

# **ANALYSIS OF A CLOSED TOLL SYSTEM ON CROATIAN MOTORWAYS IN RELATION TO OPEN TOLL SYSTEMS**

*Research Paper*

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## **ABSTRACT**

*The subject and goal of this paper is the analysis of the closed toll system in the Republic of Croatia in comparison with open toll systems in member states of the EU. The research was conducted on the basis of historical data collected on the Internet and academic literature that were necessary for a better presentation of the issue.*

*This paper is a benchmark for determining traffic and revenue from tolls, i.e. a comparison of an open toll system, especially for light vehicles compared to an existing closed toll system. The paper also provides insight into the issue of the introduction of vignettes in Croatia and operation of motorways, taking into account other direct and indirect factors, including the economy, tourism, road safety, GDP, etc.*

*Key words: revenue from tolls, vignets, traffic, passenger vehicles, motorways, revenue from vignets*

## 1. INTRODUCTION

From the moment they were opened to traffic until the last year of the analysis, ie 2016, Croatian motorways did not meet the expectations of investors in terms of profitability. This primarily refers to revenues that are not sufficient to cover construction and maintenance costs, resulting in losses that have a large impact on the state budget. Due to the obviously high toll prices, the desired inflow of traffic from local roads, where the largest number of traffic accidents still happens, did not occur.

The Republic of Croatia faces serious problems on Croatian motorways - huge traffic jams and convoys in the summer, accumulated short-term debts, a large number of employees, ie a non-optimized toll management model, etc. One of the solutions to these problems is the introduction of vignettes modeled on neighboring countries. (Austria, Hungary and Slovenia). Rare studies, such as the study of prof. Dadić from the Faculty of Transport and Traffic Sciences, speak in favor of the introduction of vignettes. However, there is no study that clearly states the financial impact of different vignette models on the state budget, revenues and costs of motorway operators in the Republic of Croatia.

## **1.1. Sources and methods of data collection**

Primary and secondary research was conducted during the preparation of this paper. In the primary research, historical data and data related to revenues, expenditures and the number and category of vehicles on Croatian motorways were used. The research placed special emphasis on trucks and cars, which are the largest users on Croatian motorways and thus generate the majority of revenue. The primary research was a key part for the preparation of the paper because the data obtained by this research were compared between operators in the Republic of Croatia and the respective operators in the EU.

Secondary research is based on the study of academic literature in the field of highway infrastructure. For the purposes of the research, the legally defined domestic and foreign ordinances related to toll systems were observed.

## **2. VIGNETTES IN THE EUROPEAN UNION**

This section deals with vignette toll systems in Austria, Hungary and Slovenia and presents the most important data related to the ownership structures of operators, basic functionalities of each operator, impact on revenues due to vignette implementation over the years, ways of financing operating and other costs, vignette tariffs for cars and toll prices for heavy vehicles.

The aim of this part is, based on the obtained information on traffic, financing and vignette tariffs, to create a benchmark needed to calculate different models of vignettes applicable to traffic and the overall network of motorways in Croatia.

### **2.1. Introduction**

A vignette is a sticker whose purchase pays a toll for a certain period and serves as a replacement for a closed toll system, where the price is based on the number of kilometers traveled. The vignette system is used in a large number of European countries, but this chapter will deal with toll systems in Austria, Hungary and Slovenia, given that these are neighboring countries of the Republic of Croatia and are most economically connected with Croatia. In a large number of European countries, vignettes affixed to windscreens are used, and in Hungary, Romania and Slovakia they are in electronic form, so the physical method of issuing vignettes is no longer used in those countries. In Moldova and Romania, vignettes are used on all types of roads, while in Bulgaria they are used for roads outside populated areas. The average price of annual vignettes for passenger cars in the European Union is between €30 and €150, depending on the country. In the European Union countries that apply the vignette system, there are vignette tariffs for a shorter period, which are mainly used for tourists and transport vehicles, but in the Swiss side, drivers who use motorways must buy an annual vignette. Vignettes can mostly be bought at border crossings and petrol stations. Once affixed to the windscreen, they cannot be transferred to other vehicles without being damaged, which guarantees the safety of such a toll system. The traffic of such motorways is monitored by security cameras of motorway operators and the police, who control the correctness and validity of vignettes in all groups of vehicles.

## 2.2. Austria

ASFINAG (Autobahnen und Schnellstraßen Finanzierungs Aktiengesellschaft) is a company founded in 1982 that operates Austrian motorways and is owned by the Republic of Austria. Initially, its activities were limited to the provision of financial services, but in 1997 it was transformed into a company responsible for the construction, tolling, financing and operating of Austrian motorways. In the same year, vignettes were introduced for all vehicles up to 3.5 tonnes operating on Austrian motorways. The tolls themselves are the main source of income for ASFINAG given that the company does not receive money from the state even though it is wholly owned by it. The main goal is to ensure optimized traffic flow, traffic safety and driving comfort taking into account the requirements of motorway users. Since 2005, ASFINAG's operational tasks have been performed by five subsidiaries, while the parent company remains responsible for strategy development and financial services.

Branches within ASFINAG are:

- Alpenstraßen GmbH – operation of alpine roads
- ASFINAG Bau Management GmbH – motorway construction
- ASFINAG Maut Service GmbH – providing toll services
- ASFINAG Commercial Services GmbH – portfolio management, consulting services and project management.

Based on the collected data, the total length of Austrian motorway networks in 2015 was 2,199 km, of which 383 km were tunnels and the total number of bridges was 5,175. The average daily traffic in 2015 was 32,434 vehicles up to 3.5 tons and 4,066 vehicles with a total weight above 3.5 tons.

The following table presents historical data showing the change in revenue from VAT-free vignettes due to the increase in the Austrian motorway network. Based on the data in the table, it can be concluded that ASFINAG invests in the expansion of the motorway network every year, which ultimately results in an increase in revenue by an average of 5% per year. Comparing 2014 with 2013, the number of kilometers traveled on Austrian motorways, when all vehicle categories are added up, is 28.976 billion kilometers, which resulted in an increase of 4.5% compared to the previous year.

Table 1. Toll revenue in Austria from 2005 to 2015

ASFINAG	Year	Motorway network (in km)	Toll revenues without VAT (in millions)
	2005	2,035	1,192 €
	2006	2,061	1,250 €
	2007	2,103	1,435 €
	2008	2,103	1,516 €
	2009	2,135	1,387 €
	2010	2,175	1,536 €
	2011	2,175	1,561 €
	2012	2,177	1,622 €
	2013	2,177	1,687 €
	2014	2,183	1,826 €
	2015	2,199	1,859 €

Source: work of the author according to the data from the ASECAP pages: <http://www.asecap.com/>

The smallest increase in traffic was recorded in 2005, while from 2006 to 2008 this number increased as did the revenues themselves. Due to the global economic crisis, in 2009 there was a decline in revenues compared to the previous period, and the recovery was followed by a continuous increase in traffic and revenues. The use of Austrian motorways and expressways is subject to tolls for all types of motor vehicles, where the method of tolling is determined according to the maximum permissible weight of each vehicle. For motor vehicles with a maximum permissible gross weight of up to 3.5 tonnes (passenger cars, motorcycles and residential vehicles), the obligation to display a vignette is in force. In the case of motor vehicles with toll trailers, only the maximum permissible towing vehicle weight is relevant.

Table 2. Comparison of vignette prices in Austria for passenger cars and motorcycles in 2015 and 2016

Vignettes	10 days		2 months		annual	
	2015.	2016.	2015.	2016.	2015.	2016.
Type of vehicle						
Passenger cars up to 3.5 tons with or without a trailer	8.70 €	8.80 €	25.30 €	25.70 €	84.40 €	85.70 €
Motorcycles	5.00 €	5.10 €	12.70 €	12.90 €	33.60 €	34.10 €

Source: work of the author according to the data from the ASECAP pages: <http://www.asecap.com/>

The table above compares vignette prices for passenger cars and motorcycles in 2015 and 2016 where there was an average price increase of 1.5% for both vehicle types and for all three forms of vignettes, and the table is based on the length of the period.

Of the other vehicles, trucks, buses and residential vehicles weighing more than 3.5 tonnes are subject to tolls according to the power of the vehicle and require a Go-Box. Go-Box is a tolling method using a microwave system that registers each passage under the toll control portal so as not to interfere with traffic flow and create large crowds, and can be purchased at about 180 points of sale. Therefore, a Go-Box unit must be installed on the inside of the windscreen before using motorways and expressways. Each vehicle registration plate above 3.5 tonnes must have its own Go-box device. By applying such a system, tolls can be paid in advance and subsequently.

When paying in advance, the existing toll credit is stored on the Go-Box and must be paid in advance, similar to pre-paid phone cards. In addition to cash, a number of credit and debit cards can be used as a means of payment. For "post-paid" payments, all transactions are settled later. The calculation is performed directly by ASFINAG via Go-Direkt or registered cards such as credit or debit cards.

