

# Calculation of Life Cycle Costs in Green Procurement of Passenger Cars from Romania

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## *Abstract*

The article presents a method of calculating the life cycle costs of green passenger car purchases in Romania. Green purchases are purchases that take into account not only the purchase price but also the costs of maintenance and operation. Research by other authors has shown that sometimes the life cycle cost is more relevant than the purchase price and other times the purchase price is more relevant than the life cycle cost. In order to determine which of the two is more relevant, the life cycle costs were calculated for three representative passenger car models for the Romanian market in 2018 (Ford Fiesta, Hyundai i20 and Opel Corsa), costs that were compared to purchase prices. Also, the main problems found in estimating the life cycle costs were identified.

*Keywords:* green procurement, cost-per-life cycle, passenger car, purchase price.

*JEL classification:* H57, H83

## **1. Introduction**

Lately, green purchases have become more and more important due to the pressure of public opinion on combating the phenomenon of global warming. Thus, the governments of the EU states and around the world have implemented various legislative provisions that encourage the purchase of environmentally friendly products, passenger cars being the most important source of pollution worldwide.

The purpose of green procurement is to protect the environment and improve economic sustainability. The European Commission (2016b) defined green procurement as the processes in which contracting authorities (procurers) purchase works, goods or services that have a reduced environmental impact over the life cycle.

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Also, the United Nations 2030 Agenda for Sustainable Development attaches great importance to promoting sustainable procurement as a way to improve sustainability and as an objective of sustainable economic development (UN, 2015).

## 2. Literature review

Most of the time, ecological products have higher prices, but have lower maintenance and operating costs over the life cycle than other products on the market. European Commission (2016a) considers that green purchases represent a way to save money when considering the whole life cycle, by the quality of the materials used or the superior characteristics of the products that lead to the reduction of pollution and the resulting waste.

Ghisetti, (2017) considers that ecological purchases result in the procurement of "green" products that have a smaller impact on the environment compared to other similar products on the market, when considering the whole life cycle.

Buniamin et al., (2016) believe that public and private organizations should choose "healthier" works, products or services promoting sustainable consumption, recycling and "green" buildings, which operate with less energy.

But the purchase of green products requires methods for the evaluation of the offers more complex, easy to understand and clear. In this context, the establishment of life cycle costing methods has become particularly important even though their use is still quite limited (Parikka-Alhola and Nisinen, 2012). Such a method of calculating life cycle costs in the case of the procurement of passenger cars is presented below.

As the government is the largest buyer in a country, it can influence and stimulate the purchase of green products (Walker and Brammer, 2009). The demand for ecological products can be stimulated by governments, thus involving companies in various ecological activities (Buniamin et al., 2016).

At the level of the European Union, public authorities are the biggest consumers. Each year, public funds representing approx. 14% of the GDP of the European Union (meaning approx. 1.8 trillion euros) are spent. This huge purchasing power can be used to encourage the purchase of environmentally friendly products or services, which reduce consumption, contribute to sustainable development and reduce pollution (European Commission, 2016b).

The European public procurement directives of 2014 require that for several product categories (including passenger cars) the impact on the environment and the consumption of fuel / energy will be taken into account in the process of evaluating the offers by calculating life cycle costs (European Commission, 2016a).

The transposition of these European directives in the case of Romania was made by the issuance by the Romanian National Agency for Public Procurement (ANAP) of the Order no.1068 from 04.10.2018 for the approval of the Guide regarding the green public procurement. This guide contains the minimum environmental protection requirements that certain products must meet in order to be admitted to procurement procedures. In the case of motor vehicles, the guide states that the minimum requirements for environmental protection are the norm (standard) of pollution which is currently Euro 6 and the level of CO<sub>2</sub> emissions.

### **3. Research questions**

The research aims to establish the most relevant award criterion for the three passenger cars analyzed and to identify the main problems found in estimating the life cycle costs. The article tries to answer the following questions:

- Which criterion is more relevant: the lowest purchase price or the lowest life cycle cost?
- Does the ranking of the winning bidders change if the two award criteria are applied?
- What are the most important problems that arise when estimating life cycle costs?

### **4. Findings**

Romanian Law no. 98/2016 stipulates that the evaluation of the offers can be done using the following award criteria: best quality-price ratio, best quality-cost ratio, lowest price and lowest cost.

