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Selected vehicle emission assessment issues in passenger transport services

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The paper presents an analytical method for determining the pollutant emission of transport modes, based on emission indicators for various vehicle types and statistical data. The method developed enables the determination of the emission of various vehicle types without the need to carry out tests on real vehicles. The purpose of this paper is to compare the vehicle emission results obtained using the developed analytical method with the real-world results obtained in RDE tests based on a case study, i.e. an analysis of the emission of passenger transport modes in Warsaw. The paper contains a summary of the results of measurements and calculations, as well as an analysis of potential areas of application for the developed analytical method.

Key words: *vehicle emission, RDE tests, emission analysis, passenger vehicles, emission indicators*

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1. Introduction

Poland is one of the more motorised countries in the European Union. According to the data presented by Statistics Poland (GUS), in 2020 as many as 664 passenger vehicles were registered per 1,000 inhabitants, placing Poland third in relation to the other Member States [23]. The statistics compiled by GUS based on the data from the Central Register of Vehicles (CEP) show that the number of passenger vehicles in the country exceeded 25 million, the largest share of which were vehicles registered in the Mazowieckie Voivodeship (just under 4 million). The age structure of the vehicle fleet in 2020 in Poland indicates that most vehicles in use are older than 10 years. These cars accounted for more than 75% of all vehicles [24]. The statistical data, including a detailed breakdown of passenger vehicles by age, are shown in Fig. 1.

Furthermore, a dominant proportion of over 53% of passenger vehicles in 2020 were gasoline engine vehicles and over 32% were diesel engine vehicles as shown in Fig. 2. The low share of vehicles powered by alternative fuels, combined with the rather advanced age of vehicles, is indicative of the potentially high emission of passenger transport modes in Poland, especially in urban areas. Although an upward trend in the number of new vehicles, including electric vehicles, can be observed in recent years, the purchase of this type of vehicle is still unattainable for a large segment of the Polish society. Often, the most convenient choice for vehicle ownership is still buying used vehicles imported from the Western European countries. The above contributes to some of the worst air quality results in Polish cities compared to other centres in the European Union. One of the most polluted agglomerations in Poland is Warsaw, which shows one of the highest vehicle ownership rates in Europe. Warsaw also has one of the highest daily commuter vehicle inflow rates [24]. The development of transport organised via mobile apps or car sharing is also becoming apparent.

In April 2022, a report was published on the actual pollutant emission generated by transport in Warsaw [22]. The report was developed by The Real Urban Emissions Initiative (TRUE), a joint initiative of the International Automobile Federation (FIA) and the International Council on Clean Transportation (ICCT). The document contains a detailed assessment of vehicle pollutant emissions and recommendations for improving the environmental effectiveness of road transport in Warsaw. Air pollution measurements from almost 150,000 vehicles were used in the analyses. The report's main findings are that diesel vehicles significantly exceed the limits for nitrogen oxide emissions. Emissions from diesel vehicles were between 1.6 and 4.3 times higher than permitted, according to the report. For vehicles that meet the higher emission standards, requiring type-approval under real-world driving conditions (RDE tests), their emissions are lower than the highest permitted by the RDE tests, but exceed laboratory air pollutant emission standards. Furthermore, the particulate matter (PM) emissions limit was exceeded by around 1.5% of diesel vehicles. These results apply to vehicles meeting the Euro 4 standard and above. Particularly noteworthy is the fact that as many as 83% of passenger vehicles in Warsaw do not meet the emission durability conditions; a large share of passenger vehicles in Warsaw, i.e. approximately 32%, are vehicles whose average age exceeds 13 years and whose mileage exceeds 223,000 km.

Considering the above, the authors determined the actual emission of the transport modes available to a taxi corporation operating in Warsaw. Due to the high frequency of taxi use and the significant daily mileage of these vehicles, they are a significant source of emissions in urban areas. The cited report [3] presented a comparison of the emission of taxis offering services in Warsaw and Brussels. The report's authors also determined the statistics on the age and average mileage of this type of vehicles in both cities. The average age of taxis in Warsaw is around seven years, while in Brussels it is only four years. It should be noted that this difference is undoubtedly due to the restrictions placed on vehicles intended to carry passengers for a fee in Brussels. The upper age limit for these vehicles is seven years. Despite the lower average age of Warsaw taxis compared to personal vehicles, most have a mileage of over

300,000 km, which undoubtedly translates into the vehicles' higher emission relative to Brussels taxis. The report [22] also indicates, in relation to Warsaw taxis, that nitrogen oxide emissions are nearly twice as high and PM emissions more than four times as high as those of passenger transport vehicles in Brussels. If similar legal restrictions on the operation of taxis were to be adopted in Warsaw, regarding their age and technical condition, nearly 43% of the vehicles currently in use would have to be taken out of service. Replacing existing vehicles with alternatively-fuelled vehicles could reduce pollution in Warsaw by almost 60%. It can therefore be concluded that motorised transport, especially in urban areas, contributes significantly to environmental degradation and affects the comfort of living in the city.

