Reducing the death toll of road accidents in Costa Rica through the introduction of roadworthiness inspections by the government.

by

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Abstract

This paper investigates the effects on traffic safety and the associated economic savings of the introduction of RITEVE, the Periodical Technical Inspections (PTI) in Costa Rica. Since there were no national estimates for the costs of crashes in Costa Rica available, this study derives and evaluates in a first step different ways to estimate these costs. Subsequently these are used for a cost-benefit analysis to benchmark the policy decision to introduce periodical technical inspections. The findings show that there are considerable economic gains from having such a system in place with high cost-benefit ratios. The study shall give insights and encourage other countries to introduce or consider such measures as they can be an important step toward more road safety and reduce the cost of crashes for society and the economy.

Keywords: Periodic technical inspection; Costa Rica; cost-benefit analysis; policy; cost-unit rates

JEL Classification: D61, D78, L51, R41

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1. Introduction

The goal of this paper is to scientifically determine the human lives saved as well as injury reductions associated with the periodical technical inspection (PTI) regime introduced in Costa Rica in 2003. The study goal includes further an assessment of the economic impacts of PTI. The methodological framework for the economic assessment is a cost-benefit analysis.In 2004, the WHO stated in their first "World report on road traffic injury prevention" on page 163 the following about the road safety situation in Costa Rica [1]:

"In Costa Rica traffic crashes and their consequences are clearly a public health problem. They are the leading cause of violent deaths, the leading cause of death in the 10-45 years age group, and the third leading cause of years of life lost due to premature death. The cost to the country of traffic crashes amounts to almost 2.3% of the gross domestic product."

For this background, the Costa Rican government introduced a national road safety plan (NRSP) with the objective to reduce the mortality rate by 19% during the period 2001-2005. Actions were taken in the fields of traffic laws, police surveillance, education, infrastructure, and research. In 2002 the periodic vehicular technical inspection (Riteve) was introduced. Immediately after the launch of Riteve, the accident rate dropped down by around 40%.

Costa Rica further introduced a new seat belt law in 2004 accompanied by a public awareness campaign and strong police enforcement to increase seat belt usage for drivers. The usage of seat belts increased from 24 percent to 82 percent, and the fatality rates dropped.

The first objective of the study is to prove whether this reduction of accidents is caused indeed by PTI. The second objective is to assess the benefits and costs of the Riteve-system.

2. Methodological approach

The first objective is to find out whether a causal relation between PTI (Riteve) and the empirically observable reduction of accidents exists. Riteve was introduced in 2002. The seatbelt law was introduced in 2004. Therefore, a regression analysis is performed to prove whether the accident effects are mainly influenced by Riteve or the seatbelt law.

The second objective is to find out the social benefits and social costs of the PTI. For the assessment of the benefits and the costs, the economic method of the cost-benefit analysis (CBA) is used. The CBA is a method of applied welfare economics, which is used to find out whether measures are socially desirable. The overall result of the CBA is a benefit-cost ratio (BCR). Ratios greater than one – which means that benefits exceed costs – prove that the system implementation is profitable for the whole of society. Therefore, it provides a helpful component for decision making in the public sector [2–5].

The general approach of a CBA are the following steps [2]:

1. Definition of cases (e.g., with or without PTI)
2. Identification of relevant parameters (e.g., traffic, environment)
3. Quantification of the physical effects
4. Transformation of the effects of step 3 into monetary values
5. Calculation of the benefit-cost ratio

The study is following this suggested structure.

3. Cost-benefit analysis

This chapter is structured according to the general approach for a CBA described above.

3.1 Definition of cases: The Riteve system in Costa Rica

The cost-benefit analysis (CBA) requires a distinction between benefits and costs.

Benefits are defined as resource savings which are the result of introducing a measure. In this case, the introduction of PTI is the measure. The impact of PTI can be evaluated by comparing the situation without PTI (=with-out case) and the situation with PTI (with case). Within this CBA the introduction of Riteve represents the so-called with-case. The with-case must be compared to the situation without Riteve. The benefits can then be calculated as the difference between the without-cause and the with-case. Therefore, the benefits represent the cost savings achieved due to the introduction of Riteve.

The without-case is for Costa Rica very clear and straightforward because before 2002 there was not a regulatory inspection regime established for safety systems (except deficient inspection of public transport vehicles). The with-case exists since 2003. In the following, the characteristics of the with-case are examined more in-depth.

The PTI in Costa Rica is organized as an annual inspection that all vehicles must pass to be driven legally. The vehicle inspection is carried out by a private company (Riteve SyC, SA). Riteve SyC, SA is part of the Applus+ group which operates in more than 70 countries in the fields of inspections, trials, and certifications.

The purpose of the inspection is to ensure that the vehicle complies with basic safety standards of Costa Rica. The last number of the license plate (e.g., 5) indicates the month in which the inspection of the vehicles must be carried out (5 = May). The inspection tests cover the safety of the vehicle and the emissions coming from the tailpipe. Following vehicle types are inspected: automobiles, light load, motorcycles, taxis, buses, heavy load, semi trucks, trailers.

