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ECONOMIC CALCULATION OF CO_2 EMISSIONS FROM VEHICLES IN THE CONTEXT OF THE SUSTAINABLE DEVELOPMENT OF THE ROAD TRANSPORT SYSTEM

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Abstract: *This paper presents an applied investigation of the technical characteristics of carbon dioxide (CO_2) emissions produced during the combustion processes in internal combustion engines used in road vehicles. Also, it is presented an economic justification for the CO_2 emissions. Furthermore, the quantity of CO_2 generated per liter of fuel was calculated for various fuel types. Based on combustion equations, the resulting CO_2 emissions from gasoline- and diesel-powered vehicles were then analyzed in relation to different operating parameters. The paper also presents the financial resources regarding the cost of CO_2 emitted by the analyzed cars. The paper aim is to raise awareness of the environmental and global warming impacts of old and new vehicles with petrol, diesel or LPG engines using real-life cases.*
Key words: *car fuels, car lifespan, spark-ignition engine (SI engine), compression ignition engine (CI engine), air pollution, GHG emissions, emissions certificate***.**

1. INTRODUCTION

According to European Parliament data, transport-related activities account for a significant share of total CO_2 emissions, with road transport contributing approximately 72% [1]. Despite ongoing technological improvements in fuel efficiency, total emissions have not decreased significantly, primarily due to the increasing number of vehicles relying on internal combustion engine technology.

Road vehicles powered by fossil fuels represent a major contributor to air pollution, alongside industrial activities and other transportation systems. The combustion of these fuels within internal combustion engines leads to the release of greenhouse gases, which significantly impact environmental quality and human health [2].

Various studies show that motor vehicle emissions represent a significant contribution to the overall level of harmful substances released into the environment.

The manufacturing sector remains the largest consumer of fossil fuels, followed by transport-related activities. Around 25% of all dangerous air emissions come from vehicle-generated CO_2. [5].

A variety of driving techniques, generally known as eco-driving or defensive driving, have been encouraged because improving fuel efficiency in practice depends on how vehicles are driven. These approaches aim to achieve comparable objectives, particularly in terms of safety, efficiency, and less environmental effect, even if they are not the same as preventive driving.

Driving defensively is different from driving preventively because the latter focuses only on traffic safety. Respecting each other's laws and principles improves road safety, lowers the number of accidents, reduces fuel consumption, noxious pollution levels, and traffic noise levels.

From an economic perspective, decisions related to vehicle operation can be supported by estimating the costs associated with fuel consumption and emissions. This approach enables a more accurate evaluation of resource utilization within transport processes. [6].

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Fuel consumption, safety considerations, traffic conditions, infrastructure, and environmental factors must all be considered when analysing vehicle operation. From the standpoint of CO_2 emissions, eco-driving is defined by driving behaviours that minimize fuel consumption, thereby reducing emissions.

Experts in the field conduct in-depth research in this area, in order to highlight the good manners and practices of operating road transport in optimal conditions, by presenting the techniques and methods of driving cars that do not cause damage to the environment, but also the harmful effects that exhaust fumes have on human health, on flora and fauna, on the habitats where people live.

2. ECO-DRIVING RULES

Eco-driving practices consist of a set of operational guidelines aimed at reducing fuel consumption and minimizing pollutant emissions during vehicle use:

- verifying the technical condition of the vehicle prior to departure;
- achieving engine warm-up through vehicle operation rather than prolonged idling;
- switching off the engine during extended stationary periods;
- maintaining a safe following distance between vehicles, adapted to driving speed;
- adopting anticipatory driving behavior, prioritizing gradual deceleration instead of abrupt braking;
- avoiding aggressive driving styles, including rapid acceleration or high-speed operation;
- minimizing sudden braking events;
- preventing excessive acceleration during vehicle start-up;
- selecting appropriate gear ratios in a timely manner to ensure efficient engine operation;
- maintaining smooth vehicle control by avoiding abrupt steering or input variations;
- reducing unnecessary vehicle load by removing excess items;
- regularly monitoring and adjusting tire pressure (e.g., at intervals of 500–1000 km or periodically);
- removing external accessories (such as roof racks or bicycle carriers) when not required;
- limiting the use of auxiliary onboard systems that are not essential;
- performing maintenance activities at appropriate service intervals;
- using manufacturer-recommended components and materials in maintenance and repair operations;
- utilizing engine braking during downhill driving to reduce fuel consumption;
- applying energy recuperation techniques during deceleration or downhill operation (specific to hybrid and electric vehicles);
- planning trips in advance to identify efficient routes and reduce unnecessary travel;
- optimizing transportation efficiency by ensuring appropriate vehicle loading and route utilization.