Usually, in green purchases the life cycle cost of a product is much more relevant than the purchase price. There are products on the market that have a low purchase price but have higher life-cycle maintenance and operating costs than other similar products. Calculating life cycle costs and comparing them with the purchase prices can determine which product variant is the best choice.

The present research calculates the life cycle costs and compares them with the purchase prices for the three best-selling models of passenger cars on the Romanian market in 2018, namely **Ford Fiesta**, **Hyundai i20** and **Opel Corsa**. These models are in class B, have low fuel consumption and comply with the Euro 6 pollution norm.

In the case of passenger cars, the life cycle cost consists of the purchase price, fuel costs, tires, car batteries, compulsory insurance, optional insurance, periodic inspections, accidental current repairs and the resale price at the end of operation.

The calculations that follow was based on the hypothesis that the passenger cars travel annually an estimated average run of 15,000 km, the duration of use of the cars being 10 years. Thus, it turns out that the cars travel throughout their lifetime of use a total of 150,000 km.

For the three passenger cars analyzed, the main features are detailed in Table 1.

**Table 1. The main features of the passenger cars Ford Fiesta, Hyundai i20 and Opel Corsa**

No.	Features	Ford Fiesta	Hyundai i20	Opel Corsa
1	Purchase price (VAT included) (euro)	9,800	9,090	7,873
2	Equipment version	Trend	Standard	Enjoy
3	Pollution norm	Euro 6	Euro 6	Euro 6
4	CO <sub>2</sub> level (g/km)	101	112	126
5	Motor power (HP)	86	84	70
6	Cylindrical capacity (cm <sup>3</sup> )	1,100	1,248	1,229
7	Number of engine cylinders	3	4	4
8	Torque (Nm)	110	122	115
9	Engine distribution type	chain	belt	chain
10	Traction type	front traction	front traction	front traction
11	Gearbox	5-speed manual	5-speed manual	5-speed manual
12	Maximum speed (km/h)	170	170	162
13	Acceleration 0-100 km/h (s)	14.0	12.8	16.0
14	Number of doors	4	4	4
15	Fuel used	gasoline	gasoline	gasoline
16	Extra-urban consumption (l/100 km)	3.7	4.8	5.0
17	Urban consumption (l/100 km)	5.6	6.8	7.4
18	Mixed consumption (l/100 km)	4.4	5.6	5.8
19	Real consumption (l/100 km)	6.4	7.6	7.8
20	Fuel tank capacity (liters)	42	50	45
21	Total length (mm)	4,040	4,035	4,021
22	Width of car (mm)	1,734	1,734	1,746

No.	Features	Ford Fiesta	Hyundai i20	Opel Corsa
23	Height (mm)	1,483	1,474	1,481
24	Wheelbase (mm)	2,493	2,570	2,510
25	Maximum authorized total mass (kg)	1,640	1,580	1,605
26	Unladen mass (kg)	1,035	1,055	1,163
27	Maximum payload (kg)	605	540	442
28	Number of airbags	6	6	46
29	Air conditioning	YES	YES	YES
30	Luggage volume (liters)	303	301	285
31	Type of tires	185/65 R15	185/65 R15	185/65 R15

Sources: web sites <https://www.hyundai-motor.ro/remat-i20>;  
[http://www.hyundaitimisoara.ro/asset/oferta\\_pdf/noul\\_i20/i20-ledline.pdf](http://www.hyundaitimisoara.ro/asset/oferta_pdf/noul_i20/i20-ledline.pdf);  
<https://www.hyundai-motor.ro/noua-generatie-hyundai-i20-spatiu-si-dotari-imbinat-armonios>;  
<http://www.automarket.ro/masini-noi/hyundai/i20-125-benzina-mpi-84cp-man5-comfort-111485/specificatii.html>;  
<http://radacini.ro/oferte-speciale/opel-corsa-70cp-oferta-stoc/>;  
<https://www.opeldibas.ro/masini-in-stoc/opel-corsa-enjoy/>;  
[https://rocmsimages.carusseldwt.com/getImage/Downloads/www\\_opeldealer\\_ro/doc\\_1539848067439\\_ro\\_corsa\\_2018\\_10\\_10.pdf](https://rocmsimages.carusseldwt.com/getImage/Downloads/www_opeldealer_ro/doc_1539848067439_ro_corsa_2018_10_10.pdf);  
<https://www.ford.ro/autoturisme/fiesta/caracteristici>;  
<https://www.cars-data.com/ro/ford-fiesta-1.1-85cp-trend-specs/75702>