At Riteve the vehicle must pass seven different stations. The test procedure can be described as follows [6]:

1. Basic exterior check (vehicle´s turn signals, high beams/low beams, windshield wipers, horn, the angle of the headlights, tread on the tires).
2. Basic interior check (checking the inside of the vehicles with a focus on the functioning of the seatbelts).
3. Shocks and struts test (responsiveness of the vehicle to shocks is tested).
4. Brake test (a computer-based measure of the ability of the brakes to stop).
5. Side-to-side test (similar to the shock test, but each wheel is tested separately).
6. Underbody inspection (undercarriage of the vehicle is inspected with a focus on oil leaks).
7. Emission test (tailpipe measurement of the emission for different speed situations).

Riteve operates 13 fixed stations in Costa Rica (Alajuela, Cartago, Heredia, San José Sur, Guápiles, Puntarenas, Pérez Zeledón, San Carlos, Canas, Liberia, Limón, Nicoya). There are also four mobile stations outside the Great Metropolitan Area (GMA), which travel around to smaller cities and towns.

For the year 2017 the activities of Riteve can be summarized as follows [7]: 1,142,184 periodic vehicular technical inspections were carried out. 46.6% of the inspected vehicles failed their technical inspection in the first inspection. In the second inspection 76.4% passed the re-inspection and 23.6% did not pass the re-inspection. This signifies that over both inspection rounds after the second inspection 94.6% of the vehicles passed the Riteve. 5.4% of the vehicles did not pass their technical inspection. For the year 2017, the number of vehicles without approval was 118,281.

Motorcycles had the highest rate of approvals while semi-trucks had the lowest rate. Three main causes of rejection in 2017 were:

- excess of the polluting emissions,
- imbalance in the breaks,
- tire weathering.

3.7% of the inspected vehicles failed in 2017 because of serious identification defects.

The next table shows for the period from 2014 to 2017 the share of vehicles which passed the annual PTI without a defect. The average value over this period is that 52.5 percent of the vehicles had no defects.

Year	Vehicles without defects in percent
2014	52.0%
2015	51.5%
2016	53.0%
2017	53.4%
Average	52.5%

Table 1: Share of vehicles without defects at Riteve from 2014 to 2017.

Source: [7–10]*; own calculation.*

3.2 Description of the vehicle-stock

The average age of the vehicles inspected is of 16 years. The vehicles used for tourism transportation are the youngest, and the trailers and semi-trailers are the oldest. 75% of the vehicles have gasoline, and 23% of them have diesel. Only 0.03% of the vehicles are electric, and 0.05% of them are hybrids [7]. The next figure shows the development of the vehicle-stock in Costa Rica for the period from 2002 to 2015. With the term "vehicle", the following categories are covered: automobiles, buses, high and light loads, taxis, special equipment, and motorcycles. These vehicle categories are used within the official accident statistics. The graphic shows a drop in the number of vehicles from the year 2005 to the year 2006. The statistical reason is that the passenger car stock is lowered by 27 percent. Further, there is a sharp decrease by 72 percent for heavy loads and 20 percent for light loads. The statistic, however, records only the vehicles paying the vehicle circle permits (=marchamos), which is collected by the Na-

tional Insurance Institute (INS). The vehicle circle permits include mandatory automobile insurance (SOA), property tax, sales tax, and other taxes, as well as unpaid traffic fines. Apparently, many vehicle owners did not pay their marchamos in 2006, which leads to a significant decrease of the vehicle stock. Further, it could be assumed that those vehicles did not pass the Riteve process.

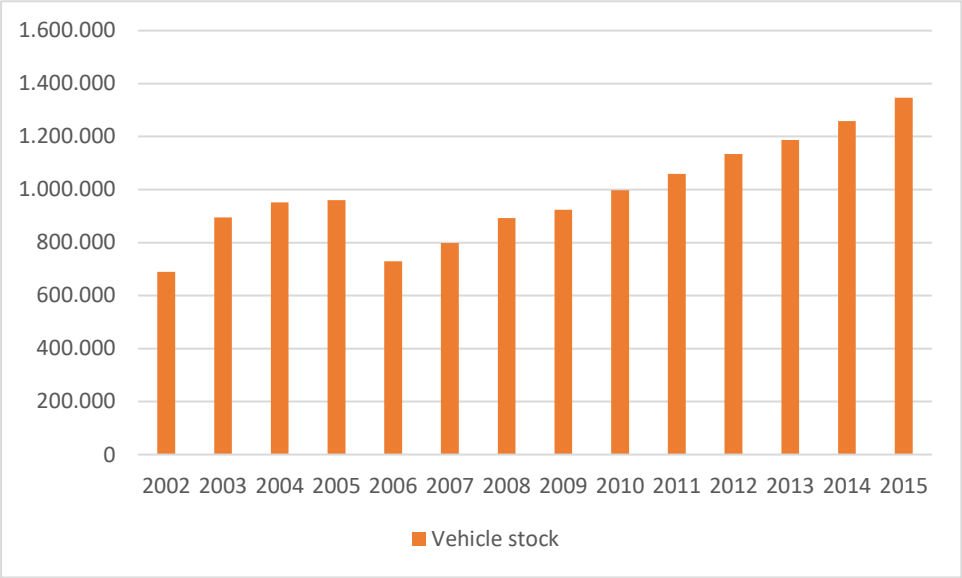

Figure 1: Development of the vehicle stock in Costa Rica from 2002 to 2015.