Table 3. Toll price per kilometer according to vehicle category and emission class in Austria

CATEGORY	Category 2 (two axles)	Category 3 (three axles)	Kategorija 4+ (four or more axles)
<b>A</b> EURO-emission class EURO VI	0.157 €/km	0.220 €/km	0.330 €/km
<b>B</b> EURO- emission class EURO EEV	0.172 €/km	0.241 €/km	0.361 €/km
<b>C</b> EURO- emission class EURO IV a. V	0.190 €/km	0.266 €/km	0.399 €/km
<b>D</b> EURO- emission class EURO 0 to III	0.213 €/km	0.298 €/km	0.447 €/km

Source: work of the author according to the data from the ASECAP pages: <http://www.asecap.com/>

Table 3 shows the tariff codes for vehicles with a total weight of more than 3.5 tonnes according to the category and emission of exhaust gases. The numerical values in the table show the price of the toll in euros per kilometer traveled. In addition to the above methods of toll payment on some parts of Austrian motorways, it is necessary to pay an additional toll for driving through certain tunnels and mountain passes. The table also shows that vehicles that pollute the environment pay more for tolls.

ASFINAG mostly covers its operating costs with tolling. Funds for refinancing overdue financial debts are obtained on the international capital market. For this purpose, ASFINAG has established a program of medium-term bills (EMTN) where the Republic of Austria is the guarantor, and enables the issuance of bonds at favorable financing costs. In 2014, the company issued a € 750 million bond with a seven-year maturity and a coupon of 1.375%.

### **2.3. Hungary**

In Hungary, motorways are leased by several concessionaires, but the prices of vignettes for cars and motorcycles, as well as the classic toll collection per kilometer for trucks, are unique to all concessionaires. Vignettes were introduced in Hungary in 2001, and since 2008 they can also be purchased online, via SMS, phone calls that can be paid with credit cards or by debiting the phone bill. This new system is called e-vignette and enables much faster service and eliminates the cost of printing and distributing physical vignettes in the form of labels. Vignettes became popular immediately after their introduction because they allowed users to use highway services faster and more efficiently without stopping at more affordable prices compared to indoor and outdoor tolling systems.

AKA Zrt. (AKA Alföld Concession Motorway Co. Ltd.) is one of the concession companies responsible for the operation and maintenance of the M5 motorway with a total length of 156.5 km. The company is financed with the help of financial institutions, with the help of the state. Namely, AKA receives funds from the state in the form of fees and financial support over time.

M6 Duna Autópálya Koncessziós Zrt. (Danube Concession Motorway Co. Ltd.) is the concessionaire also responsible for the operation and maintenance of the M6 and M8 sections which were opened to traffic on 11 June 2006. It is financed by issuing commercial papers on financial markets and loans from the European Investment Bank.

MAK Zrt. (Mecsek Motorway Concession Private Company Limited by Share) is the company responsible for the design, construction, operation, maintenance and financing of these activities on the sections M6 Szekszard - Bóly and M60 Bóly - Pécs. As with AKA, projects are financed with the help of financial institutions where funds are obtained from banks and the state in the form of fees and financial support.



M6 Tolna Autópálya Koncessziós Zrt. (M6 Tolna Motorway Concession Ltd.) is the last concession company responsible for design, construction, financing, operation and maintenance. The M6 sections of the motorway were opened to traffic on 31 March 2010. The company is financed through financial markets and with the help of the European Investment Bank.

The use of Hungarian motorways and expressways is subject to toll payment for all types of motor vehicles, where the method of toll collection is determined according to the maximum permissible weight of an individual vehicle. In 2015, the average number of light vehicles used on Hungarian motorways was 13,456, and the number of heavy vehicles above 3.5 tons was 3,010 vehicles.

The following table shows the changes in toll revenues from 2005 to 2015 as well as the continuous expansion of the Hungarian motorway network. Until 2009, toll revenues on Hungarian motorways grew at an average rate of 21% when the economic and financial crisis led to a decline in revenues, as well as reduced investment in increasing the network itself.

In Hungary, vignettes can be purchased electronically and are divided into:

- e-vignettes - for vehicles up to 3.5 tons
- Hu-Go - for vehicles over 3.5 tons.

The following table shows the prices of vignettes for different types of vehicles up to 3.5 tons in 2015. The toll collection system for the purchase of e-vignettes includes motorcycles, personal vehicles and their trailers, as well as trucks with a permissible gross weight of up to 3.5 tons, camping vehicles and buses and their trailers. All these vehicles may be used on Hungarian motorways only with a pre-purchased e-vignette. According to the data in the table, the amount of toll depends on the category of vehicle and the type of vignette, and is determined on the basis of the traffic license of each vehicle. Prices of e-vignettes have not changed in the last three years, while compared to 2013 they are lower by about 4%.

Table 4. Vignette prices in Hungary for vehicles up to 3.5 tons in 2015

Vignettes	State			Regional
	10 days	1 month	1 year	1 year
<b>D1M</b> (motorcycles)	4.68 €	-	-	-
<b>D1</b> (motorcycles, personal vehicles up to 3.5 tons)	9.47 €	15.22 €	136.87 €	15.92 €
<b>D2</b> (personal vehicles with more than 7 people, campers up to 3.5 tons)	18.94 €	30.45 €	136.87 €	31.85 €
<b>U</b> (trailers for vehicles in category D2 and B2)	9.47 €	15.22 €	136.87 €	15.92 €
<b>B2</b> (buses)	42.63 €	69.98 €	636.86 €	63.69 €

Source: author's work according to the data of the Croatian Auto Club: [www.hak.hr](http://www.hak.hr)

In addition to vignettes valid throughout the country purchased for a certain period, there is also an annual and regional vignette that is used on the motorways of only one county. When buying a vignette, it is important to check that the data on the expiration date, vehicle category, registration number and country code have been entered correctly. E-vignettes can be purchased online, via SMS and at petrol stations.

Hu-Go electronic vignettes whose price is based on the distance traveled apply to vehicles with a total weight above 3.5 tons. This type of tolling is suitable primarily for vehicles used on Hungarian motorways to transport goods and raw materials inside and outside Hungary, as well as for transit vehicles from foreign countries. Table 6 shows the price of tolls per kilometer traveled in 2015, and the price remained identical in 2016.

Table 5. Toll price per kilometer in Hungary for vehicles over 3.5 tons in 2015

Vehicle category	J2 (two axles)		J3 (three axles)		J4 (four or more axles)	
	motorway	state road	motorway	state road	motorway	state road
≥ Euro III	0.142 €	0.060 €	0.199 €	0.104 €	0.289 €	0.180 €
EURO II	0.167 €	0.071 €	0.233 €	0.123 €	0.361 €	0.225 €
≤ EURO I	0.192 €	0.082 €	0.268 €	0.141 €	0.434 €	0.270 €

Source: author's work according to National Toll Payment Services: [www.toll-charge.hu](http://www.toll-charge.hu)

The Hu-Go system offers the option to purchase a one-way vignette (without registration) for a predetermined route that must be purchased before using motorways. In this type of payment, the registration number of the truck in question must be included in the registration number of the truck.

For unregistered users, a one-way ticket is valid from the moment of purchase until the end of the next day. Registered users can purchase a subscription ticket no later than 30 days before the start of the trip, and it is valid from midnight on the first day until midnight the next day. The advantages of registration are manifested in the simplicity and faster way of paying tolls, which, in addition, can be paid in several ways and in the possibility of refunding a certain amount of money.

Another way to pay for motorways is to use the Hu-Go system with a device that is placed in the cab of a truck. Using such a device is the simplest and safest form of toll payment. The installed unit needs to be registered only once and all you need to do is check that it is on, correct, that the number of axles is entered correctly and that there are enough funds in the account for a particular trip.

Hungarian State Toll Service LLC was established in 2013 with the aim of carrying out activities related to tolling, fines and validation of electronic and physical forms of vignettes, as well as for the Hu-Go system, for state motorways and main roads.

## **2.4. Slovenia**

DARS d.d. (Motorway Company of the Republic of Slovenia) is a joint stock company owned by the Republic of Slovenia established in 1993, which is managed by the Slovenian State Holding in accordance with the act of the Slovenian State Holding. The company operates in accordance with corporate governance codes for companies with capital assets of the state adopted by the Slovenian State Holding. Until 31 December 2003, the company had the status of a public company in the form of a joint stock company, and since 1 January 2004 it has had the status of a joint stock company as a company. At the end of December 2003, the company merged with PVAC (Motorway Maintenance Company), the company responsible for road maintenance. At the beginning of January 2004, the Republic of Slovenia issued a special agreement to DARS for the construction, maintenance and management of motorways, as well as toll collection, and the vignette system itself was introduced on 1 July 2008 for a total of 576 km of motorways in the Republic of Slovenia, and semi-annual and annual vignettes were originally applied. Concession obligations paid by DARS to the Republic of Slovenia are calculated as the difference between tolling and motorway operating costs.

The following table shows the movement of DARS's revenues in relation to the increase of the motorway network in Slovenia, where the continuous growth of toll revenues is visible even during the global economic crisis. From 2004 and Slovenia's accession to the European Union until 2014, the motorway network in Slovenia increased by approximately 250 km, which is an increase of 68% compared to 2004 when Slovenia had only 358 km of motorways.