The main costs considered for calculating the life cycle cost for each of the three passenger cars are:

### A. The purchase price

The purchase price for Ford Fiesta passenger car is 9,800.00 euros, (VAT included), for Hyundai i20 is 9,090.00 euros, (VAT included) and for Opel Corsa is 7,873.00 euros, (VAT included) (sources: <https://www.hyundai-motor.ro/remat-i20>; <https://www.opeldibas.ro/masini-in-stoc/opel-corsa-enjoy/>; <https://www.cars-data.com/ro/ford-fiesta-1.1-85cp-trend>).

### B. Cost of fuel consumed during use

The cost of one liter of fuel (which in the case of the three passenger cars is gasoline) that was used in the calculations below was 6.50 lei / liter (VAT included) and the exchange rate lei / euro taken into account was 4.70 lei (source: The Romanian National Regulatory Authority for Energy - Statistics of the cost of fuel on the Romanian market).

In order to take into account the real conditions of the road traffic in Romania, the fuel consumption taken considered will be the mixed consumption increased by 2 liters per 100 km.

The cost of fuel consumed during the use of the three passenger cars analyzed is:

- Ford Fiesta passenger car:

$$\begin{aligned} & \text{annual distance} \times \text{liter price of gasoline} \times (\text{mixed consumption} + 2.0 \text{ liters}) = \\ & = 15,000 \text{ km / year} \times 6.50 \text{ lei / liter} \times (4.4 + 2.0) \text{ liters / 100 km} = 6,240.00 \text{ lei / year} \end{aligned}$$

- Hyundai i20 passenger car:

$$\begin{aligned} & \text{annual distance} \times \text{liter price of gasoline} \times (\text{mixed consumption} + 2.0 \text{ liters}) = \\ & = 15,000 \text{ km / year} \times 6.50 \text{ lei / liter} \times (5.6 + 2.0) \text{ liters / 100 km} = 7,410.00 \text{ lei / year} \end{aligned}$$

- Opel Corsa passenger car:

$$\begin{aligned} & \text{annual distance} \times \text{liter price of gasoline} \times (\text{mixed consumption} + 2.0 \text{ liters}) = \\ & = 15,000 \text{ km / year} \times 6.50 \text{ lei / liter} \times (5.8 + 2.0) \text{ liters / 100 km} = 7,605.00 \text{ lei / year} \end{aligned}$$

### C. Cost of maintenance and operation

The cost of maintenance and operation consists of the costs detailed in the following:

- **the cost of service inspections.** Service inspections are performed according to the manufacturer's rules and recommendations annually or when a certain distance is traveled.

The estimated average annual cost of a service inspection for the Ford Fiesta passenger car is 450.00 lei / year, resulting in an estimated total cost of 4,500.00 lei.

The estimated average annual cost of a service inspection for the Hyundai i20 passenger car is 650.00 lei / year, resulting in an estimated total cost of 6,500.00 lei and the estimated average annual cost of a service inspection for the Opel car Corsa is 600.00 lei / year, resulting in a total estimated cost of 6,000.00 lei (sources: <https://www.hyundai-motor.ro/remat-i20>; <https://www.opeldibas.ro/masini-in-stoc/opel-corsa-enjoy/>; <https://www.cars-data.com/ro/ford-fiesta-1.1-85cp-trend>).

The differences between the values of the above service inspections are justified by the following considerations:

- Ford Fiesta engine has only three cylinders, the smallest cylindrical capacity and the type of distribution is on chain, which leads to lower service costs (smaller number of spark plugs replaced, replacement of the distribution is done after 150,000 km, less engine verifications etc);

- Hyundai i20 engine has four cylinder engine and belt distribution;
- Opel Corsa engine has four cylinders and chain distribution.
- **the cost of current repairs;**

The average annual cost of the current repairs for the Ford Fiesta passenger car is 300.00 lei / year, for the 10-year service life the total estimated cost that results is 3,000.00 lei. For both Hyundai i20 and Opel Corsa passenger cars, the average annual cost of current repairs is 400.00 lei / year, the total estimated cost being 4,000.00 lei (sources: <https://www.hyundai-motor.ro/remat-i20>; <https://www.opeldibas.ro/masini-in-stoc/opel-corsa-enjoy/>; <https://www.cars-data.com/ro/ford-fiesta-1.1-85cp-trend>).