Source: [11–14], *own visualization.*

3.3 Quantification of the accident effects

In Costa Rica, the accident data is obtained through the official transit part of the Traffic Police General Directorate. When an accident occurs, it enters the database in two ways (handheld and paper). Because part of the primary task of the police is to save lives, and because of the limited resources that exist, the focus is on accidents with injuries and fatalities. There is no priority to count accidents only with property damage [15]. Therefore, the CBA is focused on injuries and fatalities and not on property damages. This on the other hand signifies that by ignoring property damages, the possible benefits of Riteve are underestimated.

The following graph illustrates the effects of introducing Riteve on vehicle crashes. There is a clear impact of Riteve on vehicle crashes. In the second year of introducing Riteve (=2003), the vehicle crashes are reduced significantly by minus 42 percent. Only in the years 2006, 2014 and 2015 are again increases in vehicles crashes. However, those increases do not affect the first initial decrease.

Nevertheless, it would be interesting to have a more profound investigation why in those years the accidents increased. However, in a second step, it must be clarified whether the decrease of the vehicle crashes is indeed caused by the Riteve inspection regime. Therefore, it is necessary to run a regression.

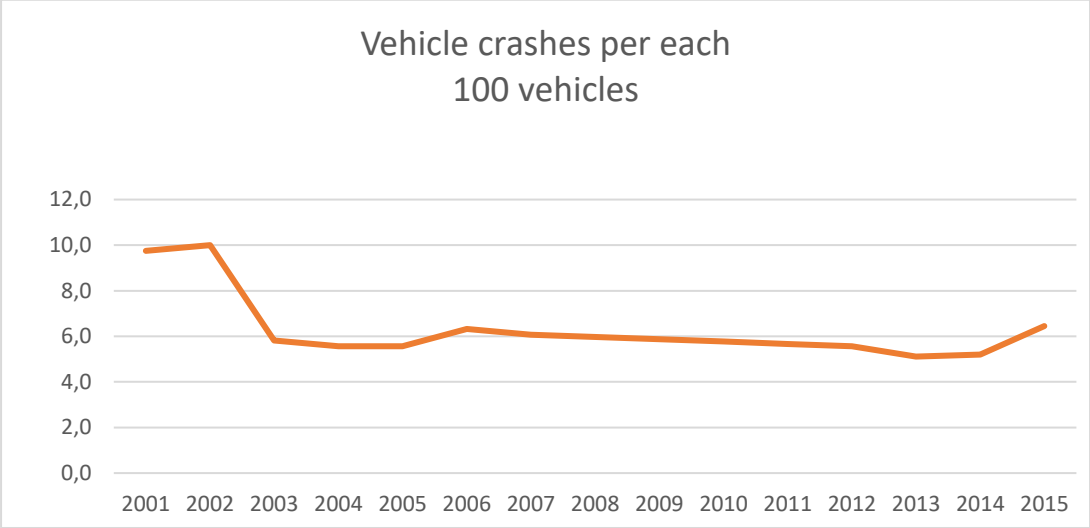

Figure 2: Vehicle crashes per each 100 vehicles in Costa Rica from 2001 to 2015

Source: [13,16], *own calculation and visualization.*

To prepare the regression a scatter plot is first created. The next figure shows the scatter plot for the relation between introducing PTI (with-case) and vehicle crashes per every 100 vehicles and having no PTI (without-case) and vehicle crashes. The scatter plot graphic shows that it is very like that the introduction of Riteve has the effect of reducing accidents.