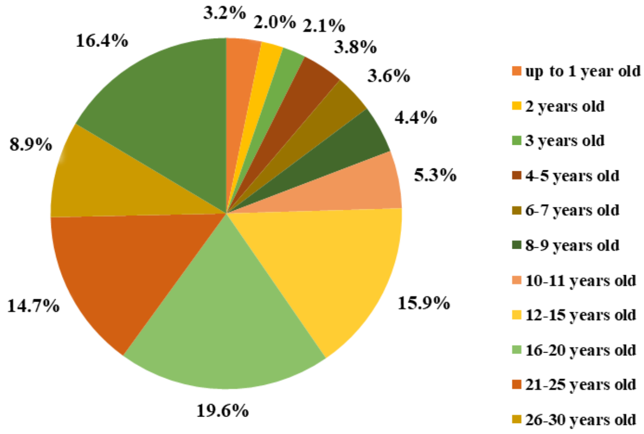

Fig. 1. Age structure of passenger vehicles in Poland in 2020 [24]

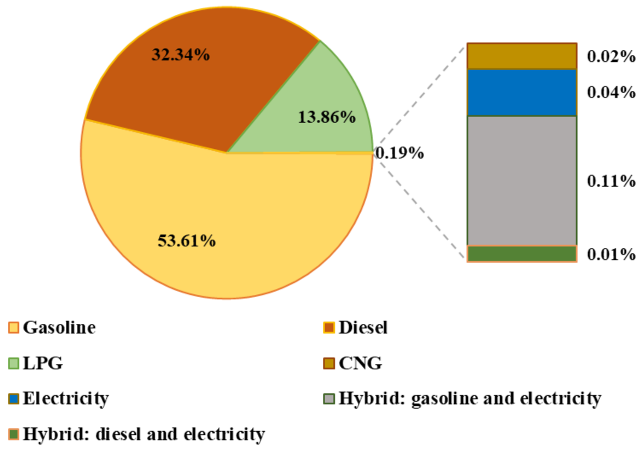

Fig. 2. Fuel type structure of passenger vehicles in Poland in 2020 [24]

The deliberations on pollutant emissions in transport presented in the paper are limited to determining the greenhouse gas emissions, such as carbon dioxide, carbon monoxide and nitrogen oxides. The above assumption is required to compare the emissions determined under the real-world conditions of the RDE road tests with the emission calculations determined by the analytical method, developed using the statistical emission indicators for transport modes defined by the authors.

2. Methodology

In the paper, the authors used the analytical indicator method of calculating the emission of transport modes to determine the emission of vehicles and the environmental impact of individual vehicle types. The diagram presenting the method is shown in Fig. 3. The emissions of main air pollutants were identified based on the report concerning the methodology for estimating air pollutant emissions in Poland, published in 2018 [34]. However, the methodology developed by GUS did not specify the values of unit emission indicators of particular types of air pollutants for selected types of road transport modes. Based on the data published by GUS, the authors of this paper determined the values of the constant emission indicators for particular types of air pollutants for:

– various types of vehicles, i.e. passenger vehicles, light-duty vehicles, heavy-duty vehicles, motorcycles and buses
– various types of fuels, i.e. gasoline, diesel and LPG
– various ranges of engine cubic capacities.

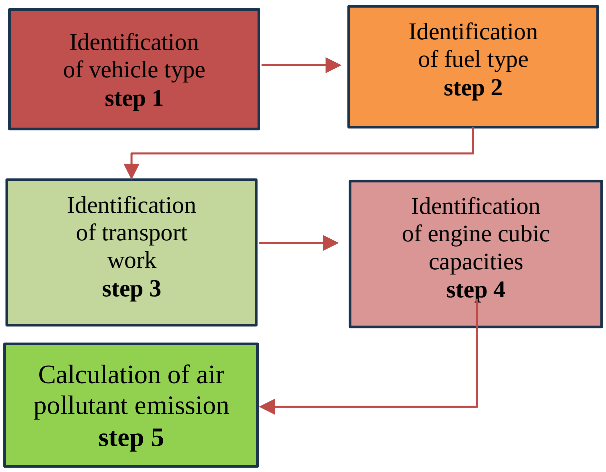

Fig. 3. The diagram of analytical indicator method of calculating the emission of transport modes [21]

In the scope of the present paper, an analysis of the emission of 11 types of passenger vehicles was carried out and their characteristics are presented in Table 1.