The explanation for the difference of 1,000.00 lei is the superior reliability of the Ford Fiesta car compared to the other two models.

- **the cost of periodically replacing of the tires;**

A replacement of four tires will be considered after every 30,000 km., the tire type being identical for all three passenger cars analyzed.

For all three types of passenger cars, the cost of regular tire replacement is:

$$4 \text{ tires} \times 200 \text{ lei / tire} = 800.00 \text{ lei / periodic replacement}$$

(sources: <https://www.best-tires.ro/anvelope-vara/185/65/R15>; <https://www.anvelope-autobon.ro/catalog-anvelope/cauciucuri-185-65-r15/>).

Also, **the cost due to the replacement of the batteries** is the same for the three types of cars, respectively 580.00 lei, because during the 10 years of use, the batteries will be replaced twice, once at every four years of use. Currently the price of a premium car battery is approx. 290.00 lei / piece (sources: [https://www.neobat.ro/baterii-auto-exide/capacitate-50\\_ah](https://www.neobat.ro/baterii-auto-exide/capacitate-50_ah); <https://sorgeti.ro/baterie-auto-exide-50ah>).

- **the cost with the compulsory insurance;**

The estimated average cost of compulsory insurance for a car that has an engine with a cylinder capacity between 1,000 and 1,100 cm<sup>3</sup> (Ford Fiesta passenger car) is 390.00 lei / year resulting in the lifetime a value of 3,900.00 lei.

The estimated average cost of compulsory insurance for a passenger car that has an engine with a cylinder capacity between 1,200 and 1,400 cm<sup>3</sup> (Hyundai i20 and Opel Corsa passenger cars) is 580.00 lei / year, resulting in the lifetime a value of 5,800, 00 lei (source: Romanian Financial Supervisory Authority – Car Insurance Sector - Statistics on the Romanian market).

- **the cost with the optional insurance.**

The cost with the optional insurance for the lifetime of the Ford Fiesta passenger car is 10,000.00 lei (meaning 1,000.00 lei / year) and for Hyundai i20 and Opel Corsa passenger cars is 12,000.00 lei (1,200.00 lei / year) (source: Romanian Financial Supervisory Authority – Car Insurance Sector - Statistics on the Romanian market).

The legal provisions in force mention that, in calculating the life cycle cost, all the annual costs related to the operation and maintenance of the vehicles will be taken into account, to which the discount rate for the respective year will be applied, so that all costs will be expressed in the year in which the procurement is made.

By the Joint Order of President of Romanian National Procurement Agency (ANAP) and of the president of the Romanian National Forecast Commission no.1170 / 2017, the level of the discount rate that will be used in 2018 for the award of contracts that use “the lowest cost” award criterion was set at 4.5%.

For the Ford Fiesta passenger car, the total discounted maintenance and operation cost is detailed in Table 2. The total discounted maintenance and operating cost was calculated using the formula  $1 / (1 + a)^n$ , where  $n = 1, 2, \dots, 10$  (number of life cycle years) and the coefficient  $a$  is the discount rate.

**Table 2. The total discounted maintenance and operation cost for Ford Fiesta**

Year / Cost	1	2	3	4	5	6	7	8	9	10
Cost of fuel (lei)	6,240	6,240	6,240	6,240	6,240	6,240	6,240	6,240	6,240	6,240
Cost of service inspections (lei)	450	450	450	450	450	450	450	450	450	450
Cost of current repairs (lei)	300	300	300	300	300	300	300	300	300	300
Cost of the tires (lei)	0	800	0	800	0	800	0	800	0	800
Cost of the batteries (lei)	0	0	0	290	0	0	0	290	0	0
Cost of compulsory insurance (lei)	390	390	390	390	390	390	390	390	390	390
Cost with the optional insurance (lei)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Cost of maintenance and operation (lei)	8,380	9,180	8,380	9,470	8,380	9,180	8,380	9,470	8,380	9,180
Discount factor for $a =$	0.957	0.916	0.876	0.839	0.802	0.768	0.735	0.703	0.673	0.644



Year / Cost	1	2	3	4	5	6	7	8	9	10
4.5%										
Discounted maintenance and operation cost (lei)	8,020	8,409	7,341	7,945	6,721	7,050	6,159	6,657	5,640	5,912
Total discounted maintenance and operation cost (lei)	<b>69,854.00</b>									
Total discounted maintenance and operation cost (euros)	<b>14,863.00</b>									

Source: own calculations

For the Hyundai i20 passenger car, the total discounted maintenance and operation cost is detailed in Table 3.