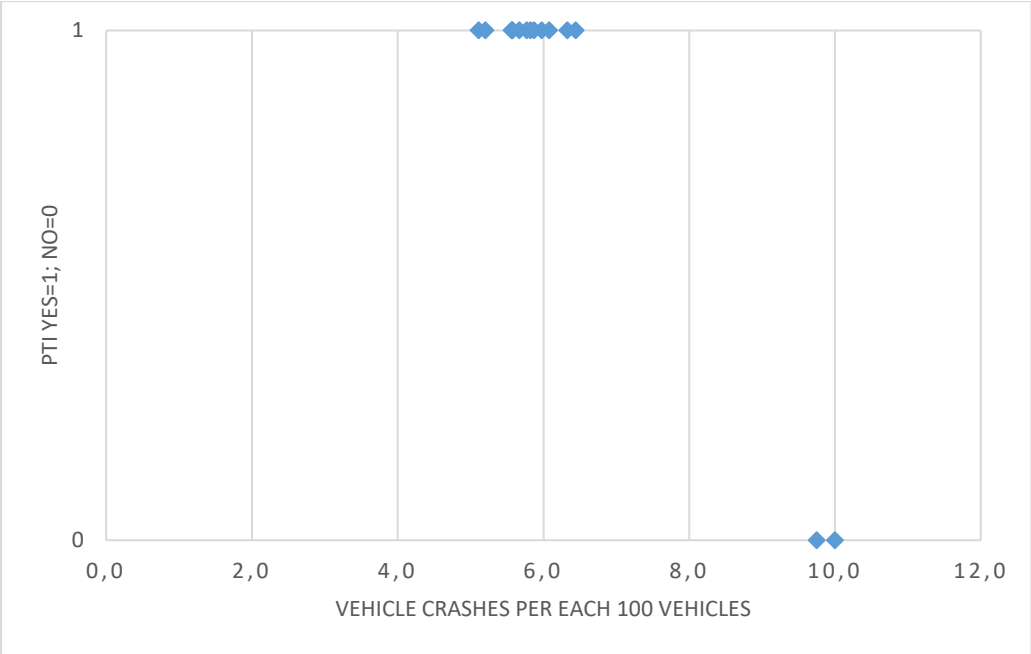

Figure 3: Relation between introducing Riteve in Costa Rica and the number of vehicle crashes per each 100 vehicles.

Source: own calculation and visualization.

The regression analysis is needed to get a causal relation between Riteve and vehicle crashes.

Using a regression with the dummy variable (DV) for PTI with the expressions one equal to PTI is in use, and 0 equal to PTI does not exist, as an independent variable and the number of vehicle crashes per each 100 vehicles (VC) as the dependent variable. The regression function is:

VC = -4.1DV + 9.9 with an R-squared = 0.94.

The regression implies that the number of vehicle crashes per each 100 vehicles is reduced by 41%. As a next step, the number of accidents must be related to the accident consequences. Accident consequences are fatalities and injuries. The number of fatalities and injuries for the period from 2001 to 2011 can be derived using empirical

ratios (injuries/accidents, fatalities/accidents) from a statistic for the period from 2012 to 2015 (see table 2).

Vehicle accidents, injuries, and fatalities			
Year	Total		
	Accidents	Injuries	Fatalities
2012	63,129	24,024	330
2013	60,699	25,999	294
2014	65,454	27,924	359
2015	86,738	31,278	398

Table 2: Number of road accidents and their consequences to injuries and fatalities for the period from 2012 to 2015

Source: [17]

Based on this table the average empirical relation between injuries and accidents is 0.399. The empirical relation between fatalities and accidents is 0.005.

Table 3 shows the actual number of accidents, the number of accidents for the case that Riteve was not introduced (without-case), the number of avoided accidents by Riteve (with-case), the number of avoided fatalities (with-case), and the number of avoided injured persons (without-case).

Year	Accidents	Accidents without PTI	Avoided accidents by PTI	Avoided fatalities by PTI	Avoided injuries by PTI
2001	64,774	64,774	0	0	0
2002	68,976	68,976	0	0	0
2003	52,085	72,919	20,834	105	8,313
2004	53,039	74,255	21,216	107	8,466
2005	53,493	74,890	21,397	108	8,538
2006	46,170	64,638	18,468	93	7,369
2007	48,480	67,872	19,392	98	7,738
2008	53,326	74,656	21,330	107	8,511
2009	54,241	75,938	21,697	109	8,657
2010	57,542	80,559	23,017	116	9,184
2011	60,021	84,029	24,008	121	9,580
2012	63,129	88,381	25,252	127	10,076
2013	60,699	84,979	24,280	122	9,688
2014	65,454	91,636	26,182	132	10,447
2015	86,738	121,433	34,695	175	13,844

Table 3: Calculation of the number of accidents without Riteve, the avoided number of accidents by Riteve, the avoided number of fatalities by Riteve and the avoided number of injured persons by Riteve.

Source: own calculation.

3.4 Cost-unit rates for fatalities and injured persons

A national accounting system of the resource losses by road accidents does not exist for Costa Rica. In Germany, for example, every year the Federal Highway Research Institute determines the costs resulting from road traffic accidents in Germany [18]. Therefore, the recommendation for Costa Rica is to establish an economic road accident cost bill.

The question for this study is, what are the correct Costa Rican monetary values to evaluate the losses by road accidents. That means cost-unit rates for fatalities and injured persons must be derived. Therefore, the part on the monetary evaluation of accidents has an outstanding meaning. Coming up with the calculation of accident cost-

saving means that economic theory must evaluate the loss of human life and the costs of personal injuries.

In general, the specification of cost-unit rates for all traffic effects can be done with different evaluation methods. The following figure shows which kind of evaluation methods are in use. It can be distinguished between subjective and objective methods. The subjective method is based on the rational decision of humans to pay money to avoid road accidents. The objective methods try to find empirical evidence of how road accidents affect the economic situation of society.