The source of the data used to determine the constant and statistical values of the emission indicators was the data derived from the 2015 GPR survey conducted on behalf of the General Directorate for National Roads and Motorways, data from the database of the Ministry of Digital Affairs, based on the odometer readings, among others, collected in CEP. In the analytical index method, the emission of particular vehicle types can be determined for passenger vehicles, light-duty vehicles and heavy-duty vehicles, with different versions of fuels used and engines of different cubic capacities. The indicators define pollutant emission expressed in units [g/km]; the method does not require using a complex mathematical formulation, and has the form of a statistical analysis adequate for the Polish transport organisation conditions. In this method, the emission of transport modes is calculated as the product of the emission indicator and the mileage of the given vehicle type. The emissions of the main air pollutants determined as a result of the literature review and real-world tests are presented in Table 2.

Table 1. Types of vehicles analysed in terms of pollutant emissions in the case study

Vehicle type (production year)	Vehicle code	Fuel type	Engine capacity [cm^3]	Power [kW]	Emission class
Opel Astra 2017	V1	gasoline	999	77	Euro 6b
VW Golf 2017	V2	gasoline	1,498	96	Euro 6c
VW Touran 2018	V3	gasoline	1,395	110	Euro 6b
Škoda Superb 2018	V4	diesel	1,968	110	Euro 6c
Peugeot 308 2018	V5	diesel	1,499	96	Euro 6d-Temp
Mercedes-Benz C220 2018	V6	diesel	2,143	125	Euro 6b
BMW 530d 2017	V7	diesel	2,993	195	Euro 6b
Toyota Prius 2019	V8	hybrid	1,798	90	Euro 6d-Temp
VW Jetta 2015	V9	diesel	2,000	105	Euro 6b
Hyundai i30 2015	V10	diesel	1,600	96	Euro 6b
Škoda Octavia 2015	V11	diesel	1,900	77	Euro 6b

Calculation of air pollutant emissions for vehicles indicated in Table 1 is carried out using the statistical values of the indicators presented in Table 3, as well as the length of the road connecting the points of dispatch and collection of cargo or passengers covered by the types of vehicles, by the following equation:

$$E_m = l\ (i, j)\ x\ W_{m,k} \quad (1)$$

where E_m – the emission of m-th type air pollutants (NO_x, CO_2, CO) generated by the k-th vehicle type, l (i, j) – the length of connecting the i-th sending point with the j-th receiving point, $W_{m,k}$ – m-th type air emission factor taken from Table 2, for the k-th vehicle type.

Table 3 presents the statistical values of the emission factors of particular transport modes.

Table 2. Results of the vehicles' real-world emission – RDE measurements for various vehicle types [g/km] [1, 18, 20, 31]

Vehicle type	NO_x	CO_2	CO
	RDE	RDE	RDE
V1	0.0910	140.0000	0.9900
V2	0.0110	154.0000	0.3160
V3	0.0200	172.0000	0.1610
V4	0.0130	152.0000	0.0200
V5	0.0600	139.0000	0.0200
V6	0.0780	150.0000	0.0130
V7	0.0330	156.0000	0.0350
V8	0.0840	118.0000	0.0060
V9	0.2200	107.0000	0.0050
V10	0.2500	125.0000	0.0062
V11	0.1350	202.0000	0.0105

Table 3. Emission indicators for various vehicle types [g/km]

Vehicle type	NO_x	CO_2	CO
	IM	IM	IM
V1	0.07241	71.79265	0.50972
V2	0.12731	83.77379	0.50705
V3	0.07241	71.79265	0.50972
V4	0.19522	44.66578	0.01267
V5	0.19522	44.66578	0.01267
V6	0.19968	60.76343	0.01610
V7	0.19968	60.76343	0.01610
V8	–	–	–
V9	0.19968	60.76343	0.01610
V10	0.19522	44.66578	0.01267
V11	0.19522	44.66578	0.01267

Under the analytical indicator method, having the relevant data in the form of:
- the test vehicle's mileage in connection with the transport task in question
- the test vehicle's engine cubic capacity
- the fuel type used

using constant statistical indicators, it is possible to determine the approximate emissions of a given vehicle type with regard to the following air pollutants:
- carbon oxides
- carbon dioxide
- nitrogen oxides
- nitrogen dioxide
- PM2.5 and PM10.