**Table 3. The total discounted maintenance and operation cost for Hyundai i20**

Year / Cost	1	2	3	4	5	6	7	8	9	10
Cost of fuel (lei)	7,410	7,410	7,410	7,410	7,410	7,410	7,410	7,410	7,410	7,410
Cost of service inspections (lei)	650	650	650	650	650	650	650	650	650	650
Cost of current repairs (lei)	400	400	400	400	400	400	400	400	400	400
Cost of the tires (lei)	0	800	0	800	0	800	0	800	0	800
Cost of the batteries (lei)	0	0	0	290	0	0	0	290	0	0
Cost of compulsory insurance (lei)	580	580	580	580	580	580	580	580	580	580
Cost with the optional insurance (lei)	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Cost of maintenance and operation (lei)	10240	11040	10240	11330	10240	11040	10240	11330	10240	11040
Discount factor for a = 4.5%	0.957	0.916	0.876	0.839	0.802	0.768	0.735	0.703	0.673	0.644
Discounted maintenance and operation cost (lei)	9,800	10,113	8,970	9,506	8,212	8,479	7,526	7,965	6,892	7,110
Total discounted maintenance and operation cost (lei)	<b>84,572.00</b>									
Total discounted maintenance and	<b>17,994.00</b>									

Year / Cost	1	2	3	4	5	6	7	8	9	10
operation cost (euros)										

Source: own calculations

For the Opel Corsa passenger car, the total discounted maintenance and operation cost is detailed in Table 4.

**Table 4. The total discounted maintenance and operation cost for Opel Corsa**

Year / Cost	1	2	3	4	5	6	7	8	9	10
Cost of fuel (lei)	7,605	7,605	7,605	7,605	7,605	7,605	7,605	7,605	7,605	7,605
Cost of service inspections (lei)	600	600	600	600	600	600	600	600	600	600
Cost of current repairs (lei)	400	400	400	400	400	400	400	400	400	400
Cost of the tires (lei)	0	800	0	800	0	800	0	800	0	800
Cost of the batteries (lei)	0	0	0	290	0	0	0	290	0	0
Cost of compulsory insurance (lei)	580	580	580	580	580	580	580	580	580	580
Cost with the optional insurance (lei)	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Cost of maintenance and operation (lei)	10385	11185	10385	11475	10385	11185	10385	11475	10385	11185
Discount factor for a = 4.5%	0.957	0.916	0.876	0.839	0.802	0.768	0.735	0.703	0.673	0.644
Discounted maintenance and operation cost (lei)	9,938	10,245	9,097	9,628	8,329	8,590	7,633	8,067	6,989	7,203
<b>Total discounted maintenance and operation cost (lei)</b>	<b>85,720.00</b>									
<b>Total discounted maintenance and operation cost (euros)</b>	<b>18,238.00</b>									

Source: own calculations

#### D. Resale price at end of service life

At the end of the service life, the resale price for a 10-year-old Ford Fiesta is 2,900 euros. For the Hyundai i20, this price is 2,700 euros and for the Opel Corsa is 2,800 euros (sources: <https://www.autovit.ro/autoturisme/hyundai-i20/2008;>

<https://www.olx.ro/autoturisme/-opel-corsa-2008/>;  
<https://www.bestauto.ro/auto/ford/fiesta/2008>).

At the end of the service life, the resale price is subtracted from the cost calculated on the life cycle, because this value is received by the current owner of the passenger car from the next owner, after the completion of the sale-purchase process.

## 5. Discussion

The main life cycle cost elements for the three passenger cars analyzed are presented in Table 5.