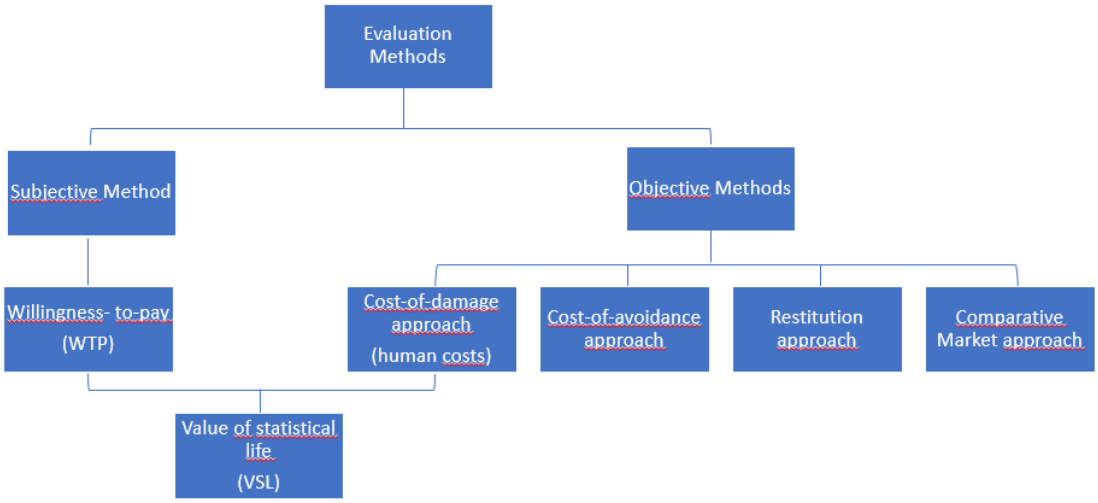

Figure 4: Evaluation methods

Source: own visualization.

The evaluation methods can be characterized as follows:

- The willingness-to-pay approach (WTP) as a subjective method questions how much the victim of an accident will pay to be able to avoid the accident or what compensation amount will be accepted by the victim to approve the damage.

- In line with the cost-of-damage approach, the damage caused by accidents is assessed; an essential criterion is the decline of the gross domestic product because of the accident.
- The cost-avoidance approach determines the amount that must be paid so that an accident does not happen or could be lowered in its consequences (e.g., change from fatality to personal injury).
- The restitution approach counts the direct costs caused by road accidents (for example, property damage, medical costs, administrative costs). Altogether the restitution costs reflect the costs to restore road casualties.
- Within the comparative market analysis (=market data divergence analysis), the costs of given effects are indirectly determined; different damage produces different prices on other markets (e.g., real estate market); the difference is calculated as the equivalent value of the damage.

The VAS can be calculated both based on the subjective method or on the objective method.

For Costa Rica it is possible to derive cost-unit rates from both, objective and subjective methods. Cost-of-damage and restitution-cost are used as objective methods to derive cost-unit rates for fatalities and injuries.

For injured persons the restitution-cost approach is used because the following information is available [19]:

- In 2017, 43,987 patients injured by road accidents received medical attention, costing the health service close to US$55 million.
- 54% of the injured patients were motorcyclists.

That means that the health costs per injured person are US$1,250. This cost-unit rate does not consider that injuries must be separated into severe and slight casualties.

According to the Costa Rica Social Security Fund (CCSS) in 2017, 571 patients in critical condition received medical attention equivalent to over US$25 million.

That means for Costa Rica that the injured people can be divided into two economic cost groups:

- Seriously injured persons have on average a cost-unit rate of US$43,783. This cost-unit rate corresponds to the European cost-unit rate of severe injuries.
- Minor injured persons have on average a cost-unit rate of US$691. This cost-unit rate corresponds to the European cost-unit rate for minor injuries.

The suggestion is to use the cost-unit rate for severe injuries of US$43,783 and the cost-unit rate for slight injuries of US$691.

Alternatively, a weighted cost-unit rate for injuries can be derived. The share of severe injuries of all injuries is 1.3 percent in 2017. The share of slight injuries of all injuries is 98.7 percent. The cost-unit rate for all kinds of injuries is US$1,518.

Another approach estimating the cost-unit rate for injuries can be oriented on the insurance costs for road accidents. In the marchamo payment (circulation permit) that vehicle owners in Costa Rica must pay every year, there is an insurance amount included that covers for up to six million colones (around US$10,600). That means that the insurance does not cover the costs for severe injured persons and that the difference must come from the amount paid by contributors to the basic social security insurance system. With that, the rate of US$10,600 can also be interpreted as the cost-unit rate for injuries by accidents. This rate is calculated without considering the actual costs of

severely injured persons. Therefore, this cost-unit rate might reflect an average cost-unit rate for all injuries.

The cost-unit rate for fatalities mainly includes the production loss and human costs (cost-of-damage approach). Both are making up more than 90% of the total costs per fatality [20]. Human costs account for the pain, sorrow, and grief about the deceased of its relatives and friends. Therefore, this approach needs a national calculation process based on the willingness-to-pay approach. The production loss is mainly based on the contribution of the casualty to the GDP. The next figure shows the GDP per capita for Costa Rica in US$ for the years from 2012 to 2022. The GDP per capita for 2017 is for our considerations relevant. The GDP per capita is US$11,685 in 2017.