We consider that the rule of two seconds has a defining role in ecological driving, but also in preventive driving (Fig. 1 [7]).

However, a more accurate interpretation of

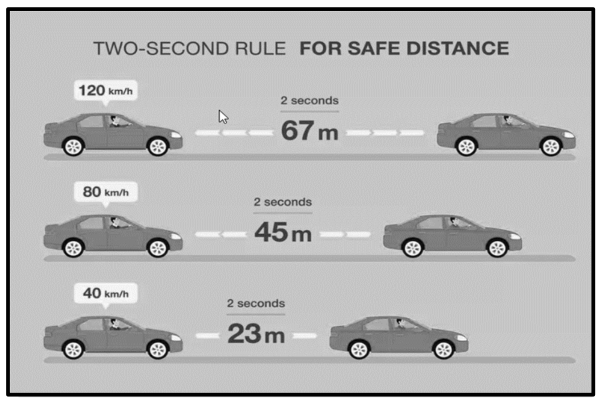

Fig. 1 The two second rule in preventive/defensive driving

this rule indicates that, at a speed of 40 km/h, a vehicle travels approximately 22.2 m within a two-second interval, as calculated based on the corresponding velocity conversion.

However, when accounting for vehicle geometry, the effective spacing between the rear of the leading vehicle and the front of the following vehicle, as illustrated in the figure, is decreased by the vehicle length.

For example, assuming a vehicle length of 5 m, an initial distance of 22.2 m—corresponding to a speed of 40 km/h and a time interval of two seconds—decreases to 17.5 m. Similar calculations can be applied to higher speeds, such as 80 km/h and 120 km/h, yielding proportionally adjusted distances.

The application of the two-second rule effectively increases the psychophysical reaction time from approximately 1.1–1.2 seconds, as suggested in the literature and considered in vehicle expertise analyses [8], to a more conservative value of two seconds. In real traffic conditions, these larger distances are often perceived as excessive, and drivers behind may attempt to reduce the gap or overtake, considering it unnecessary.

Even so, the rule remains particularly useful for less experienced drivers, as the additional reaction time contributes to safer vehicle operation and allows a greater margin for error.

3. THEORETICAL CONSIDERATIONS REGARDING CHEMICAL NOXIOUS EMISSIONS FROM VEHICLES

Fuel oxidation causes internal combustion engines to produce exhaust gases during operation, which releases pollutants into the atmosphere.

The modern human society is aware of a constant evolution brought about by advances in science and technology.

Alterations in atmospheric composition, whether through changes in concentration or the introduction of harmful substances, have direct consequences on ecosystems and human health.

The oxidation of carbon-based fuels within engine cylinders leads to the formation of carbon dioxide (CO_2), which is a major greenhouse gas contributing to the enhancement of the greenhouse effect and global warming. When dissolved in water, CO_2 reacts to form carbonic acid (H_2CO_3), thereby influencing chemical processes in natural environments.

As a result of this process, the phenomenon of surface water acidification occurs, especially sea and ocean water.

To demonstrate in practice the amount of CO_2 and H_2O emitted by a car's internal combustion engine per 1 km driven, we have presented a few chemical concepts next.

The quantities of the two chemical compounds were determined and expressed in kg/liter, based on the combustion processes occurring in spark-ignition (SI) and compression-ignition (CI, or diesel) engines operating on primary carbon-based fuels. On this basis, the corresponding combustion equations for gasoline, diesel, and LPG were formulated and analyzed. From a chemical perspective, these fuels can be primarily characterized as mixtures of alkanes.