**Table 5. Life cycle costs for Ford Fiesta, Hyundai i20 and Opel Corsa**

No	Price / cost	Ford Fiesta	Hyundai i20	Opel Corsa
1	Purchase price (euros)	<b>9,800.00</b>	<b>9,090.00</b>	<b>7,873.00</b>
2	Total discounted maintenance and operation cost (euros)	14,863.00	17,994.00	18,238.00
3	Resale price at end of service life (euros)	2,900.00	2,700.00	2,800.00
<b>The cost of the passenger car on the life cycle (euros)</b>		<b>21,763.00</b>	<b>24,384.00</b>	<b>23,311.00</b>
<b>Cost per kilometer (euros/km)</b>		<b>0.145</b>	<b>0.163</b>	<b>0.155</b>

*Source:* own calculations

The following conclusions are drawn from the data analysis in the table above:

- if the award procedure had been carried out using the award criterion “lowest price”, the ranking would be the one presented in Table 6;

**Table 6. Ranking in case of applying the award criterion “the lowest price”**

Award criterion	The lowest price		
	No.	Passenger car	Position in ranking
	1	Opel Corsa	1 <sup>st</sup> place
	2	Hyundai i20	2 <sup>nd</sup> place
	3	Ford Fiesta	3 <sup>rd</sup> place

*Source:* based on the data in Table 5

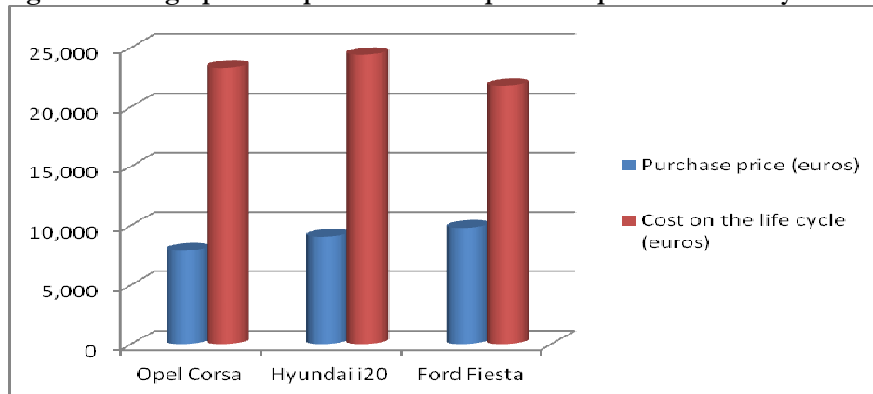
- if the award procedure had been carried out using the award criterion “the lowest cost”, the ranking would be the one presented in Table 7;

**Table 7. Ranking in case of application of the "lowest cost" award criterion**

Award criterion	The lowest cost		
No.	Passenger car	Position in ranking	Cost on the life cycle (euros)
1	Ford Fiesta	1 <sup>st</sup> place	21,763.00
2	Opel Corsa	2 <sup>nd</sup> place	23,311.00
3	Hyundai i20	3 <sup>rd</sup> place	24,384.00

*Source:* based on the data in Table 5

The graphical representation of purchase prices and life cycle costs is shown in Figure 1.

**Figure 1. The graphical representation of purchase prices and life cycle costs**

*Source:* based on the data in Tables 6 and 7

## Conclusions

The article presents a method of calculating the life cycle costs for the three best-selling cars in class B on the Romanian market in 2018, as well as a comparison of the situations in which the award criterion was the lowest purchase price or the lowest life cycle cost.

It can be seen that the Ford Fiesta car is in the last place of the ranking in the case of applying the criterion lowest purchase price and in the case of applying the award criterion the lowest life cycle cost, more relevant, is in the first place of the ranking.

The difference between the life cycle costs of passenger cars on the 1st and 3rd places (Ford Fiesta and Hyundai i20) is worth 2,621 euros / car. This difference can become much larger when purchasing and operating a fleet containing a large number of passenger cars.

For the three passenger cars analyzed, research has shown that the cost per life cycle is more relevant than the acquisition price. This conclusion coincides with the findings of other authors and is in line with the definition of green public procurement of the EU.

The main problem found in estimating the life cycle costs is the accuracy with which the operating and maintenance costs are estimated because these costs may vary depending on the prices / tariffs practiced by the companies that sell fuel, repair cars or sell insurance. Also, the resale price of the vehicles can vary greatly in the same country depending on the prestige of the brand of the vehicle sold, the size of the market, the sales area, the preferences of the buyers, etc. All these elements can be appealed by the tenderers who have not won the procurement procedure.

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