As part of the verification of the developed analytical indicator method intended for the determination of the transport modes' emission, the indicator emission was compared with the results of real-world measurements obtained in RDE tests for the three main types of air pollutants, i.e. nitrogen oxides, carbon oxides and carbon dioxide. The results of real-world vehicle measurements are widely published in the literature [1, 3, 10–12, 17, 19, 20, 29–33, 35]. Reviewing passenger vehicle emissions regulations and comparing laboratory tests with real emission results are also widely published [3, 6]. The transport modes' real-world emissions used in the paper are based on literature data [1, 18, 31] and on real-world tests carried out in the engineering thesis [20]. It should be emphasised that analyses of the emission of vehicle-generated pollutants can vary depending on a number of external factors. The test results are affected by the test conditions, e.g. ambient temperature, topography, road conditions, vehicle characteristics such as age, mileage, and technical condition [2, 16, 25, 31].

The analytical method proposed by the authors, which is based on the determination of a constant emission factor, enables the determination of the approximate pollutant emission values. If a large number of real-world test results is available, it is possible to analyse the impact of other factors on emission and to correct the constant indicators in terms of additional criteria, such as the vehicle's age or technical condition. The analytical method developed does not take these factors into account and this may constitute a further stage of the research work. It should also be pointed out that emission measurement methods based on real-world measurements of the transport modes' emission have the highest accuracy in determining the vehicle's real-world emissions. Tests of emission can be carried out for various vehicle types, in various traffic conditions, in different natural topographies as well as using various fuels and engines [9, 19, 27, 28, 36]. RDE tests require the use of rather complex test instrumentation and a considerable amount of time to be carried out under various traffic conditions. The research methodology adopted utilised real-world study results published in the literature [1, 18, 31] and results obtained during real-world tests carried out in the Poznan agglomeration in the engineering thesis [20]. The measurements were carried out using the SEMTECH DS exhaust fume analyser. An illustration of the two vehicles tested in terms of real-world emission is presented in Fig. 4 and Fig. 5.

Fig. 4. Vehicle tested in real-world conditions (Toyota Prius) [20]

Fig. 5. Vehicle tested in real-world conditions (VW Golf) [20]

The measuring equipment for the RDE tests (SEMTECH DS exhaust fume analyser) is mounted inside the vehicles; in addition, an independent power generator used to supply the exhaust fume analysers is placed outside on a special platform (Fig. 4). The analytical indicator method does not enable testing the emission of hybrid vehicles, but it does enable the determination of the emission of electric vehicles. New hybrid and electric technologies appear to be the solution to further attempts to decarbonise transport modes [8, 19, 27]. Considering the above, the emission of transport modes is also affected by factors such as:

- traffic congestion as well as adequate road designing and topography [5, 7, 14, 16]
- conventional vehicles' adaptation to enable utilisation of new fuel types [10, 28]
- natural topography, vehicle load [11, 17, 25, 33]
- the engine's operating conditions and its technical condition [3, 36].

The issue of emission will remain relevant until vehicles that emit pollutants from fuel combustion are in use. It should be emphasised that, in addition to the RDE tests, which are considered the most accurate tests for the emission of transport modes, there are other methods for determining the emission of vehicles, including indirectly behind the vehicle [26].

3. Results

The analytical method developed by the authors enables the determination of the emission of transport modes without the need for real-world testing and is based on statistical data showing the given vehicle type's emissions [21]. Based on a case study, emission calculations were carried out for vehicles providing taxi services in the Warsaw agglomeration, using constant air pollutant emission values. The emissions determined by the analytical method based on statistical data were compared with the results of real-world pollutant emissions determined based on data obtained from literature sources (RDE test results) [1, 18, 31] and from results of tests carried out by the authors of the engineering thesis [20]. Passenger vehicles providing taxi services in the Warsaw agglomeration were classified into categories V1 to V11. For each vehicle category, the emission of a representative transport mode was determined and a simplification was adopted, assuming that a given type of vehicle has the same emission values. The authors analysed the emission of transport modes providing passenger transport services in the Warsaw agglomeration. The company providing transport services in Warsaw has more than 250 vehicles, 130 of which are included in the calculation example. The vehicles (11 types) included in the case study individually travel approx. 100 km per day, with the vehicles collectively travelling nearly 3.6 million km per year. Therefore, they transport a minimum of 4 million passengers. For the purposes of the analysis, it was assumed that the vehicle types V1 to V11 have the same technical parameters in terms of exploitation and their emission in the given type group are the same. This assumption resulted from the fact that it was impossible to carry out real-world emission tests on a large population of vehicles travelling around Warsaw. The real vehicle mileage data are presented in Table 4.