Alkanes are saturated hydrocarbons, i.e., molecules consisting only of carbon (C) and hydrogen (H) atoms, where neighbouring carbon atoms are bonded by single C-C bonds.

All other valencies of carbon are satisfied by hydrogen, hence the term *saturated*. The formula of a non-cyclic alkane is C_nH_{2n+2}, where n is a non-zero natural number. From n = 3 upwards, the molecule can be branched (called isoalkane).

Some examples are methane (CH_4), n = 1; ethane (C_2H_6), n = 2; propane (C_3H_8), n = 3; butane and isobutane (C_4H_{10}), n = 4; pentane (C_5H_{12}), n = 5; hexane (C_6H_{14}), n = 6 and so on.

An alkene is a partially unsaturated hydrocarbon (containing C=C double bonds). Aromatic compounds are unsaturated molecules that are based on a ring of six carbon atoms, each bonded to its neighbours by a double bond and a single bond respectively.

The simplest form is benzene, C_6H_6.

Benzene is a homogeneous mixture of hydrocarbons (mainly isoalkanes, cycloalkanes and aromatic compounds) of relatively low molecular weight (n = 4-12), plus various additives.

The compressive strength of gasoline (up to detonation) is measured by comparison with that of isooctane (n = 8).

Liquefied petroleum gas, LPG, is a flammable mixture of saturated and unsaturated short-chain hydrocarbons (n = 3-4), mainly propane and butane, in a ratio of 40/60 or 50/50.

On combustion (complete oxidation), an alkane $C_nH_{(2n+2)}$ emits a quantity of CO_2 equal to 44n g/mol (where 44 is the molecular mass of CO_2), as well as H_2O vapour in the amount of 18(n+1) g/mol (where 18 is the molecular mass of water).

Diesel consists of long-chain hydrocarbons (n = 10-15), about 75% saturated and about 25% aromatic, plus the necessary additives. The compression ignition performance of diesel is measured by comparison with cetane (n = 16, also called hexadecane).

3.1 CO_2 and H_2O Emissions per Liter of Gasoline Fuel

In emission calculations, gasoline is represented by octane (C_8H_{18}), a typical hydrocarbon component. Its molar mass is 114 g/mol, obtained from the atomic composition of carbon and hydrogen. Under complete combustion, one mole of octane produces about 352 g of CO_2 and 162 g of H_2O. Based on these results, the emission factors are approximately 3.09 g of CO_2 and 1.42 g of H_2O per gram of fuel.

If a gasoline density of 0.740 kg/L is considered, the same values can be expressed per unit volume. In this case, the combustion of one liter of gasoline generates roughly 2.28 kg of CO_2 and 1.49 kg of water vapor. The total mass of combustion products relative to the fuel mass is therefore around 4.46.

3.2 Diesel Fuel Emissions: CO_2 and H_2O Analysis

In this analysis, diesel is represented by hexadecane (n=16), with a molar mass of 226 g/mol. During complete combustion, one mole produces about 704 g of CO_2 and 306 g of H_2O.

These values correspond to approximately 3.11 g CO_2 and 1.35 g H_2O per gram of fuel. When a density of 0.850 kg/L is considered, the results can be expressed per liter, giving about 2.64 kg CO_2 and 1.55 kg H_2O per liter of fuel. The ratio between the total combustion products and the initial diesel mass is close to 4.53.

3.3 LPG Fuel Emissions: CO_2 and H_2O Analysis

For the purposes of this analysis, LPG is treated as a mixture of propane and butane in equal proportions, which leads to an average carbon number of n=3.5.

Under complete combustion, one mole of this mixture produces approximately 154 g of carbon dioxide (CO_2). This corresponds to an emission factor of about 3.02 g CO_2 per gram of fuel.

Considering a fuel density of 0.55 kg/L at 15 °C, the emissions can also be expressed on a volumetric basis, resulting in approximately 1.66 kg CO_2 per liter of LPG. The ratio between the total mass of combustion products and the initial fuel mass is therefore close to 3.

The main characteristics of the fuels used in SI and CI engines are depicted in Table 1.