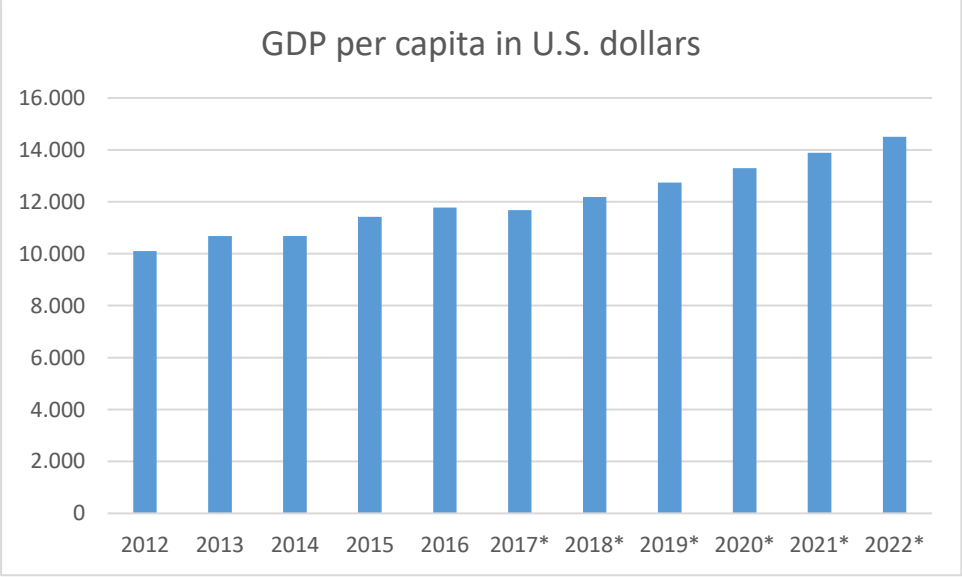

Figure 5: Gross domestic product (GDP) per capita in Costa Rica 2022*; Costa Rica: Gross domestic product (GDP) per capita in current prices from 2012 to 2022* (in U.S. dollars)

Source: [21], *own visualization.*

The next figure shows the life expectancy at birth in Costa Rica from 2006 to 2016. The average life expectancy at birth in Costa Rica was 79.83 years in 2016.

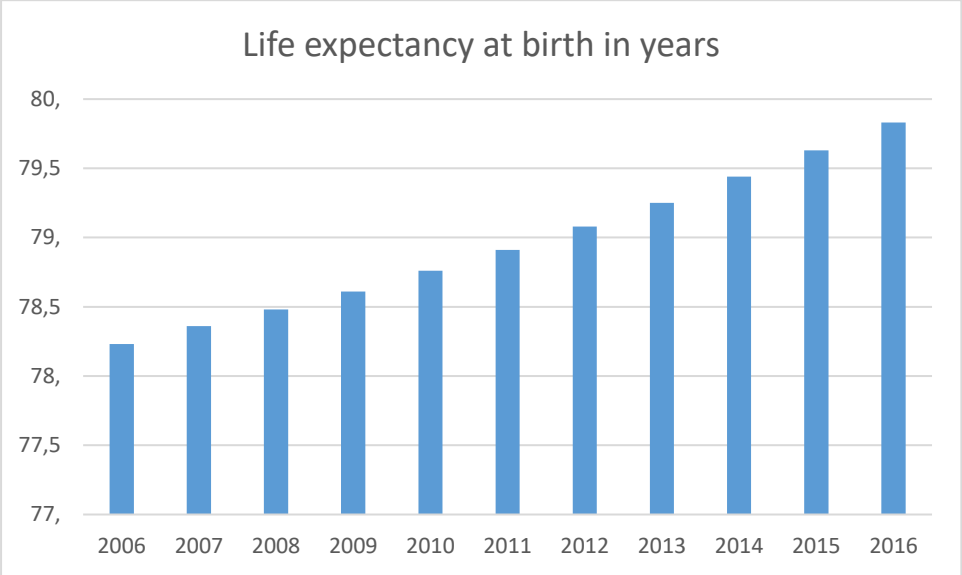

Figure 6: Costa Rica: Life expectancy at birth from 2006 to 2016

Source: [22], *own visualization.*

Assuming the causalities are distributed equally across all age groups then the average lost remaining life is 40 years. This means that the GDP loss of a fatality is 40 years multiplied with a GDP per capita of US$11,685 equaling US$466,407.

Based on the objective methods the suggestion is to use the following cost-unit rates:

- The average cost-unit rate for severe and slight injuries: US$1,518
- The cost-unit rate for fatalities: US$466,407.

Now the question is how trustworthy this calculation is.