Table 6. Toll revenues in Slovenia from 2005 to 2014

DARS (SLO)	Year	Km	Toll revenues without VAT (in millions)
SLO becomes a member of the European Union	2004	358	-
	2005	450	139.40 €
	2006	455	151.96 €
	2007	457	172.72 €
	2008	552	201.62 €
	2009	592	238.00 €
	2010	606	290.10 €
	2011	606	298.34 €
	2012	607	294.88 €
Introduced vignette 2B for vans	2013	607	305.30 €
	2014	607	348.99 €
	2015	610	349.92 €

Source: author's work according to ASECAP data: <http://www.asecap.com/>

Toll collection in Slovenia takes place in three ways:

- vignettes for vehicles up to 3.5 tons
- open toll systems for vehicles over 3.5 tonnes
- closed toll systems for vehicles over 3.5 tonnes.

The vignette toll system is intended for vehicles with a total weight of up to 3.5 tons, regardless of the total weight of the trailer. In Slovenia, there are different types of vignettes with regard to the period of use of motorways, and they are: seven-day, monthly, semi-annual and annual vignettes. It should be noted that some categories of vehicles do not have the option to purchase vignettes for certain periods.

Table 7. Vignette prices in Slovenia for vehicles up to 3.5 tons in 2015

Vignettes	7 days	1 month	6 months	1 year
VEHICLE CATEGORY				
Motorcycles (category 1)	7,50 €	-	30 €	55 €
Vehicles up to 1.3 m high, up to 3.5 t (category 2A)	15 €	30 €	-	110 €
Vehicles over 1.3 m high, up to 3.5 t (category 2B)	30 €	60 €	-	220 €

Source: author's work according to the data of the Croatian Auto Club: <http://www.hak.hr>

Vignettes are used by sticking to the inside of the windshield. Once affixed, they can no longer be moved to other vehicles without being damaged, which then makes them invalid. Slovenian vignettes can be purchased at border crossings and at petrol stations at no extra charge.

On motorways with an open toll collection system, the toll station is both an entry and an exit, where the amount of toll depends on the calculation and not on the total distance traveled. In this way, users pay the toll only if they go through the toll station. Vignette for vehicles up to 3.5 tons on Slovenian motorways can be paid in cash, by cards and electronically by DARS card.

Vehicles with a total weight over 3.5 tons pay tolls depending on the use at each toll station, subsequent or pre-payment with ABC OBU unit (on-board-unit), installed inside the cab of the truck, DARS card or simply passes with DKV CARD. However, it should be noted that new OBUs are no longer available due to the possibility of transfer from one vehicle to another, which is a criminal offense. Electronic media are used for non-cash toll payment for trucks with a maximum permissible weight exceeding 3.5 tons, for the first (R3) and second (R4) toll class. Payment of tolls with regard to emission class EURO III or higher is possible with a suitably adapted electronic device. Based on the completed application, DARS ensures the adaptation of the electronic device for each vehicle determined by its registration number and EURO emission class for which it meets the necessary conditions. In this case, where there are no vignettes, the toll is paid on the basis of the categorization of the vehicle with regard to the number of axles, EURO class and on that basis the price per kilometer is determined. The DARS company has a specially designed calculator on its website that calculates the price of tolls for drivers for a certain route within the borders of Slovenia..

Based on the analysis of motorway managers in Austria, Hungary and Slovenia, it is concluded that the implementation of the vignette system for light vehicles has led to an increase in revenue compared to the closed and open toll system. However, it should be taken into account that the continuous increase in revenues among foreign operators was greatly influenced by the increase in the overall network of motorways. As noted in Chapter 2.3, motorway traffic in Hungary has gained even more popularity since 2008 when e-vignettes were introduced that allow their users a simpler way to buy vignettes without having to stop at points of sale solely to purchase a vignette.

The following section presents the results of the analysis of the existing closed toll collection system in Croatia, which is also the starting point in detecting the problems faced by motorway operators in the Republic of Croatia. The analysis of the closed system will also show the division of Croatian operators into public and private, methods of financing and the main characteristics of each of them, after which the advantages and disadvantages of the existing closed toll system in the Republic of Croatia will be presented in detail.

### 3. ANALYSIS OF THE EXISTING CLOSED TOLL SYSTEM

The practice of tolling on motorways in the Republic of Croatia is in line with the principle that the user pays for the use of the motorway as much as he has used the service. Tolling in the Republic of Croatia began in 1972, and referred to the section of the motorway between Zagreb and Karlovac.

Intensive construction of motorways in the Republic of Croatia took place in the period from 1997 to 2008, when all newly built sections were included in the existing toll system. ENC toll was introduced in the summer of 2006 on all motorways except the Zagreb - Macelj Motorway (AZM) and the system was gradually upgraded and modernized. The system includes electronic tolling without the mediation of the cashier, and the tolling process takes place using an ENC device located on the inside of the vehicle's windshield and antenna on the toll lane. All groups of vehicles - IA, I, II, III and IV categories can be used with the ENC device.

In addition to electronic toll collection on motorways in the Republic of Croatia, two tolling systems are applied: open and closed. The open toll system is applied on road facilities (bridges, tunnels) and shorter sections of the motorway. In such a system, the toll station is both an entry and exit station, and the price of using the motorway is determined according to the group of vehicles. On the other hand, on motorways with multiple entrances and exits, a closed toll collection system is applied. In this system, the user takes the card at the motorway entrance and hands it over to the cashier or puts it in the automatic toll collection machine at the motorway exit, where the toll price is calculated based on the length of the section and the vehicle category.

Table 8. Average toll price per kilometer in 2015

Vehicle group	LIGHT VEHICLES (up to 3.5 tons)	HEAVY VEHICLES (above 3.5 tons)
Toll	EUR/km without VAT	EUR/km without VAT
Closed system	0.063	0.287
Open system	0.065	0.235

Source: author's work according to HUKA data: [www.huka.hr](http://www.huka.hr)

In the Republic of Croatia, the closed toll system with several entrances and exits is applied on the motorway network, while the open toll collection system is applied only to the Bregana National Park, the Krk Bridge National Park and the Biokovo National Park. The average toll price in a closed system for light vehicles is € 0.063 per kilometer without VAT, or € 0.287 per kilometer without VAT for heavy vehicles. It should be noted that motorcyclists belonging to group IA pay 60% of the toll price for light vehicles (group I).

On all motorways in the Republic of Croatia, tolls can be paid in cash, credit, debit cards, INA cards and SMART cards. The electronic toll system ENC is available on all motorways except the A2 motorway between Zagreb and Macelj.

Pursuant to Article 2 of Title II. Ordinance on tolls (Official Gazette 130/13) vehicles are distributed for the purpose of tolling according to the categories:

**IA category** – motorcycles, motor tricycles and quadricycles

**I. category** – motor vehicles with two axles up to 1.90 m high

**II. category**

- motor vehicles with two axles higher than 1.90 m, with a maximum permissible mass not exceeding 3.5 tonnes
- motor vehicles with two axles less than 1.90 m high, towing a trailer (regardless of the number of axles and the height of the trailer)

**III. category**

- motor vehicles with two or three axles weighing more than 3.5 tonnes
- motor vehicles with two axles weighing more than 3.5 tonnes, towing a trailer with one axle
- motor vehicles with two or three axles, weighing more than 3.5 tonnes, towing a trailer (regardless of the number of axles of the trailer)

**IV. category**

- motor vehicles with four or more axles with a maximum permissible mass exceeding 3.5 tonnes
- motor vehicles with two axles, weighing more than 3.5 tonnes, towing a trailer with two or more axles



- motor vehicles with three axles, weighing more than 3.5 tonnes, towing a trailer (regardless of the number of axles of the trailer).

### 3.1. Public motorway operators in the Republic of Croatia

HUKA (Croatian Association of Toll Motorway Concessionaires) is a civic, non-partisan, non-profit and professional association established to protect and promote the interests of its members. HUKA members are companies that build, maintain and operate motorways in the Republic of Croatia on the basis of the obtained concession. The Association of Concessionaires finances its activities from the annual membership fee of its members.

The aim of the association is to continuously improve cooperation between members by exchanging experiences, sharing new knowledge and discussing issues that members face in order to facilitate the resolution of obstacles and active cooperation with public bodies in the Republic of Croatia and ASECAP (Fr. Association Europeenne des Concessionnaires d'Autoroutes et d'Ouvrages a Peage).

The association consists of four companies that are divided into public and private concessionaires that operate Croatian motorways. Although each concessionaire is specific in its ownership structure and legal structure, all companies have the same task - financing, construction, maintenance of motorways and their operation primarily thanks to the revenues generated by tolling.

Table 9. Sources of funding in 2015

Sources of funding (%)	HAC	ARZ	Bina-Istra	AZM
Loans	58.5	0	0	0
Own funds	1.7	0	0	0
Tolling and other revenues	30	93.1	52.8	70
Fuel price fee (0.20 kn/l)	9.5	0	0	0
Refundable and non-refundable state funds	0	0	47.2	30
EU funds	0.3	6.9	0	0
<b>TOTAL</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

Source: HUKA's official website: [www.huka.hr](http://www.huka.hr)

Table 11 shows the members of HUKA according to the share where Croatian Motorways has the widest network of motorways in Croatia with as much as 70% share and a

total of 925.80 km. By the way, HUKA members operate the network of motorways and semi-motorways with a total length of 1,313.83 km, according to the latest data from 2015.