Table 1

Fuel Characteristics for SI and CI Engine Applications

Type and make of the car	Value/t CO_2 (euro)	CO_2/total km travelled (tons)	CO_2/year old (tons)	BNR course leu/euro	TOTAL			
					CO_2 value/total km travelled (euro)	CO_2 value/total km travelled (lei)	CO_2 value/year of age (euro)	CO_2 value/year of age (lei)
1	*2*	*3*	*4*	*5*	*6 (2x3)*	*7 (5x6)*	*8 (2x4)*	*9 (5x8)*
RENAULT CAPTUR 1.5 dCI, Euro 5	90.78	3.692	1.846	4.9427	335	1,657	168	828
VOLKSWAGEN JETTA 2.0 TDI, Euro 4	90.78	34.688	2.313	4.9427	3,148	15,564	210	1,038
RENAULT SYMBOL 1.5 dCI, Euro 3	90.78	26.667	1.269	4.9427	2,422	11,985	142	704

* Mass mixture propane-butane 50/50

4. ECONOMIC CALCULATION OF THE AMOUNT OF CARBON DIOXIDE THAT AUTOMOBILE ENGINES RELEASE INTO THE ATMOSPHERE

The economic analysis of CO_2 emissions was based on a sample of passenger vehicles. This sample consisted of six gasoline vehicles with emission standards from Euro 3 to Euro 6, three diesel vehicles meeting Euro 3 to Euro 5 requirements, and one hybrid vehicle classified as Euro 6.

Given that the greenhouse effect is primarily driven by carbon dioxide (CO_2), a major greenhouse gas responsible for global warming [9,10], it is essential to quantify the amount of CO_2 emitted by vehicle engines. Therefore, the present study begins with the calculation of CO_2 emissions based on the methodologies outlined below.

CO_2 emissions were computed based on combined fuel consumption values (urban and extra-urban) and the actual distance travelled by each vehicle at the time of analysis.

CO_2 emissions in kg/km can be calculated using the following relationship:

$$Q_{CO2} = \frac{CC \times CCO2}{100} \quad [\text{kg/km}], \qquad (1)$$

where:

Q_{CO2} - CO_2 emissions per unit distance (kg/km);

CC – fuel consumption (L/100 km);

C_{CO2} –CO_2 emission factor of the fuel (kg/L).

Table 2 shows the calculated CO_2 emissions for vehicles with SI engines, based on relation (1). The results take into account both the total mileage and the vehicle age.

Table 3 provides the corresponding CO_2 emission results for vehicles equipped with CI engines, considering the total distance traveled and the years of operation.

The European Union introduced the Emission Trading System (ETS) as a regulatory framework intended to reduce greenhouse gas emissions by creating a market for carbon allowances [11]. This mechanism contributes to meeting the climate targets defined in the Fit for 55 legislative packages. This initiative comprises a set of legislative proposals and revisions to existing European Union regulations, aimed at reducing net greenhouse gas (GHG) emissions. The package establishes a target of at least a 55% reduction in emissions by 2030 relative to 1990 levels, alongside the long-term goal of achieving climate neutrality by 2050, as mandated by the European Climate Law [12].

Table 2

Assessment of CO_2 Emissions in Relation to Cumulative Distance and Vehicle Age for Vehicles Equipped with SI Engines

The type and make of the car	Pollution norm	Fuel consumption (l/100km)	CO_2 emitted (kg/l combustible)	Tachometer (actual km)	Age	CO_2 (kg/km)	TOTAL	
							CO_2/km travelled (tons)	CO_2/1 year old* (tons)
1	*2*	*3*	*4*	*5*	*6*	*7 (3x4)/100*	*8 (5x7)*	*9 (8:6)*
TOYOTA RAV 4 hybrid	Euro 6	4.6	2.28	25,696	3	0.10448	2.685	0.895
VOLKSWAGEN JETTA TSI	Euro 6	5.4	2.28	79,217	7	0.12312	9.753	1.393
VOLKSWAGEN JETTA TSI	Euro 5	7.3	2.28	121,244	13	0.16644	20.180	1.553
DACIA LOGAN	Euro 4	5.5	2.28	133,426	13	0.1254	16.732	1.287

