared to 2009 [18].

3. Value of Time Savings from the Perspective of Hauliers

Main factors that affect the decision of hauliers to use toll roads were identified in the previous chapter. Travel time is one of the most important factors. Value of time savings plays a key role related to the use of toll roads by a haulier. When considering the construction of toll infrastructure, public authorities should estimate how hauliers value their time savings associated with the use of toll infrastructure in terms of money. Only then it is possible to make a proper and efficient pricing policy.

Knorring, et al. [6] dealt with a value of time savings in terms of the hauliers. They concluded that the value of time savings is a key factor in decision-making process of the hauliers. They stated that the hauliers, or drivers, do not just make a decision on which route to take when facing parallel routes, but every single transport route is planned with regard to the factor of time savings.

Several authors tried to estimate the value of time savings. Kawamura [25] estimated this value based on preference data collected in California. Firstly, he summarized that value of time savings ranged from $14.50/hour to $35.60/hour according to the results of previous studies. Then, he estimated the mean value of time savings as $26.8/hour based on his own collected preference data. He also defined dependence of the likelihood of using a particular infrastructure on the value of time savings when using alternative transport route (Fig. 1). Likelihood of using a particular route is increasing with increasing value of time. At value of time savings of $100/h, only low percentage of hauliers would not use given infrastructure.

Before introducing toll in the SR, Poliak and Konečný [2] addressed an issue of the use of parallel non-tolled road infrastructure in connection with definition of the methodology for determining the extent of road network charging. In conditions of the SR, they processed dependence of the proportion of hauliers willing to avoid toll roads depending on the level of toll; for two values of time savings—600 SK/hour (€19.92/hour) and 400 SK (€13.28/hour). The dependence of vehicle diversions from toll infrastructure is depicted in Fig. 3. About 30% of vehicles had bypassed toll road infrastructure

Journal of Environmental Protection, Safety, Education and Management
2015, Number 6, Volume 3, date of issue 28th November 2015 ISSN 1339-5270

in 2008 if value of time savings would have been at the level of €19.92 when assuming the toll rate of 21 SK/km (€0.697/km).

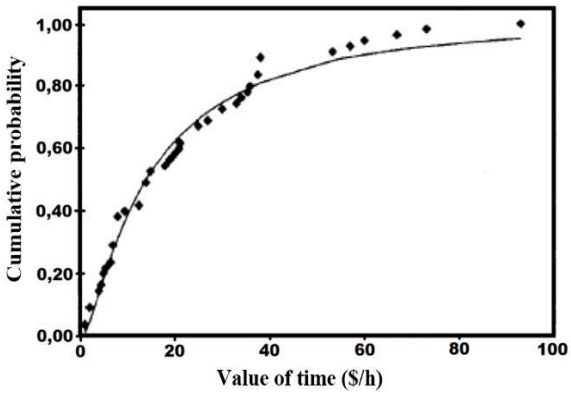

Fig. 1 – Value of travel time savings for road transport companies in the USA [25].

If value of time savings would have decreased to the level of €13.28 while keeping the same toll rate, about 37% of vehicles had bypassed toll road infrastructure. Mentioned approach was not reflected in the determination of toll rates in the SR, and the rates were processed only based on the requirements of EU legislation.

4. Conclusions

The situation where freight vehicles which bypass toll road infrastructure and use non-tolled infrastructure of lower category still persists in the EU, especially in the eastern countries. However, these non-tolled roads often lead across populated areas such as towns and villages. Methodology for pricing of road network which is applied in the EU does not take into account the factors affecting decision-making process of hauliers in route choice. But, toll rates are determined based on the costs of construction and operation of the road network. Hauliers prefer non-tolled road infrastructure in order to reduce their costs related to vehicle operation in the case that the costs of fees for using toll infrastructure exceed the effects associated with the use of this infrastructure, e.g., the effects in the form of time savings or savings in fuel costs. Public authorities look for solutions of transit restrictions for road freight transport on parallel non-tolled roads. However, these solutions are often not effective without a thorough inspection. It is also difficult to ensure effective control between transport service of a territory and transit of a territory.

Therefore, a suitable solution is to set the level of fees for the use of road infrastructure so that hauliers can use toll road infrastructure more efficient. Approach to determination of toll rates mentioned in this paper is based on time savings and savings in hauliers' fuel costs. At such determined rates, decrease in costs expended from public budgets can be expected. These costs particularly include costs for controls of transit on non-tolled infrastructure, costs associated with the accident rate, the impact on the environment and congestion.

Acknowledgments

This paper was developed under the support of project: VEGA No. 1/0320/14 M. POLIAK: Road Safety Improvement through Promoting Public Passenger Transport.

REFERENCES

M. Poliak, Impact of road network charging system on pricing for general Cargo transportation, Promet - Traffic &Transportation: Scientific Journal on Traffic and Transportation Research 24 (1) (2012) 25-33.

M. Poliak, V. Konečný, Factors Determining the Electronic Tolling Scope of Road Network, Journal of Economics 56 (7) (2008) 712-731.