Table 4. Transport work performed by vehicles in a month

Vehicle type	Week mileage per vehicle in each type			
	Week 1	Week 2	Week 3	Week 4
V1	622	748	508	846
V2	898	935	679	614
V3	529	650	424	656
V4	453	426	507	646
V5	558	679	682	769
V6	620	705	548	757
V7	509	756	618	745
V8	487	568	605	446
V9	688	543	785	604
V10	653	540	789	599
V11	409	279	505	345
Total km per week	6,426	6,829	6,650	7,027
Average km per week	494	525	512	541
Average km per day	99	105	102	108

The distances travelled by individual vehicles from each vehicle type were multiplied by the number of vehicles in that type. The total distance travelled by the vehicles was obtained as a result. In the case study, the vehicles mainly served service points, hotels as well as railway and airport stations. The company providing the data for the case study ceased to operate in Warsaw during the pandemic due to the limited number of passengers using taxi services in Warsaw in 2019–2020. It would have been very complicated to carry out emission test for 130 vehicles, so a simplification was adopted, which involved reading the emission for one vehicle from a given type (V1–V11), derived from literature results, supported by real-world studies and RDE tests. The emission of all transport modes from types V1 to V2 was then simulated, taking into account the real-world mileage data of 11 vehicles over a period of one month. One month's data was replicated to obtain approximate figures for the total annual mileage of individual representative vehicles. The annual mileage constituted the basis for determining the total distance travelled by all vehicles included in the study, assuming that, in the scope of a given vehicle type, the vehicles travel the same distances as the representative vehicle. The real transport work data are presented in Table 5.

Table 5. Transport work performed by vehicles in a year

Vehicle type	Total km in a month per one vehicle	Total km in a year per one vehicle	Number of vehicles	Total km in a year for all vehicles
V1	2,724	32,688	5	163,440
V2	3,126	37,512	7	262,584
V3	2,259	27,108	15	406,620
V4	2,032	24,384	10	243,840
V5	2,688	32,256	6	193,536
V6	2,630	31,560	18	568,080
V7	2,628	31,536	3	94,608
V8	2,106	25,272	19	480,168
V9	2,620	31,440	11	345,840
V10	2,581	30,972	15	464,580
V11	1,538	18,456	21	387,576
Total	26,932	323,184	130	3,610,872

For the above data, the transport modes' main pollutant emission was determined as part of RDE tests as well as the transport modes' analytical, statistical emission was determined by using the indicator method. The emission was determined for all 130 vehicles of a given type, providing annual transport services in a Warsaw taxi corporation. The vehicles adopted as reference vehicle, representative of the type [V1 to V2], are not older than 8 years. The vehicles correspond to the age structure of the vehicles providing transport services indicated in the report [22]. It should be pointed out, however, that vehicles operating in the Warsaw area have high mileage (over 300,000 km), which may contribute to significantly higher emission of transport modes relative to the results obtained in the study in question.

Figures 6–16 show the results of air pollutant emissions for various types of vehicles in one year period. During analyses taking into account the real emission from RDE tests and results from the analytical method developed by the authors, based on statistical data.

The results of air pollutant emissions in the form of NO_x obtained during one year of operation of the taxi company's vehicles, calculated using the indicator method, are higher than the emission indicators obtained as part of RDE tests (Fig. 6). The exception is the V1 vehicle, for which NO_x emissions in RDE are lower than the emissivity determined by the indicator method. The reason for this may be the low engine capacity of the V1 vehicle, as the analyzed vehicle has a petrol engine capacity of less than 1000 cm^3. Based on statistical data, the NO_x emissions of air pollutants calculated using the indicator method are higher than the results obtained in RDE tests by about 36% on average for V1–V7 vehicles. Regarding V9–V10 vehicles powered by diesel engines, NO_x emissions are higher in the measurements obtained in the RDE tests by nearly 20% on average compared to the indicator method. For the V8 vehicle, which is a hybrid vehicle, it was not possible to determine the values of statistical indicators showing the emissions of the primary air pollutants. Considering the averaged values of RDE emission measurements and calculations of NO_x emissions based on statistical data, it is possible to estimate NO_x emissions without conducting RDE tests. The error scale in such a procedure is relatively small, about 30%. The NO_x emission value obtained using the indicator method was higher than the RDE results by the indicated error.