The type and make of the car	Pollution norm	Fuel consumption (l/100km)	CO_2 emitted (kg/l combustible)	Tachometer (actual km)	Age	CO_2 (kg/km)	TOTAL	
							CO_2/km travelled (tons)	CO_2/1 year old* (tons)
1	*2*	*3*	*4*	*5*	*6*	*7 (3x4)/100*	*8 (5x7)*	*9 (8:6)*
VOLKSWAGEN GOLF	Euro 4	7.2	2.28	238,544	16	0.16416	39.159	2.447
FORD FOCUS ZX 4 USA	Euro 3	9.2	2.28	81,525	15	0.20976	17.101	1.140
DACIA SOLENZA	Euro 3	6.7	2.28	171,161	18	0.15276	26.147	1.453

* Cars are assumed to have travelled an equal number of kilometers each year.

Table 3

Assessment of CO_2 Emissions in Relation to Cumulative Distance and Vehicle Age for Vehicles Equipped with CI Engines

The type and make of the car	Pollution norm	Fuel consumption (l/100km)	CO_2 emitted (kg/l combustible)	Tachometer (actual km)	Age	CO_2 (kg/km)	TOTAL	
							CO_2/km travelled (tons)	CO_2/1 year old* (tons)
1	*2*	*3*	*4*	*5*	*6*	*7 (3X4)/100*	*8 (5X7)*	*9 (8:6)*
RENAULT CAPTUR 1.5 dCI	Euro 5	4.0	2.64	34,960	2	0.1056	3.692	1.846
VOLKSWAGEN JETTA 2.0 TDI	Euro 4	5.5	2.64	238,897	15	0.1452	34.688	2.313
RENAULT SYMBOL 1.5 dCI	Euro 3	4.3	2.64	234,897	17	0.1135	26.667	1.569

* Cars are assumed to have travelled an equal number of kilometers each year.

The European Union ranks third in terms of CO_2 emissions in the world. The emissions trading scheme obliges all production entities (power plants, factories and plants) in the European territory to hold a permit for each tonne of CO_2 emitted. Going by the "polluter pays" principle, this aspect provides financial incentives to pollute less. So, the less you pollute, the less you pay and vice versa. Polluting organizations are obliged to buy permits at auction, the price being influenced by supply and demand.

On June 24, 2021, the European Parliament adopted the European Climate Law, reinforcing the regulatory framework for greenhouse gas emissions and supporting the achievement of the objectives defined within the European Green Deal [13].

The new legislation brings major benefits in terms of water, air, land, cheaper energy, housing renovation, efficient public transport, increasing the number of charging stations for electric vehicles, reducing waste of all kinds, food and better living for the present and next generations. As regards road transport, the European Commission has requested the reduction of the pollution threshold from motor vehicles (cars and trucks) by another 15% starting from 2025, continued with a decrease of 55% for cars and 50% for trucks until 2030, reaching zero emissions in 2035. In other words, one can speak in this context of the development of a sustainable and sustainably developed road transport system.

To protect citizens and mitigate economic impacts under the new legislative framework, the application of the EU Emission Trading System (ETS) is initially limited to the construction and commercial road transport sectors. The inclusion of additional sectors, including private stakeholders, is expected to occur starting in 2029, subject to future proposals from the European Commission.

Emission allowances are often granted free of charge to organizations that are exposed to a significant risk of carbon leakage, particularly those that might move production to regions with less strict greenhouse gas (GHG) regulations. The EU ETS can be seen as a key component of European environmental policy, acting as a carbon market where organizations acquire emission allowances either through auctions or through free allocation [14].

In this system, organizations must monitor and report their greenhouse gas emissions according to the relevant regulatory requirements.

It is important to understand the difference between "carbon certificate" and "green certificate" because they are not the same thing.

The price of European Union Allowances (EUAs) for current allocations within the EU Emission Trading System (ETS) has increased by 4.8% in the carbon and energy market, reflecting the steady rise in CO_2 certificate prices. As of 15 August 2022, the EUA price reached a peak value of 90.78 EUR per tonne of CO_2 [15].