McMahon & Dahdah (2008) found a strong correlation between the income level (GDP per capita) and human costs using data from 22 countries [23]. The linear regression formula is as follows.

$$\ln_n (HC) = 2.519 + 1.125^* \ln_n (GDP/Capita) + 0.496^* Method$$

The next table presents the results for the estimation of human costs based on GDP per capita.

Year	GDP per capita in US$	Estimated human costs in US$
2012	10,099	397,000
2013	10,678	422,698
2014	10,679	422,754
2015	11,416	455,703
2016	11,776	471,898
2017	11,685	467,818
Average	**11,055**	**439,645**

Table 4: Estimation of human costs for road accidents in Costa Rica based on McMahon & Dahdah [23]**.**

Source: own calculation.

The average value for human costs is US$439,645. This value is close to the recommended cost-unit rate of US$466,407.

McMahon & Dahdad additionally derived a regression formula to calculate the Value of Statistical Life (VSL) based on the WTP [23]. With this, it is possible to derive a cost-unit rate for fatalities based on the subjective method. The formula is the following:

$$\ln_n (VSL) = 2.519 + 1.125 * \ln_n (GDP/Capita) + 0.496$$

If this formula is used, the average value of statistical life is US$721,959. The projects UNITE, and HEATCO suggest taking 13 percent of the costs per fatality to estimate the costs for severe injuries and 1 percent to estimate the costs for slight injuries [24,25]. Following this recommendation, the cost-rate for severe injuries is US$93,855, and cost-rate for slight injuries is US$7,220. Using the empirical relation between severe and slight injuries for Costa Rica in 2017 results in a weighted cost-unit rate for all road accident injuries of US$8,346.

The next table shows the two sets for accident cost-unit rates for both subjective and objective methods.

Cost category	Objective method in US$	Subjective method in US$
Fatalities	466,407	721,959
Injuries	1,518	8,346

Table 5: Proposal for accident rates for Costa Rica differentiated according to subjective and objective assessment methods.

Source: own calculation.

3.5 Costs for PTI

3.5.1 The fee for Riteve

The Public Services Regulatory Agency (ARESEP) approved an adjustment of 35% in Riteve, after more than 12 years without changing the price. This adjustment will be fragmented into three tracts, applicable every six months.

The first adjustment was made already in May 2018 and on Friday the 10 November 2018, the second adjustment will be applied. The current rates for Riteve are shown in the next table.

Main vehicle categories	Riteve prices for the first inspection	Riteve prices for the second inspection
Motorcycles	₡8,830	₡4,415
Automobiles	₡13,405	₡6,700
Taxis	₡14,460	₡7,230
Buses	₡17,650	₡8,825
Light loads	₡13,405	₡6,700
Heavy Loads	₡17,650	₡8,825
Special equipment	₡17,650	₡8,825

Table 6: Current rates of Riteve of the main vehicle categories for the inspection and reinspection.

Source: [26]

For the study, the new prices are used (see table). The table also includes the fees for the second inspection in the case that a vehicle failed the first inspection.

For the CBA the average fee for the first inspection and the average fee for the second inspection have to be calculated. The vehicle population data for the years 2012 to 2015 will be used for this purpose.

Vehicle-stock in Costa Rica								
Year	Total	Vehicle types						
		Automobile	Buses/	Light load	Heavy load	Taxis	Special Equipment	Motorcycles
2012	1,134,373	722,020	16,354	160,742	35,042	12,150	11,791	176,274
2013	1,187,624	754,689	17,411	164,736	35,392	12,261	12,879	190,256
2014	1,258,183	789,260	18,554	169,864	35,897	12,420	13,455	218,733
2015	1,346,344	833,570	17,237	176,091	36,868	12,635	14,026	255,917

Table 7: Vehicle-stock for different vehicle types from 2012 to 2015

Source: [13]

Based on Table 7 and Table 6 it is possible to calculate an average weighted fee for the first and second inspection. The weighted fee per vehicle for the first inspection is ₡12,867, and for the second fee it is ₡6,432 for the vehicles, which have to pass the second inspection, and ₡3,055 related to the total vehicle-stock. Altogether the average fee for both first and second inspection per vehicle is ₡15,922 or US$26.82.

3.5.2 Social costs for PTI

Market prices must be adjusted for pure transfer payments (for example, taxes, duties, subsidies) that do not affect resource usage [27,28]. Further profits and income taxes are irrelevant [28]. That means, within the CBA the market prices have to be reduced by the taxes, which have to be paid and the profit, which is being made.

The sales tax rate in Costa Rica is 13 percent. The corporate tax is 30 percent [29]. Further, the market price has to be reduced by profits. It is assumed that Riteve has a profit rate after taxes of 10 percent.

This results in an average fee per vehicle for Riteve of US$26.82. If the taxes and the profit are deducted, this results in a social cost-rate of US$14.95.

3.6 Benefit-cost ratio

The following table shows the results for the benefit and cost estimation of introducing PTI in Costa Rica using the objective assessment method.