The total CO_2 emission from the operation of taxi company vehicles over one year, determined using the statistical indicator, is lower for all vehicles on average by nearly 40% (Fig. 7). The most significant differences in the results were recorded for two types of vehicles, i.e., V1 and V9. These vehicles are highly different from others regarding the installed engines' characteristics, capacity, and propellant used. Considering the averaged values of RDE emission measurements and the calculation of CO_2 emissions based on statistical data, it is possible to estimate CO_2 emissions without conducting RDE tests. The error scale in such a procedure is relatively small, about 40%. The CO_2 emission value obtained using the indicator method was lower than the RDE results by the indicated error.

The total CO emission from the operation of taxi company vehicles over one year, determined using the statistical indicator method, is lower than the RDE results for V1, V4, V5, and V7 vehicles by over 50%. For the remaining vehicles, i.e., V2, V3, V6, V9, V10, and V11, CO emissions were, on average, almost twice as high (Fig. 8 and Fig. 9). Considering all the collected results of calculations and measurements, the most significant discrepancies were recorded about CO emissions in terms of the results obtained by the indicator method and the RDE tests. The average absolute value of the difference in emissivity measurements obtained in the RDE and indicator methods was about 130%. The CO emission value obtained using the indicator method was higher by the indicated error.

With the results of global NO_x emissions (Fig. 10) and CO emissions (Fig. 12), it can be concluded that the emission of NO_x and CO pollutants calculated using the indicator method is higher than the results obtained in RDE tests. The situation is different regarding CO_2 emissions (Fig. 11). A summary of the emission of primary air pollutants in a graphical interpretation is shown in Fig. 13–16.

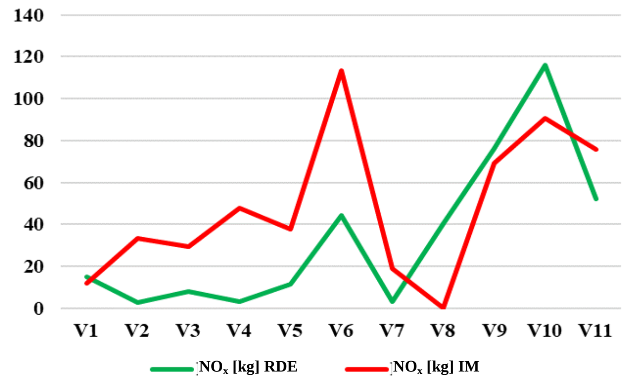

Fig. 6. Total NO_x emissions from transport trips during a one year period per type of vehicle

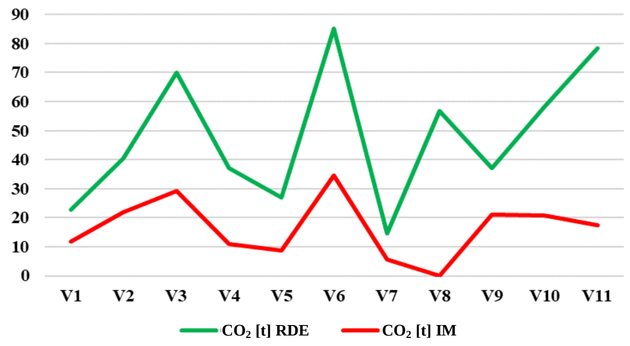

Fig. 7. Total CO_2 emissions from transport trips during a one year period per type of vehicle

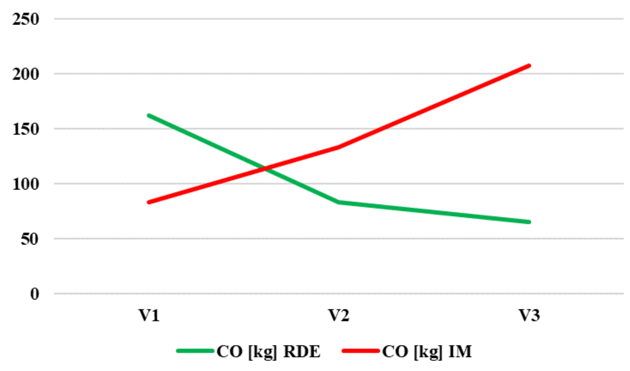

Fig. 8. Total CO emissions from transport trips during a one year period per type of vehicle (V1–V3)