Table 10. Overview of shares in motorways by ownership

Concessionaire	Motorway sign	Km in traffic	Share
HAC	A1, A3, A4, A5, A10, A11, DC532	925.8	70%
ARZ	A1, A6, A7, DC102	187.03	15%
BINA-Istra	A8, A9	141	11%
AZM	A2	60	5%
<b>Total</b>		<b>1,313.83</b>	<b>100%</b>

Source: HUKA's official website: [www.huka.hr](http://www.huka.hr)

### 3.1.1. Hrvatske autoceste d.o.o. (HAC)

Hrvatske autoceste d.o.o. (HAC) company was founded in 2001 and is wholly owned by the Republic of Croatia, and is responsible for the operation of motorways, construction and maintenance of motorways. On motorways under the jurisdiction of Hrvatske autoceste d.o.o. in accordance with the Ordinance on tolls NN 130/13, tolls are charged for the length of the section between two toll points according to the corresponding group of vehicles. The company Hrvatske autoceste održavanje i naplata cestarine d.o.o. (HAC-ONC) performs maintenance and toll collection in the name and on behalf of Hrvatske autoceste d.o.o. The main mission of HAC-ONC is to perform maintenance work and tolling while ensuring a safe and flowing highway.

Open and closed toll systems are applied on motorways in the Republic of Croatia. The open system is applied on road structures such as bridges and tunnels and on shorter sections of the motorway. In a closed toll collection system, the user takes the card at the motorway entrance and hands it over to the cashier when leaving the motorway, on the basis of which a toll is charged according to the length of the section used and the group of vehicles. According to the regulations on foreign exchange operations, users from foreign countries can also pay tolls in euros in accordance with the valid exchange rate list of the Croatian Motorways commercial bank.

The following table shows the HAC price list for 2016 by vehicle categories and the share price between NP Lučko and exit toll stations. Hrvatske autoceste d.o.o. they also offer the option of purchasing a monthly subscription ticket that provides an unlimited number of rides during the month. A monthly ticket can be bought by a natural or legal person, and it is tied to a specific vehicle and a section of the motorway.

- For I. and II. group of vehicles monthly ticket is calculated by multiplying the amount of toll by 36 with an approved discount of 10%
- For III. and IV. category is calculated by multiplying the amount of toll by 60

Table 11. Croatian Motorways (HAC), tolls

ENTRANCE / EXIT	Distance	category				
		IA	I	II	III	IV
<b>Lučko</b>		<b>ENTRANCE</b>				
Zdenčina	19,2 km	4 kn	7 kn	12 kn	17 kn	29 kn
Jastrebarsko	25,6 km	6 kn	10 kn	18 kn	25 kn	43 kn
Karlovac	44,2 km	11 kn	19 kn	34 kn	46 kn	80 kn
Novigrad	55,1 km	14 kn	24 kn	44 kn	59 kn	103 kn
Bosiljevo	68,2 km	18 kn	30 kn	55 kn	74 kn	129 kn
Vrbovsko	82,0 km	23 kn	39 kn	71 kn	95 kn	166 kn
Ravna Gora	85,0 km	28 kn	46 kn	84 kn	113 kn	197 kn
Delnice	108,0 km	31 kn	51 kn	94 kn	126 kn	219 kn
Vrata	117,3 km	33 kn	55 kn	101 kn	136 kn	237 kn
Oštrovica	127,3 km	37 kn	61 kn	111 kn	149 kn	260 kn
Rijeka (Kun)	136,2 km	42 kn	70 kn	127 kn	170 kn	297 kn
Ogulin	92,8 km	24 kn	40 kn	72 kn	98 kn	165 kn
Brinje	120,4 km	32 kn	53 kn	91 kn	127 kn	208 kn
Žuta Lokva	133,3 km	34 kn	57 kn	98 kn	137 kn	223 kn
Otočac	142,8 km	38 kn	63 kn	107 kn	150 kn	242 kn
Perušić	174,9 km	47 kn	78 kn	129 kn	183 kn	290 kn
Gospić	185,9 km	50 kn	83 kn	137 kn	195 kn	307 kn
Gornja Ploča	209,8 km	57 kn	94 kn	153 kn	219 kn	342 kn
Sveti Rok	215,0 km	59 kn	97 kn	157 kn	225 kn	351 kn
Maslenica	247,3 km	68 kn	112 kn	180 kn	259 kn	401 kn
Posedarje	254,7 km	70 kn	115 kn	185 kn	267 kn	412 kn
Zadar 1	260,7 km	71 kn	117 kn	188 kn	271 kn	418 kn
Zadar 2	269,7 km	73 kn	121 kn	194 kn	280 kn	432 kn
Benkovac	283,6 km	77 kn	128 kn	205 kn	297 kn	456 kn
Pirovac	305,1 km	83 kn	138 kn	220 kn	319 kn	489 kn
Skradin	315,5 km	86 kn	143 kn	227 kn	329 kn	504 kn
Šibenik	324,8 km	88 kn	147 kn	233 kn	338 kn	517 kn
Vrpolje	339,1 km	92 kn	154 kn	243 kn	353 kn	539 kn

Prgomet	356,2 km	97 kn	162 kn	255 kn	371 kn	565 kn
Vučevica	370,0 km	101 kn	168 kn	264 kn	385 kn	586 kn
Dugopolje	383,5 km	105 kn	174 kn	273 kn	399 kn	607 kn
Bisko	395,3 km	108 kn	179 kn	281 kn	411 kn	625 kn
Blato na Cetini	413,0 km	113 kn	187 kn	294 kn	430 kn	653 kn
Šestanovac	420,5 km	115 kn	190 kn	299 kn	437 kn	663 kn
Zagvozd	430,8 km	118 kn	195 kn	306 kn	448 kn	679 kn
Ravča	463,2 km	126 kn	209 kn	326 kn	479 kn	724 kn
Vrgorac	470,6 km	129 kn	214 kn	333 kn	490 kn	740 kn
Čarapine	489,2 km	134 kn	223 kn	346 kn	509 kn	768 kn

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

Source: official price list of Hrvatske autoceste d.o.o.: [www.hac.hr](http://www.hac.hr)

On motorways under the jurisdiction of HAC, tolls can also be paid electronically without the intervention of a cashier, and the tolling process takes place using an ENC device located on the inside of the vehicle's windshield and antenna on the toll lane.

Hrvatske autoceste d.o.o. offer two subscription models to the electronic toll system - a subscription model with a 21.74% discount throughout the year and a subscription model with a 33.48% discount for the period from November 1 to March 31. The subscription model with a 21.74% discount has no time limit in use, and is available for all vehicle categories. The device can be purchased for 122 kuna at HAC points of sale. When contracting, the subscription amount is a minimum of 100 kuna and can be replenished several times according to the user's wishes.

The second subscription model offers a discount of 33.48% in the period from November 1 to March 31, and outside the specified period a discount of 21.74% is valid. When contracting such a subscription model, the minimum payment amounts are shown at the beginning of the next page.

Table 12. Minimum payment amounts for a discount of 33.48%

	Vehicle category	Minimum payment
Legal persons	IA	1,800 kn
	I	3,000 kn
	II	5,000 kn
	III	7,000 kn
	IV	11,000 kn
Natural persons	IA	720 kn

	I	1,200 kn
	II	1,900 kn
	III	2,700 kn
	IV	4,100 kn
<b>VAT included in the gross amount of toll</b>		

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

Source: official price list of Hrvatske autoceste d.o.o.: [www.hac.hr](http://www.hac.hr)

Vehicles III. and IV. groups can obtain an annual toll discount of 30.43% in the period from 1 January of the current year to 31 December of the current year through a standing order related to a credit card. EURO emission class EURO IV vehicles also receive an additional discount of 3%, and EURO emission class EURO V vehicles an additional discount of 5%. These discounts can only be obtained using an ENC device.

### **3.1.2. Autocesta Rijeka – Zagreb d.d. (ARZ)**

The joint stock company was established in 1997 on the basis of a decision of the Government of the Republic of Croatia within the framework of the restructuring of the road network. Autocesta Rijeka - Zagreb d.d. began operations on March 15, 1998, and thus took over the functions of designing, preparing, and leading the continuation of highway construction. The concession was granted to the joint stock company for 28 years, and the company's revenues are tolls, the amount of which is determined by the ARZ according to the manner determined by the concession agreement. In addition to the toll, ARZ also has additional revenues from the use of ancillary and service facilities on the motorway route, while from its own revenues it covers the costs of motorway maintenance and repays loans.

In addition to connecting Rijeka with Zagreb, the Rijeka - Zagreb Motorway further connects the Port of Rijeka with the motorway network of Central and Western Europe and is very important in the transport of goods. The city of Rijeka is the main Croatian port with economic significance not only for the Republic of Croatia but also for neighboring countries, as well as for the region as a whole. ARZ integrates the territory of the Republic of Croatia with European transport corridors, which greatly contributes to the direct benefit and realization of new opportunities for the Croatian economy.