From this, it follows that private transports (individuals and legal entities) are not yet taxed on this principle.

These polluters do not have to obtain emission certificates until 2029, after which they will also become mandatory for private transport. In this context, we simulated by calculation the cost of CO_2 emissions for cars with SI engine and CI engine that were the object of the experimental research.

For vehicles equipped with spark-ignition (SI) engines, Table 4 presents the economic evaluation of carbon dioxide (CO_2) emissions as a function of total distance traveled and annual usage.

For cars with CI engine, Table 5 shows the economic analysis of the cost of CO_2 in proportion to the overall distance traveled and its value for each usage year.

Table 4

Economic Evaluation of CO_2 Emissions for SI Engine Vehicles as a Function of Total Distance and Annual Usage.

The type and make of the car	**Value/t CO_2 (euro)**	**CO_2/total km travelled (tons)**	**CO_2/year old (tons)**	**BNR course leu/euro**	**TOTAL**			
					CO_2 value/total km travelled (euro)	**CO_2 value/total km travelled (lei)**	**CO_2 value/year of age (euro)**	**CO_2 value of age (lei)**
1	*2*	*3*	*4*	*5*	*6 (2x3)*	*7 (5x6)*	*8 (2x4)*	*9 (5x8)*
TOYOTA RAV 4 hybrid, Euro 6	90.78	2.695	0.898	4.9427	245	1,209	82	403
VOLKSWAGEN JETTA TSI, Euro 6	90.78	9.753	1.39	4.9427	885	4,376	126	624
VOLKSWAGEN JETTA TSI, Euro 5	90.78	20.180	1.553	4.9427	1,832	9,055	141	697
DACIA LOGAN, Euro 4	90.78	16.732	1.287	4.9427	1,519	7,508	117	577

VOLKSWAGEN GOLF, Euro 4	90.78	35.159	2.447	4.9427	3,555	17,571	222	1,098
FORD FOCUS ZX 4 USA, Euro 3	90.78	17.101	1.140	4.9427	1,552	7,673	103	512
DACIA SOLENZA, Euro 3	90.78	26.147	1.453	4.9427	2,374	11,732	132	652

* The monetary value of CO_2/year of age starts from the assumption that the cars would have travelled every year an equal number of kilometers of the total resource.

Table 5

Economic Evaluation of CO_2 Emissions for CI Engine Vehicles as a Function of Total Distance and Annual Usage

The type and make of the car	**Value/t CO_2 (euro)**	**CO_2/total km travelled (tons)**	**CO_2/year old (tons)**	**BNR course leu/euro**	**TOTAL**			
					CO_2 value/total km travelled (euro)	**CO_2 value/total km travelled (lei)**	**CO_2 value/year of age (euro)**	**CO_2 value of age (lei)**
1	*2*	*3*	*4*	*5*	*6 (2x3)*	*7 (5x6)*	*8 (2x4)*	*9 (5x8)*
RENAULT CAPTUR 1.5 dCI, Euro 5	90.78	3.692	1.846	4.9427	335	1,657	168	828
VOLKSWAGEN JETTA 2.0 TDI, Euro 4	90.78	34.688	2.313	4.9427	3,148	15,564	210	1,038
RENAULT SYMBOL 1.5 dCI, Euro 3	90.78	26.667	1.569	4.9427	2,422	11,985	142	704

* The monetary value of CO_2/year of age starts from the assumption that the cars would have travelled every year an equal number of kilometers of the total resource.

5. CONCLUSIONS

The characteristics of pollutant emissions, including their volume, concentration, and composition, are strongly influenced by fuel type, vehicle design, operating conditions, and engine wear.

These specifics apply to exhaust gas emissions:

- they are taken out extremely near the runway (ground), which results in high concentrations at low altitudes. Due to their low density, such gases disperse rapidly in the atmosphere, thereby contributing to a wider environmental impact;
- large areas are subjected to it, particularly in densely populated cities. When there is heavy traffic in this area, hazardous gas concentrations are at their highest, and neighbouring building structures reduce the street's ability to ventilate.

Although LPG is often considered a cleaner alternative, its lower energy density requires higher consumption per distance travelled, which partially offsets its environmental advantages.