Year	Benefits by avoided fatalities	Benefits by avoided injuries	Total benefits	Total inspection Costs	Benefit-cost ratio
2001	-	-	-	-	-
2002	-	-	-	-	-
2003	48.9	12.6	61.6	13.4	4.6
2004	49.8	12.9	62.7	14.2	4.4
2005	50.3	13.0	63.2	14.4	4.4
2006	43.4	11.2	54.6	10.9	5.0
2007	45.5	11.7	57.3	11.9	4.8
2008	50.1	12.9	63.0	13.3	4.7
2009	51.0	13.1	64.1	13.8	4.6
2010	54.1	13.9	68.0	14.9	4.6
2011	56.4	14.5	70.9	15.8	4.5
2012	59.3	15.3	74.6	17.0	4.4
2013	57.0	14.7	71.7	17.8	4.0
2014	61.5	15.9	77.4	18.8	4.1
2015	81.5	21.0	102.5	20.1	5.1

Table 8: Social benefits, social costs in billion US$ and the benefit-cost ratio for introducing PTI in Costa Rica based on the objective assessment method.

Source: own calculation.

The next table gives an overview of the BCRs derived by using the cost-unit rates of the subjective method. However, both results show that Riteve contributes to the social welfare of Costa Rica.

Year	Benefits by avoided fatalities	Benefits by avoided injuries	Total benefits	Total inspection Costs	Benefit-cost ratio
2001	-	-	-	-	-
2002	-	-	-	-	-
2003	75.7	69.4	145.1	13.4	10.9
2004	77.1	70.7	147.8	14.2	10.4
2005	77.8	71.3	149.1	14.4	10.4
2006	67.1	61.5	128.7	10.9	11.8
2007	70.5	64.6	135.1	11.9	11.3
2008	77.6	71.0	148.6	13.3	11.1
2009	78.9	72.3	151.1	13.8	10.9
2010	83.7	76.7	160.3	14.9	10.8
2011	87.3	80.0	167.2	15.8	10.6
2012	91.8	84.1	175.9	17.0	10.4
2013	88.3	80.9	169.1	17.8	9.5
2014	95.2	87.2	182.4	18.8	9.7
2015	126.1	115.5	241.7	20.1	12.0

Table 9: Social benefits, social costs in billion US$ and the benefit-cost ratio for introducing PTI in Costa Rica based on the subjective assessment method.

Source: own calculation.

4. Limitations

The BCR derived from the objective assessment methods are more reliable than the BCR derived from the subjective assessment. The objective assessment used health costs and GDP values of Costa Rica. The plausibility of those values could be checked by using an empirical formula. Contrary to that, the cost-unit rates used for the subjective methods could be only derived by using an empirical formula without empirical evidence by data from Costa Rica. However, the WTP-cost-unit rates indicate that the benefits might be higher than the estimated benefits by the objective assessment. The policy recommendation is to derive Costa Rica-specific WTP values. The WTP values for Costa Rica should be based on questionnaires in which people, directly or indirectly, are asked how much they are willing to pay for more safety (=stated preferences), or

on actual behavior (for example buying cars with more safety components, buying newer cars) (=revealed preferences).

The reduction of accidents with property damages by Riteve is not calculated because of missing data. Therefore, the actual benefits of Riteve are higher than the calculated benefits.

A standardized national accounting for the economic costs of road accidents does not exist in Costa Rica. Therefore, it was necessary to derive national cost unit rates only based on GDP-data and health costs. It is recommended to establish an economic assessment framework, which can be used to assess all kind of transport measures. This would ease the comparison of different measures and allocate the public budget to the most effective measures.

The implementation of the calculation procedure for the economic costs of road accidents could decide whether the objective or subjective assessment method is appropriate for the resource allocation of the Costa Rican economy.

Other costs related to accidents (for example administrative costs, congestion costs) are not considered because of missing detailed information.

5. Conclusion

The implementation of Riteve has a significant and measurable effect on the reduction of road accidents in Costa Rica. It is possible to estimate the number of avoided road accidents, the avoided fatalities and the number of the avoided injured persons. Using two alternative economic assessment methods (objective and subjective assessment) demonstrate that the benefits of Riteve are higher than the costs of Riteve. However, the amount of the possible benefits is underestimated because other effects could not be considered because of missing data or missing information.

Abbreviations

ACC	Accidents
ARESEP	Public Service Regulatory Agency
BAST	Bundesanstalt für Straßenwesen (Federal Highway Administration) in Germany
BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CCSS	Caja Costarricense de Seguro Social (Costa Rican Social Security Fund)
COSEVI	Consejo de Seguridad Vial (Road Safety Council)
CRC	Costa Rican Colón; ₡
GDP	Gross Domestic Product
IMF	International Monetary Fund
INS	Instituto Nacional de Seguros (National Insurance Institute)
m	Million
MOPT	Ministerio de Obras Publicas y Transportes (Ministry of Public Works and Transportation)
NRSP	National Road Safety Plan
PTI	Periodical technical inspection
SOA	Seguro Obligatorio Automotor (Mandatory Automobile Insurance)
VSL	Value of Statistical Life
WHO	World Health Organization
WTP	Willingness-to-pay

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