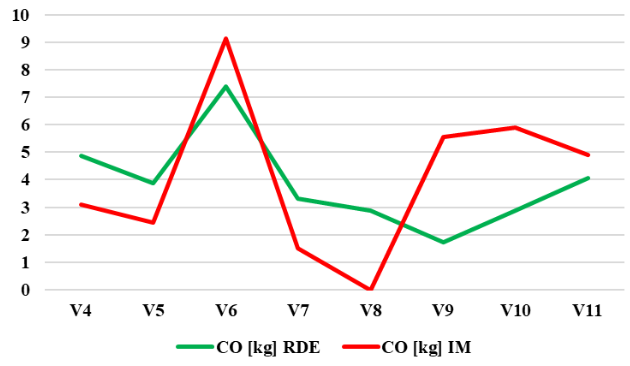

Fig. 9. Total CO emissions from transport trips during a one year period per type of vehicle (V4–V11)

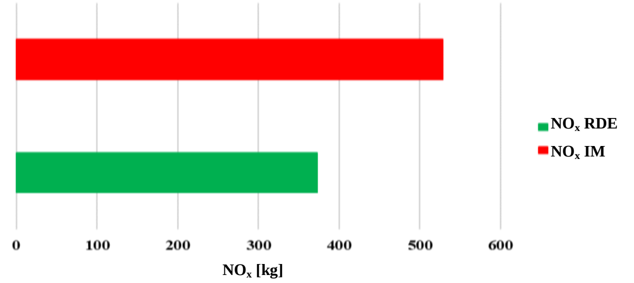

Fig. 10. Total NO_x emissions from transport trips during a one year period

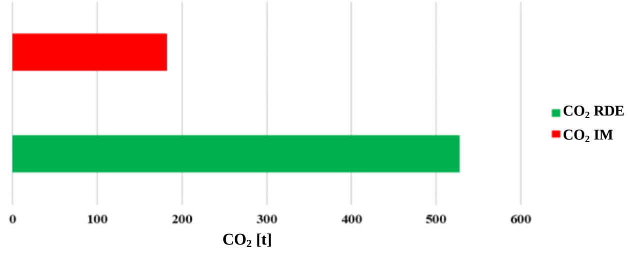

Fig. 11. Total CO_2 emissions from transport trips during a one year period

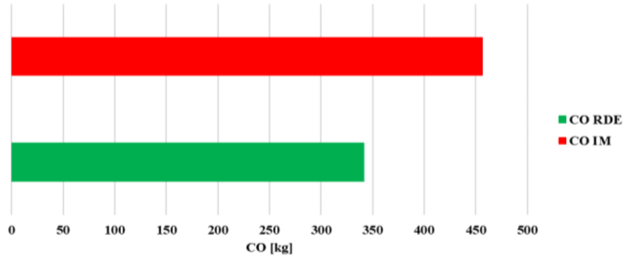

Fig. 12. Total CO emissions from transport trips during a one year period

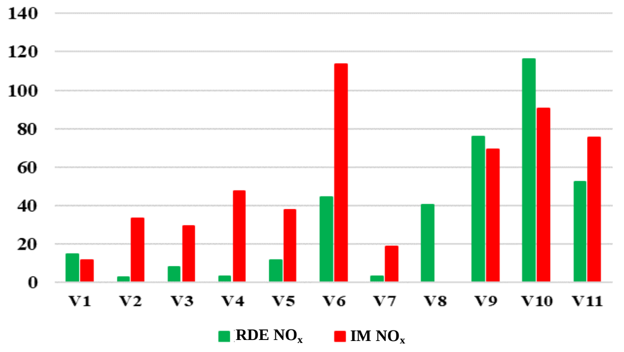

Fig. 13. Total NO_x emissions from transport trips during a one year period by vehicle type [kg]

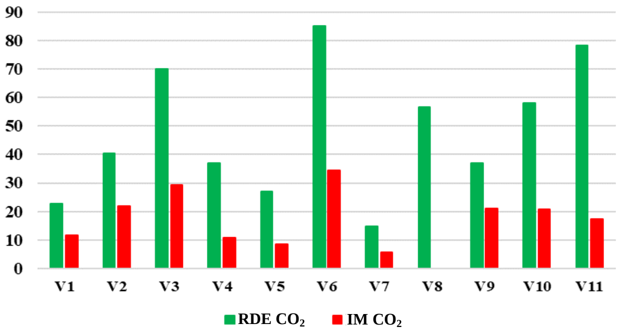

Fig. 14. Total CO_2 emissions from transport trips during a one year period by vehicle type [t]