Table 13. Toll price, Motorway Rijeka – Zagreb

Exit toll station	Entrance toll station = Zagreb				
	IA	I	II	III	IV
D. Zdenčina	4 kn	7 kn	12 kn	17 kn	29 kn
Jastrebarsko	6 kn	10 kn	18 kn	25 kn	43 kn
Karlovac	11 kn	19 kn	34 kn	46 kn	80 kn
Novigrad	14 kn	24 kn	44 kn	59 kn	130 kn
Bosiljevo	18 kn	30 kn	55 kn	74 kn	129 kn
Vrbovsko	23 kn	39 kn	71 kn	95 kn	166 kn
Ravna Gora	28 kn	46 kn	84 kn	113 kn	197 kn
Delnice	31 kn	51 kn	94 kn	126 kn	219 kn
Vrata	33 kn	55 kn	101 kn	136 kn	237 kn
Oštrovica	37 kn	61 kn	111 kn	149 kn	260 kn
Rijeka	42 kn	70 kn	127 kn	170 kn	297 kn
Most Krk	21 kn	35 kn	46 kn	81 kn	138 kn
Rupa	5 kn	8 kn	15 kn	20 kn	33 kn

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

Source: official price list of Autoceste Rijeka – Zagreb d.d.: [www.arz.hr](http://www.arz.hr)

Based on the data and calculations, it can be concluded that the subscriber's monthly, and especially annual tickets are paid for everyday users of this section of the motorway, whether for business purposes, the purpose of transporting goods or something else. However, the application of the vignette toll system would be incomparably more suitable for those users of Croatian motorways who travel frequently and use subscriber tickets under the current system, as well as for those who travel longer distances. For those who travel infrequently and cross shorter highway routes, the introduction of a vignette system would be the least appropriate.

In ARZ, toll prices have not changed since April 2014, and the following table shows the prices of subscriber monthly and annual tickets offered by the concessionaire Autocesta Rijeka - Zagreb d.o.o.

Table 14. Price list of monthly and annual subscription tickets expressed in HRK

Subscribers tickets (in HRK)	Category							
	I		II		III		IV	
	Monthly	Annual	Monthly	Annual	Monthly	Annual	Monthly	Annual
D. Zdenčina	226.80	2,268	388.80	3,888	1,020	10,200	1,740	17,400
Jastrebarsko	324.00	3,240	583	5,832	1,500	15,000	2,580	25,800
Karlovac	615.60	6,156	1,101	11,016	2,760	27,600	4,800	48,000
Novigrad	777.60	7,776	1,425	14,256	3,540	35,400	6,180	61,800
Bosiljevo	972.00	9,720	1,782	17,820	4,440	44,400	7,740	77,400
Vrbovsko	1,263.60	12,636	2,300.40	23,004	5,700	57,000	9,960	99,600
Ravna Gora	1,490.40	14,904	2,721.60	27,216	6,780	67,800	11,820	118,200
Delnice	1,652.40	16,524	3,045.60	30,456	7,560	75,600	13,140	131,400
Vrata	1,782.00	17,820	3,272.40	32,724	8,160	81,600	14,220	142,200
Oštrovica	1,976.40	19,764	3,596.40	35,964	8,940	89,400	15,600	156,000
Rijeka	2,268.00	22,680	4,114.80	41,148	10,200	102,000	17,820	178,200
Most Krk	420.00	4,200	552	5,520	2,430	24,300	4,140	41,400
Rupa	259.20	2,592	486	4,860	1,200	12,000	1,980	19,800

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

Source: official price list of Autoceste Rijeka – Zagreb d.d.: [www.arz.hr](http://www.arz.hr)

In addition to monthly and annual subscription tickets, ARZ also offers a toll service with an ENC device where the prices of tolls, discounts and the device itself are identical to those in HAC (model 21.74% and model 33.48% discount). In addition to the electronic toll system, there is also a SMART card. It is a subscription card that serves as a means of toll payment, the amount of which is granted a discount of 21.74%, and it is characterized by ease of payment to the account according to user needs and is not related to the category of vehicle. Any adult natural or legal person or craftsman who signs the application form, submits all necessary documentation to ARZ, pays a card fee of HRK 30 (VAT included) and pays a minimum amount of HRK 100 subscription to the subscriber account can become a SMART card user.

At the end of 2020, the company ARZ was merged with HAC and as such no longer exists, while the tariff policy remained the same, but within the HAC tariff policy.

### 3.2. Private Motorway operators in the Republic of Croatia

Private Motorway operators are in mixed ownership where the companies are partially privatized according to the model of private-public partnership and in which the Republic of Croatia has a share in the ownership. Bina-Istra d.d. and Autocesta Zagreb - Macelj d.o.o are under concession agreements between them and the Republic of Croatia where these companies have acquired the exclusive right to develop, design, build, finance, operate and maintain motorways and all ancillary facilities during the concession agreements.

#### 3.2.1. Bina- Istra d.d.

Bina-Istra d.d. is a company based in Pula, founded in 1995 to finance and build the Istrian Y and operate it at a high level. The company is in mixed Croatian-French ownership consisting of Bina Fincom d.d. (67%), Bouygues T.P. (16%), Croatian Motorways (14.8%) and Istrian Motorway (2.2%). On 21 September 1995 the Republic of Croatia and Bina-Istra d.d. concluded the first public-private partnership with the aim of developing transport infrastructure in Croatia with a total length of 141 km and for a period of 32 years after which the highway will be handed over to the state free of charge. The contract also provides for the takeover of the existing 54 km long section (semi-profile), including the Učka Tunnel, which needed to be renovated. In 1998, concessionaire Bina-Istra d.d. founded a limited liability company called Bina-Istra upravljanje i održavanje d.o.o., whose main task is to establish the conditions necessary for safe and comfortable traffic, as well as to maintain all sections of the Istrian Y at a high level.

Picture 1. Toll price list for the first group of vehicles in 2016

PUNA CIJENA CESTARINE	Tunel Učka	Vranja	Lupoglav	Cerovlje	Ivoli	Rogovići	Žminj	Kanfanar	Vodnjan S	Vodnjan J	Pula	Medaki	Baderna	Višnjan	Nova Vas	Buje	Umag
Tunel Učka		30,00	30,00	30,00	30,00	30,00	37,00	41,00	48,00	51,00	54,00	46,00	50,00	54,00	62,00	65,00	68,00
Vranja	30,00		0,00	0,00	0,00	0,00	5,00	12,00	18,00	21,00	24,00	16,00	20,00	24,00	32,00	35,00	38,00
Lupoglav	30,00	0,00		0,00	0,00	0,00	5,00	12,00	18,00	21,00	24,00	16,00	20,00	24,00	32,00	35,00	38,00
Cerovlje	30,00	0,00	0,00		0,00	0,00	5,00	12,00	18,00	21,00	24,00	16,00	20,00	24,00	32,00	35,00	38,00
Ivoli	30,00	0,00	0,00	0,00		0,00	5,00	12,00	18,00	21,00	24,00	16,00	20,00	24,00	32,00	35,00	38,00
Rogovići	30,00	0,00	0,00	0,00	0,00		5,00	12,00	18,00	21,00	24,00	16,00	20,00	24,00	32,00	35,00	38,00
Žminj	37,00	5,00	5,00	5,00	5,00	5,00		4,00	13,00	16,00	19,00	11,00	15,00	19,00	27,00	30,00	33,00
Kanfanar	41,00	12,00	12,00	12,00	12,00	12,00	4,00		10,00	13,00	16,00	5,00	11,00	16,00	23,00	27,00	30,00
Vodnjan S	48,00	18,00	18,00	18,00	18,00	18,00	13,00	10,00		3,00	9,00	14,00	18,00	22,00	30,00	33,00	36,00
Vodnjan J	51,00	21,00	21,00	21,00	21,00	21,00	16,00	13,00	3,00		4,00	17,00	21,00	26,00	33,00	36,00	39,00
Pula	54,00	24,00	24,00	24,00	24,00	24,00	19,00	16,00	9,00	4,00		20,00	24,00	29,00	36,00	39,00	43,00
Medaki	46,00	16,00	16,00	16,00	16,00	16,00	11,00	5,00	14,00	17,00	20,00		4,00	11,00	19,00	22,00	26,00
Baderna	50,00	20,00	20,00	20,00	20,00	20,00	15,00	11,00	18,00	21,00	24,00	4,00		5,00	15,00	18,00	21,00
Višnjan	54,00	24,00	24,00	24,00	24,00	24,00	19,00	16,00	22,00	26,00	29,00	11,00	5,00		11,00	14,00	17,00
Nova Vas	62,00	32,00	32,00	32,00	32,00	32,00	27,00	23,00	30,00	33,00	36,00	19,00	15,00	11,00		4,00	9,00
Buje	65,00	35,00	35,00	35,00	35,00	35,00	30,00	27,00	33,00	36,00	39,00	22,00	18,00	14,00	4,00		4,00
Umag	68,00	38,00	38,00	38,00	38,00	38,00	33,00	30,00	36,00	39,00	43,00	26,00	21,00	17,00	9,00	4,00	