Due to the significantly lower density of LPG compared to gasoline and diesel, vehicles operating on LPG require approximately 25–30% higher fuel consumption per 100 km traveled.

The amount of CO_2 per kilogram of fuel will increase as the number of heavy alkanes (with higher n) increases, meaning that the gasoline ($n = 8$) and diesel ($n = 16$) generate more CO_2 than LPG ($n = 3$-4).

Although LPG is generally regarded as a more environmentally friendly fuel, it still contributes significantly to carbon dioxide (CO_2)

emissions. Nevertheless, LPG-fueled internal combustion engines produce approximately 37.12% less CO_2 than diesel engines and 27.19% less than gasoline engines when normalized per 100 km traveled. Vehicles with high mileage tend to generate higher overall environmental and economic costs, since fuel consumption over time increases the total amount of CO_2 emitted.

On the other hand, if the remaining service life is taken into account, such vehicles may have a lower future impact compared to newer ones, from an economic point of view.

This is mainly because they are already close to the end of their life cycle and have already produced most of their associated emissions. In contrast, newer vehicles, although generally more efficient, still have a longer remaining lifespan during which additional fuel consumption and associated emissions will accumulate.

Specialists estimate that the average lifespan of a car is 11.5 years (at 2015 and increased up to 12.2 in 2022) [16].

As a result of the research, we found that, analyzed by age in years, five of the seven cars with SI engine have exceeded the average life span, being towards the end of their life (Volkswagen Jetta 1,4 TSI Euro 5; Dacia Logan 1,4 MPI; Volkswagen Golf 1,6 L; Ford Focus ZX4 USA 2,0L and Dacia Solenza 1,4 MPI), i.e., 71.4% of the total gasoline vehicles used in the experimental research.

Regarding the years of age of cars with CI engine, if we consider the same figure, two out of three cars have exceeded the average lifetime (Volkswagen Jetta, 2.0 TDI and Renault Symbol 1.5 dCI), i.e., 66.66% of the total diesel cars used in the experimental research.

An analysis of the car park in Romania (at this date consisting of almost 8 million cars), shows that 3/4 of them (approximately 6,134,557 cars) are older than 11 years.

The average age of the car fleet existing at this date in our country, reported at the end of 2021, is 16.4 years [17].

These observations, suggest that gradually replacing older vehicles can help reduce CO_2 emissions and support the transition toward more sustainable mobility solutions, including electrification. This shift can be seen as an important step in the move toward electromobility.

Studies on fuel consumption in both urban and extra-urban conditions show that actual values are often higher than those declared by manufacturers. In the present study, however, the economic analysis is based on the combined fuel consumption values provided by manufacturers.

For this reason, the estimated CO_2 emissions should be considered conservative, since real driving conditions usually involve higher fuel consumption. As a consequence, the corresponding economic cost of CO_2 emissions is also likely underestimated.

At the scale of the national vehicle fleet, which exceeds 10 million vehicles, the total volume of CO_2 emissions is considerable. This situation is further influenced by the relatively high average age of vehicles, differences in their technical condition, and the limited attention given to engine selection and driving practices that could help reduce environmental impact.

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Calculul economic al emisiilor de Co₂ provenite de la autovehicule în contextul dezvoltării durabile a sistemului de transport rutier

Rezumat: *Lucrarea tratează problema emisiilor de dioxid de carbon (CO_2) produse de motoarele cu ardere internă utilizate în vehiculele rutiere, atât din perspectivă tehnică, cât și economică. Au fost estimate cantitățile de CO_2 generate per litru de combustibil pentru diferite tipuri de carburant, iar pe baza ecuațiilor de ardere au fost analizate emisiile asociate vehiculelor pe benzină și motorină, în funcție de parametri relevanți de funcționare. Studiul include și o evaluare a implicațiilor financiare legate de costul emisiilor de CO_2 pentru vehiculele investigate. Utilizarea unor exemple reale permite evidențierea impactului pe care vehiculele noi și uzate, echipate cu motoare pe benzină, motorină sau GPL, îl au asupra mediului și asupra încălzirii globale.*

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