Directive No. 1999/62/EC of the European Parliament and of the Council on the charging of heavy goods vehicles for the use of certain infrastructure, modified by Directive No. 2006/38/EC.

M. Poliak, Implementation of electronic toll collection in the Slovak Republic, in: International Conference ITS, Bratislava, Slovakia, Sept. 10-11, 2008.

S.R. Vadali, R.S. Gupta, K.N. Womack, M. Pappu, Trucking industry responses in a changing world of tolling and rising fuel prices, Texas Transportation Institute, Texas A&M University System, College Station, TX, No. SWUTC/07/167167-1, 2007.

J.H. Knorring, R. He, A.L. Kornhauser, Analysis of route choice decisions by long-haul truck drivers, Journal of the Transportation Research Board 1923 (2005) 46-60.
T.G. Golob, A.C. Regan, Impact of highway congestion on freight operations: Perceptions of trucking industry managers, Transportation Research. Part A: Policy and Practice 35 (7) (2001) 577-599.
R. Bain, Credit Implications of Traffic Risk in Start-Up Toll Facilities, Standard & Poor's Infrastructure Finance, London, 2002, p. 29.
A. Yalcin, J. Hashiuchi, S. Mizokami, A study on expressway toll pricing based on the results of social experiment, in: TRB 85th Annual Meeting, 2005.
N.J.W.V. Zyl, M.H. Raza, In search of the value of time: From South Africa to India, in: Travel Survey Methods: Quality and Future Directions, 2006, pp. 457-484.
T. Geiselbrecht, M. Burris, T. Baker, L. Zhou, M. Waltman, J. Montes, State highway 130 value pricing project for the Austin district, Texas Transportation Institute, Texas A&M University System, College Station, TX, 2008.
Ministry of Transport of the USA, -[on-line] Available on - URL: https://cms.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations.
Ministry of Transport of Canada, -[on-line] Available on - URL: http://laws-lois.justice.gc.ca/eng/regulations/SOR-2005-313/.
Ministry of Transport of New Zealand, -[on-line] Available on - URL: http://www.nzta.govt.nz/resources/rules/work-time-and-logbooks-2007-index.html.
Ministry of Transport of Australia, -[on-line] Available on - URL: http://www.ntc.gov.au/filemedia/Publications/HVDF_Basic_July08.pdf.
Regulation (EC) No 561/2006 of the European Parliament and of the Council of 15 March 2006 on the harmonisation of certain social legislation relating to road transport and amending Council Regulations (EEC) No 3821/85 and (EC) No 2135/98 and repealing Council Regulation (EEC) No 3820/85.
V. Konečný, M. Poliak, A. Poliaková, Economic Analysis in a Road Transport Enterprise, Publisher EDIS – University of Zilina, 2010, p. 283.
K.J. Fender, D.A. Pierce, An Analysis of the Operational Costs of Trucking: A 2012 Update, American Transportation Research Institute. -[on-line] Available on - URL: http://atri-online.org/2012/09/17/an-analysis-of-the-operational-costs-of-trucking-a-2012-update/.
Toll in the Czech Republic, -[on-line] Available on - URL: http://www.mytocz.eu/sk/mytny-system-2/sadzby-myta/index.html (Jul. 1, 2013).
Toll in Hungary, -[on-line] Available on - URL: http://toll-charge.hu/Electronic-toll/Pricing/ (Jul. 3, 2013).
Toll in Germany, -[on-line] Available on - URL: http://www.toll-collect.de/en/all-about-the-toll/toll-rates.html (Jul. 3, 2013).
Toll in Poland, -[on-line] Available on - URL: http://www.viatoll.pl/sk/vozidla-nad-3-5-t/sadzobnik-poplatkov (Jul. 1, 2013).
Toll in Austria, -[on-line] Available on - URL: https://www.go-maut.at/portal/portal (Jul. 1, 2013).
Toll in the Slovak Republic, -[on-line] Available on - URL: https://www.emyto.sk/web/guest/toll/rates (Jul. 3, 2013).
K. Kawamura, Perceived value of time for truck operators, Transportation Research Record 1725, Transportation Research Board, National Research Council, Washington, DC, 2000.

CONTACT ADRESS

Author: Miloš Poliak, doc. Ing. PhD.
Workplace: Faculty of Operation and Economics of Transport and Communications, University of Zilina
Address: Univerzitná 1, Žilina, Slovak republic
E-mail: milos.poliak@fpedas.uniza.sk

Author: Štefánia Semanová, Ing. PhD.
Workplace: Faculty of Operation and Economics of Transport and Communications, University of Zilina
Univerzitná 1, Žilina, Slovak republic
E-mail: stefania.semanova@fpedas.uniza.sk

Author: Michaela Mrníková, Ing.
Workplace: Faculty of Operation and Economics of Transport and Communications, University of Zilina
Address: Univerzitná 1, Žilina, Slovak republic
E-mail: michaela.mrnikova@fpedas.uniza.sk