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

Source: official price list of Bina-Istra d.d.: [www.bina-istra.hr](http://www.bina-istra.hr)



Picture 2. Toll price list for II. group of vehicles in 2016

PUNA CIJENA CESTARINE	Tunel Učka	Vranja	Lupoglav	Cerovlje	Ivoli	Rogovići	Žminj	Kanfanar	Vodnjan S	Vodnjan J	Pula	Medaki	Baderna	Višnjan	Nova Vas	Buje	Umag
Tunel Učka		44,00	44,00	44,00	44,00	44,00	55,00	60,00	70,00	76,00	81,00	66,00	74,00	80,00	92,00	97,00	104,00
Vranja	44,00		0,00	0,00	0,00	0,00	13,00	18,00	28,00	33,00	38,00	24,00	31,00	37,00	50,00	61,00	61,00
Lupoglav	44,00	0,00		0,00	0,00	0,00	13,00	18,00	28,00	33,00	38,00	24,00	31,00	37,00	50,00	61,00	61,00
Cerovlje	44,00	0,00	0,00		0,00	0,00	13,00	18,00	28,00	33,00	38,00	24,00	31,00	37,00	50,00	61,00	61,00
Ivoli	44,00	0,00	0,00	0,00		0,00	13,00	18,00	28,00	33,00	38,00	24,00	31,00	37,00	50,00	61,00	61,00
Rogovići	44,00	0,00	0,00	0,00	0,00		13,00	18,00	28,00	33,00	38,00	24,00	31,00	37,00	50,00	61,00	61,00
Žminj	55,00	13,00	13,00	13,00	13,00	13,00		9,00	19,00	24,00	30,00	16,00	22,00	29,00	40,00	52,00	52,00
Kanfanar	60,00	18,00	18,00	18,00	18,00	18,00	9,00		14,00	19,00	23,00	10,00	17,00	23,00	35,00	47,00	47,00
Vodnjan S	70,00	28,00	28,00	28,00	28,00	28,00	19,00	14,00		8,00	14,00	20,00	27,00	33,00	46,00	57,00	57,00
Vodnjan J	76,00	33,00	33,00	33,00	33,00	33,00	24,00	19,00	8,00		8,00	25,00	32,00	38,00	51,00	62,00	62,00
Pula	81,00	38,00	38,00	38,00	38,00	38,00	30,00	23,00	14,00	8,00		31,00	37,00	44,00	57,00	67,00	67,00
Medaki	66,00	24,00	24,00	24,00	24,00	24,00	16,00	10,00	20,00	25,00	31,00		11,00	17,00	29,00	39,00	39,00
Baderna	74,00	31,00	31,00	31,00	31,00	31,00	22,00	17,00	27,00	32,00	37,00	11,00		11,00	22,00	33,00	33,00
Višnjan	80,00	37,00	37,00	37,00	37,00	37,00	29,00	23,00	33,00	38,00	44,00	17,00	11,00		16,00	27,00	27,00
Nova Vas	92,00	50,00	50,00	50,00	50,00	50,00	40,00	35,00	46,00	51,00	57,00	29,00	22,00	16,00		8,00	15,00
Buje	97,00	55,00	55,00	55,00	55,00	55,00	47,00	40,00	51,00	57,00	62,00	34,00	28,00	21,00	8,00		8,00
Umag	104,00	61,00	61,00	61,00	61,00	61,00	52,00	47,00	57,00	62,00	67,00	39,00	33,00	27,00	15,00	8,00	

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

Source: official price list of Bina-Istra d.d.: [www.bina-istra.hr](http://www.bina-istra.hr)

Picture 3. Toll price list for III. group of vehicles in 2016

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

PUNA CIJENA CESTARINE	Tunel Učka	Vranja	Lupoglav	Cerovlje	Ivoli	Rogovići	Žminj	Kanfanar	Vodnjan S	Vodnjan J	Pula	Medaki	Baderna	Višnjan	Nova Vas	Buje	Umag
Tunel Učka		87,00	87,00	87,00	87,00	87,00	106,00	116,00	136,00	146,00	156,00	130,00	143,00	156,00	181,00	191,00	200,00
Vranja	87,00		0,00	0,00	0,00	0,00	19,00	29,00	49,00	59,00	68,00	42,00	56,00	68,00	93,00	104,00	113,00
Lupoglav	87,00	0,00		0,00	0,00	0,00	19,00	29,00	49,00	59,00	68,00	42,00	56,00	68,00	93,00	104,00	113,00
Cerovlje	87,00	0,00	0,00		0,00	0,00	19,00	29,00	49,00	59,00	68,00	42,00	56,00	68,00	93,00	104,00	113,00
Ivoli	87,00	0,00	0,00	0,00		0,00	19,00	29,00	49,00	59,00	68,00	42,00	56,00	68,00	93,00	104,00	113,00
Rogovići	87,00	0,00	0,00	0,00	0,00		19,00	29,00	49,00	59,00	68,00	42,00	56,00	68,00	93,00	104,00	113,00
Žminj	106,00	19,00	19,00	19,00	19,00	19,00		13,00	32,00	42,00	52,00	26,00	38,00	52,00	77,00	86,00	96,00
Kanfanar	116,00	29,00	29,00	29,00	29,00	29,00	13,00		22,00	32,00	42,00	16,00	29,00	42,00	65,00	77,00	86,00
Vodnjan S	136,00	49,00	49,00	49,00	49,00	49,00	32,00	22,00		13,00	22,00	35,00	49,00	62,00	86,00	96,00	107,00
Vodnjan J	146,00	59,00	59,00	59,00	59,00	59,00	42,00	32,00	13,00		13,00	46,00	59,00	74,00	96,00	107,00	116,00
Pula	156,00	68,00	68,00	68,00	68,00	68,00	52,00	42,00	22,00	12,00		56,00	68,00	83,00	107,00	116,00	128,00
Medaki	130,00	42,00	42,00	42,00	42,00	42,00	26,00	16,00	35,00	46,00	56,00		16,00	29,00	52,00	62,00	74,00
Baderna	143,00	56,00	56,00	56,00	56,00	56,00	38,00	29,00	49,00	59,00	58,00	16,00		16,00	38,00	49,00	59,00
Višnjan	156,00	68,00	68,00	68,00	68,00	68,00	52,00	42,00	62,00	74,00	53,00	29,00	16,00		26,00	35,00	46,00
Nova Vas	181,00	93,00	93,00	93,00	93,00	93,00	77,00	65,00	86,00	96,00	107,00	52,00	38,00	26,00		13,00	22,00
Buje	191,00	104,00	104,00	104,00	104,00	104,00	86,00	77,00	96,00	107,00	116,00	62,00	49,00	35,00	13,00		13,00
Umag	200,00	113,00	113,00	113,00	113,00	113,00	96,00	86,00	107,00	116,00	128,00	74,00	59,00	46,00	22,00	13,00	

Source: official price list of Bina-Istra d.d.: [www.bina-istra.hr](http://www.bina-istra.hr)

Toll collection system on motorway sections operated by Bina-Istra d.d. was established as a closed system, and the amount of toll was determined by the valid price list of Bina-Istra d.d. under the Concession Agreement. The toll can be paid at toll stations with cards, kuna cash and euros according to the valid exchange rate on the day of the transaction.

Picture 4. Toll price list for IV. group of vehicles in 2016

PUNA CIJENA CESTARINE	Tunel Učka	Vranja	Lupoglav	Cerovlje	Ivoli	Rogovići	Žminj	Kanfanar	Vodnjan S	Vodnjan J	Pula	Medaki	Baderna	Višnjan	Nova Vas	Buje	Umag
Tunel Učka		189,00	189,00	189,00	189,00	189,00	222,00	240,00	277,00	296,00	315,00	264,00	290,00	315,00	360,00	380,00	397,00
Vranja	189,00		0,00	0,00	0,00	0,00	33,00	52,00	89,00	107,00	125,00	75,00	101,00	125,00	171,00	190,00	209,00
Lupoglav	189,00	0,00		0,00	0,00	0,00	33,00	52,00	89,00	107,00	125,00	75,00	101,00	125,00	171,00	190,00	209,00
Cerovlje	189,00	0,00	0,00		0,00	0,00	33,00	52,00	89,00	107,00	125,00	75,00	101,00	125,00	171,00	190,00	209,00
Ivoli	189,00	0,00	0,00	0,00		0,00	33,00	52,00	89,00	107,00	125,00	75,00	101,00	125,00	171,00	190,00	209,00
Rogovići	189,00	0,00	0,00	0,00	0,00		33,00	52,00	89,00	107,00	125,00	75,00	101,00	125,00	171,00	190,00	209,00
Žminj	222,00	33,00	33,00	33,00	33,00	33,00		21,00	57,00	75,00	95,00	45,00	69,00	95,00	140,00	158,00	177,00
Kanfanar	240,00	52,00	52,00	52,00	52,00	52,00	21,00		39,00	57,00	75,00	26,00	52,00	75,00	120,00	140,00	158,00
Vodnjan S	277,00	89,00	89,00	89,00	89,00	89,00	57,00	39,00		21,00	39,00	64,00	89,00	114,00	158,00	177,00	196,00
Vodnjan J	296,00	107,00	107,00	107,00	107,00	107,00	75,00	57,00	21,00		21,00	84,00	107,00	133,00	177,00	196,00	215,00
Pula	315,00	125,00	125,00	125,00	125,00	125,00	95,00	75,00	39,00	21,00		101,00	125,00	153,00	196,00	215,00	234,00
Medaki	264,00	75,00	75,00	75,00	75,00	75,00	45,00	26,00	64,00	84,00	101,00		26,00	52,00	95,00	114,00	133,00
Baderna	290,00	101,00	101,00	101,00	101,00	101,00	69,00	52,00	89,00	107,00	125,00	26,00		26,00	69,00	89,00	107,00
Višnjan	315,00	125,00	125,00	125,00	125,00	125,00	95,00	75,00	114,00	133,00	153,00	52,00	26,00		45,00	64,00	84,00
Nova Vas	360,00	171,00	171,00	171,00	171,00	171,00	140,00	120,00	158,00	177,00	196,00	95,00	69,00	45,00		21,00	39,00
Buje	380,00	190,00	190,00	190,00	190,00	190,00	158,00	140,00	177,00	196,00	215,00	114,00	89,00	64,00	21,00		21,00
Umag	397,00	209,00	209,00	209,00	209,00	209,00	177,00	158,00	196,00	215,00	234,00	133,00	107,00	84,00	39,00	21,00	