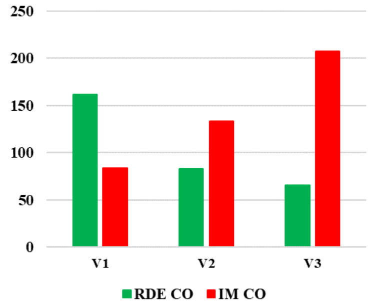

Fig. 15. Total CO emissions [kg] from transport trips during a one year period by vehicle type (V1–V3)

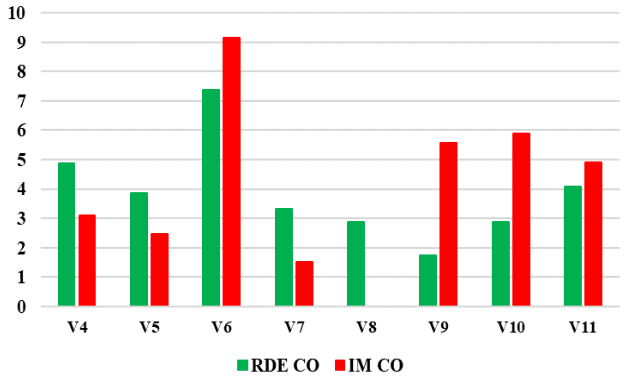

Fig. 16. Total CO emissions [kg] from transport trips during a one year period by vehicle type (V4–V11)

4. Discussion

An analytical indicator method intended for determining the vehicles' main pollutant emission enables the calculation of approximate main pollutant emission generated by various types of transport modes. The method enables the determination of the emission of basic and most commonly used passenger vehicles quickly and in a manner comparable in terms of quantities to the results obtained in RDE tests. In order to better represent the reality, the method should be supplemented with elements correcting the emission in terms of external factors, such as the vehicle's age, technical condition and mileage. These factors are currently not taken into account in the calculation of emission using the indicator method. Nevertheless, the absence of these factors makes it possible to record approximate emission of a given vehicle type, which can be used practice in all kinds of designing and simulation activities when estimating emissions without the need for labour-intensive road tests.

The organisation of passenger transport, e.g. in urban areas, optimising passenger transport routes in terms of cost, can be combined with a calculation of the transport modes' emission and the external costs generated. In this way, passenger transport planning can become more sustainable and the selection of transport modes with lower emission may contribute to a reduction in the transport's negative impact on the environment. The indicator method intended for determining the emission of transport modes presented in this paper allows for quick estimation of the emission of the main transport mode types. The results illustrate the main pollutant emission by the most common road transport modes used for passenger and freight transport.

5. Conclusions

An analysis of the total emissions of the test vehicles, i.e. the annual emissions of, e.g. nitrogen oxides, allowed for obtaining results that demonstrated a higher emission of the vehicles tested in real-world conditions than that obtained in the analytical method calculations, except for vehicle type V9 and V10. However, because the vehicles providing transport services in Warsaw are heavily used, the actual vehicle emission in Warsaw, determined in the RDE tests, may prove to be up to twice as high. In such a case, the emission values obtained in the analytical method will coincide with the real-world measurements of vehicle emission in the RDE tests. The same applies to air pollutant emissions for carbon dioxide and carbon oxides.

In terms of the annual transport plans and the transport work performed by the 130 vehicles analysed, nitrogen oxide and carbon oxide emissions are higher in the analytical method calculations. In terms of the total annual carbon dioxide emissions, the real-world emissions determined by the RDE tests are higher. The vehicles analysed in the calculation example, on an annual basis, collectively emit between 375 kg and 528 kg of nitrogen oxides, from 182 t to 341 t of carbon dioxide and from 341 kg to 456 kg of carbon oxide. Considering the averaged values of RDE air pollutant emission measurements and calculations of emissions based on statistical data in the indicator method, it is possible to estimate air pollutant emission without conducting RDE tests with the indicated above errors (chapter 3).

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Nomenclature

CEP	Central Register of Vehicles
CO	carbon monoxide
CO_2	carbon dioxide
FIA	International Automobile Federation
GPR	General Traffic Measurement 2015
GUS	Statistics Poland
ICCT	International Council on Clean Transportation
IM	indicator method for determining vehicle emission
LPG	liquefied petroleum gas
NO_x	nitric oxides
PM	particulate matter
RDE	Real Driving Emission test
TRUE	The Real Urban Emissions Initiative

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