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

Source: official price list of Bina-Istra d.d.: [www.bina-istra.hr](http://www.bina-istra.hr)

Another toll collection method offered by Bina-Istra d.d. is contactless electronic toll collection (ENC) using ENC devices. The conditions of use and the rights and obligations of users who use the ENC are determined by the General Terms and Conditions of the ENC package and electronic toll collection with payment cards of Bina-Istra d.d. The General Terms and Conditions determine the manner of establishing a contractual relationship for users of the ENC package, the conditions of use and the procedure in case of non-compliance with the General Terms and Conditions.

ENC service packages are toll subscriptions for the use of the Istrian Y at preferential tariffs defined in the subscription price list where funds are paid to the user account when buying an ENC device or when recharging the account for future use. Bina-Istria d.d. offers several ENC packages based on user requirements:

- ENC package „Plus“ – for users who often travel on the Istrian Y and thus receive an additional discount
- ENC package „Easy“ – for users who do not travel as often, but still get a discount
- ENC package „Next“ – use of ENC devices with deferred payment
- ENC package „No limit tunel Učka“ – for users who pass through the Tunnel Učka every day.

Table 15. Price list of Bina-Istra subscription packages in 2016

ENC package "Plus"	Discount on regular price		ETC package validity period	Minimum payment to the account
	Učka tunnel	Other sections		
I. and IA. category	50%	30%	90 days	200.00 kn
II. category	50%	30%	90 days	300.00 kn
III. category	40%	30%	120 days	1,500.00 kn
IV. category	40%	30%	120 days	2,500.00 kn
ENC package "Easy"	Discount on regular price		ETC package validity period	Minimum payment to the account
	Tunel Učka	Other sections		
I. and IA. category	10%	10%	unlimited	200.00 kn
II. category	10%	10%	unlimited	300.00 kn
III. category	10%	10%	unlimited	1,500.00 kn
IV. category	10%	10%	unlimited	2,500.00 kn
ENC package "No limit tunnel Učka"	Discount on regular price		ETC package validity period	Minimum payment to the account
	Učka tunnel	Other sections		
I. category	unlimited	/	calendar month	360.00 kn
II. category	unlimited	/	calendar month	530.00 kn

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

Source: official price list of Bina-Istra d.d.: [www.bina-istra.hr](http://www.bina-istra.hr)

### 3.2.2. Autocesta Zagreb – Macelj d.o.o. (AZM)

The Zagreb - Macelj motorway is the last member of HUKA to cover 60 km of the motorway network in the Republic of Croatia. The company was founded in 2003 by the Government of the Republic of Croatia for the purpose of financing, construction, maintenance of the Zagreb - Macelj Motorway and its operating. Shortly after its establishment, the company was partially privatized according to the model of public-private partnership in which the Republic of Croatia has a 49% share, and Pyhrn Concession Holding GmbH a 51% share.

With the concession agreement of 11 July 2003 between the company and the Republic of Croatia, the company acquired the right to operate, develop, design, finance, build, maintain the motorway and all ancillary facilities for a period of 28 years. In 2004, the Zagreb - Macelj d.o.o. entrusted the operation of the motorway to Egis Road Operation Croatia d.o.o.

The following table shows toll prices for I. and III. vehicle category at the AZM concessionaire. The reason why only these two categories were taken into account is to focus on the most frequent participants of the Autocesta Zagreb - Macelj d.o.o., as well as to facilitate price comparisons between domestic and foreign concessionaires.

Table 16. Toll price list for all categories of vehicles on Autocesta Zagreb – Macelj d.o.o. in 2016

I. category	Zaprešić	Mokrice	Sv. Križ Začretje	Krapina	Đurmanec	Trakošćan
Zaprešić		11.00	18.00	21.00	27.00	48.00
Mokrice	11.00		4.00	5.00	17.00	22.00
Sv. Križ Začretje	18.00	4.00		1.00	9.00	14.00
Krapina	21.00	5.00	1.00		6.00	11.00
Đurmanec	27.00	17.00	9.00	6.00		5.00
Trakošćan	48.00	22.00	14.00	11.00	5.00	
<b>II. kategorija</b>						
Zaprešić		16.00	28.00	32.00	41.00	72.00
Mokrice	16.00		5.00	7.00	25.00	33.00
Sv. Križ Začretje	28.00	5.00		2.00	13.00	21.00
Krapina	32.00	7.00	2.00		9.00	17.00
Đurmanec	41.00	25.00	13.00	9.00		8.00
Trakošćan	72.00	33.00	21.00	17.00	8.00	
<b>III. kategorija</b>						
Zaprešić		24.00	42.00	49.00	63.00	110.00
Mokrice	24.00		8.00	11.00	39.00	51.00
Sv. Križ Začretje	42.00	8.00		3.00	20.00	33.00
Krapina	49.00	11.00	3.00		13.00	26.00
Đurmanec	63.00	39.00	20.00	13.00		12.00
Trakošćan	110.00	51.00	33.00	26.00	12.00	
<b>IV. kategorija</b>						
Zaprešić		47.00	3.00	97.00	123.00	215.00
Mokrice	47.00		15.00	22.00	75.00	99.00
Sv. Križ Začretje	83.00	15.00		6.00	40.00	64.00
Krapina	97.00	22.00	6.00		26.00	50.00
Đurmanec	123.00	75.00	40.00	26.00		24.00
Trakošćan	215.00	99.00	64.00	50.00	24.00	

Middle exchange rate of the Croatian National Bank: 1 € = 7,483 kn

Source: author's work based on the price list of Autoceste Zagreb – Macelj d.o.o.,

[www.azm.hr](http://www.azm.hr)

A closed toll system has been established on the motorway with two front tolls and four toll stations at motorway junctions, and tolls can be paid in cash in kunas and euros, cards, AZM card, KARTA 40, and there is a special payment for people with disabilities.

SMART cards are electronic cards for passing through automatic toll lines intended for frequent motorway users who provide users with a certain discount on the regular toll price. The discount is deducted upon payment or surcharge, and the deposit when buying a new card is 20 kn and is returned when the undamaged card is returned. With AZM card for I. and II. group of vehicles, the minimum payment is 200 kn and a discount of 25% is realized. For III. and IV. groups of vehicles, the minimum payment is also HRK 200, and a discount of 13% is granted for an amount higher than HRK 2,000.

KARTA 40 provides a discount for drivers I. and II. categories, and allows: 40 passes, 40% discount and validity for 40 days. The unused amount on KARTA 40 is not returned to the user.

### **3.3. Advantages and disadvantages of the existing toll system**

Until 2006 in the Republic of Croatia, the previous practice showed that the flow of vehicles in the system of conventional toll collection was reduced. Accordingly, a new toll collection system based on microwave electronic toll collection (ENC) technology is being introduced with the aim of improving and enhancing traffic flow.

ENC is a toll collection method in which the transaction is performed automatically between a vehicle equipped with a battery-powered device and a short-range communication system with an antenna located on the toll lane. At toll stations, there is at least one separate passage that serves for automatic electronic toll collection. ENC can be defined as a subsystem of intelligent transport system applied on roads for better communication and management solutions, and contains, among other things, the possibility of electronic payment within which the electronic financial transaction service to which the ENC toll system belongs is defined.

In the Republic of Croatia, the electronic toll collection service is provided by HAC, ARZ and Bina-Istra. ARZ and HAC have signed an agreement on bilateral full interoperability in the provision of services, while Bina-Istra operates in incomplete interoperability with HAC and ARZ, ie a user with the same ENC device can use the services of HAC and ARZ and Bina-Istra, but with two subscriber accounts. Any legal or natural person who signs the application form, pays the fee for the ENC device and submits all the documentation stated in the application form can become a user of the ENC device. The AZM manager does not provide the toll collection service with the ENC device.

Apart from ENC devices and electronic toll collection, all concessionaires on Croatian motorways also support a closed toll system, which is still the most common form of toll payment. In the open system, tolls are paid at toll stations when entering the motorway. In a closed toll system, the user at the entrance of the motorway takes a toll card which he hands over to the cashier at the exit from the motorway and on the basis of which a toll is charged according to the length of the used section and group of vehicles.

### **3.3.1. Advantages of the system**

In the world, the electronic toll collection system is a common and very common method of collection, while in the Republic of Croatia it is slowly becoming an increasingly popular method of toll collection. The ENC system is a fast and efficient way of tolling which is one of the main reasons for its popularity.

There are many benefits of electronic tolling, and most of them are manifested in:

- **time savings** - Users of electronic toll collection do not have to stop to pay the same, which greatly contributes to time savings during travel.
- **emissions of harmful gases** - Elimination of stopping, braking and movement of vehicles when taking a toll card or paying tolls reduces the emission of exhaust gases.

- **capacity increase** - Traffic lanes with an electronic toll collection system compared to the conventional method of payment have, on average, tripled the flow of vehicles.
- **reduction of the number of traffic accidents** - It has been shown that the number of traffic accidents occurring near toll stations has decreased due to a decrease in traffic congestion.
- **fuel savings** - In the electronic toll collection system, deceleration, acceleration and braking when paying tolls are almost completely eliminated. The facts greatly help in saving fuel for future needs. In addition, these benefits play an essential role in reducing vehicle operating costs.
- **simplification of toll collection** - When paying tolls, there is no cash money transaction in the electronic toll system, which reduces difficulties in handling money. Centralizing user accounts helps increase audit control.
- **payment flexibility** - In the ENC system, passengers do not have to worry about asking for cash to pay the toll because the toll is paid through their user account.
- **reduction of congestion** - The use of ENC system increases the flow of vehicles because vehicles do not have to stop at toll stations. The number of vehicles waiting in line has been reduced, and thus the average waiting time has been reduced.
- **increase data collection** - Information such as daily traffic, vehicle types, etc. can be collected more easily and quickly through the toll system.

The main advantages of a closed toll system are:

- **security of toll collection** - Users who do not use the ENC toll system when using the motorway take the entrance card without presenting it to the cashier at the exit can not pass the toll stations.
- **toll system per kilometer traveled** - Each motorway operator in the Republic of Croatia charges for the use of motorways according to a pre-determined price list

- **better service for users in terms of information** - Closed toll system is a simpler way to use the highway and the toll collection itself.
- **a wider range of toll payments with various instruments** - Upon arrival at the toll station, the user can pay the toll in cash and with various payment cards.

### **3.3.2. Disadvantages of the system**

The main disadvantages of the closed toll system are the jams at the toll booths, especially in the summer during the peak tourist season. This affects the dissatisfaction of both domestic and foreign users.

Travel time due to congestion affects the general dissatisfaction of users and the potential loss of traffic and consequently revenue from tolls since some users use parallel roads that are not charged.

One of the potential problems is also the obligation to maintain a closed toll system, which is imposed by a larger number of employees, especially cashiers in toll booths. One of the possibilities of reducing such costs is the automation of toll booths without the presence of cashiers such as the system on the Bina Istra network when at night and due to lower traffic on the 145 km network employs about 10 employees since users can pay by card, via ENC device. in cash, by SMS and all without the presence of the cashier.

There is also a risk of cash manipulation which is significantly reduced in the vignette system.

### **3.4. Estimated revenue**

In 2015, all motorway operators recorded an increase in traffic of 7.21% compared to the previous year, and thus revenues also increased. Compared to 2014, total revenues increased by 6.5%, of which the concession company Bina-Istra d.d. generated revenues by 13.22% higher than in 2014. From 2008 to 2015, revenues grew by an average of 2.81% per year, and the following table shows the projection of revenue growth in the closed toll system applied in the Republic of Croatia.



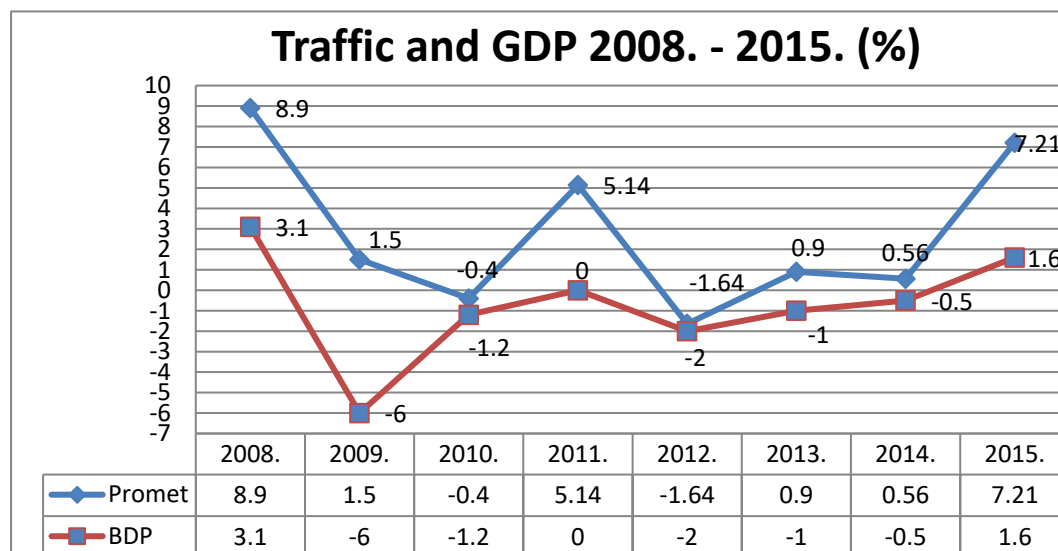
Picture 5. Revenue projection of the closed toll system on Croatian motorways from 2014 to 2026 with a continuous annual revenue growth of 2% (in euros)

Prihodi (rast 2% godišnje)	2014.	2015.	2016.	2017.	...	2025.	2026.
Zatvoreni sustav	297.885.560	317.671.642	324.025.075	330.505.576	...	387.239.959	394.984.758

Source: Authors

According to the existing toll system, the projection of the average annual revenue growth by 2% by 2026 by motorway operators in Croatia should generate revenues in the amount of about € 395 million. Revenue growth of 2% per year was obtained on the basis of the National Report for 2015 from HUKA, where in the period from 2008 to 2015, the average annual revenue growth of all operators was recorded by exactly 2% per year.

Graph 1. Traffic and GDP from 2008 to 2015



Source: HUKA National Report for 2015

The chart representing the traffic and GDP in the Republic of Croatia shows and confirms that the traffic increase or decrease is closely related to the growth or decrease of GDP.

Based on the analysis of motorway operators in Croatia with all their characteristics and differences in ownership structure, price lists and payment methods, it is concluded that the application of different tariff policies and ENC subscription models for each concessionaire is repulsive for motorway users. For example, in order for a user with an ENC device to be able to use motorways at each concessionaire, it is necessary to stop and encode the device separately

at each subscription point of sale at each concessionaire, provided that the AZM billing system does not support electronic billing system. In addition to all the above, some ENC subscription models with some concessionaires have a limited subscription validity period, so this can be taken as another shortcoming of the existing toll system.

As a potential solution, with the introduction of the vignette charging system, it is necessary to achieve full interoperability between all motorway operators in Croatia with a single price list per kilometer and common subscription models (along with existing ones) that would allow users to contract a single product at one point of sale, highway of all concessionaires without stopping and additional coding.

## 4. CONCLUSION

The aim of this paper was to make a comparison of traffic, toll revenues and other specifics based on historical data from the practice of motorway operators in Croatia and individual EU countries that use vignettes. We also compared open toll systems on the principle of vignette with the existing closed toll system at the operators in the Republic of Croatia.

The biggest challenge in introducing the vignette system is to find the optimal ratio of vignette prices for personal vehicles for all three periods that would lead to an increase in traffic on Croatian motorways and the retention or increase in toll revenue. It is possible to determine the minimum and maximum revenues from vignettes on the basis of reasoned assumptions, because it is impossible to predict the behavior of foreign and domestic users, as well as their sensitivity to changes in toll prices. The goal should be to increase traffic on motorways without compromising safety, then consider the possibility of discounts on long-term tariffs and increase prices during the tourist season when traffic elasticity and vignette prices are most favorable.

In conclusion, the fact is that the traffic on Croatian motorways is not what was desired when drafting the business plan, and therefore there are big problems for most operators and the state budget. According to statistics, the neighboring countries covered in this paper also generated lower toll revenues by applying a closed toll system. The vignette system can influence the optimization of toll collection costs, which is mostly reflected in the reduction of the number of employees and the increase of customer satisfaction in terms of faster and easier traffic. Open and closed toll systems have the effect of increasing traffic safety, relieving local roads and increasing customer satisfaction. The main problems can arise in the form of slow project implementation, problems with trade unions and lack of cooperation with the authorities. The biggest problem lies in the uncertainty of achieving a secure income, which should be at least as in a closed toll system (at least a coverage point should be achieved) which can be bad for the deficit and the state budget..

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