Article

Influence of Business-Operational Performances and Company Size on CO_2 Emissions Decrease-Case of Serbian Road Transport Companies

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Abstract: This research includes the analysis and comparison of long-term values of key business parameters of profit-oriented companies in Serbia, which are engaged in road transport of cargo or passengers. This paper takes into account the decreasing emissions of CO_2 and its relation to the size of business (in terms of transported cargo or number of passengers), and thus by the company's business success (income, profit). In the empirical part of this research—ecological, operational, and business factors were analyzed on a sample of road carriers from Serbia, i.e., the most common type of organized transport of people or physical goods. Key difference was made between large and small companies engaged in transport activities, followed by difference between those companies which have business activities only in Serbia, or engage also in international activities in the Balkan region (or in the rest of world). The main goal of this paper is to determine statistically significant differences between transport companies in terms of key performance indicators, depending on whether they operate only domestically or abroad. In relation to company size, this paper examined the sustainability of operations in the case of the largest transport companies, which represent half of the total transport activity in the country (by number of people transported or the amount of transported cargo), compared to all small carriers with less than 50 employees. Future research involves extending this sample of road transport companies to all Balkan countries, which have not yet become a part of the European Union and including additional operational as well as environmental indicators that are not conventionally measured during vehicle inspections.

Keywords: heavy-duty vehicles; buses; road transport; CO_2 emissions

1. Introduction

As part of the negotiations on accession to the European Union, all road transport companies from Serbia are obliged to meet strict quality standards in the field of transport and environmental protection (which is impossible to observe independently). A combination of a very long, 20-year period of economic transition in Serbia, its inadequate road and logistics infrastructure, and undeveloped freight lines with most EU countries, have caused

that the measuring of environmental influence of road transport activities has not been at the top of the list of priorities, neither for the Serbian government or for freight companies overall. The previous period (the last five to six years) includes a turnaround for solving most of the infrastructure and international trading problems, which have limited Serbian companies from recording greater business success.

Serbia significantly improved its ranking on Doing Business list defined by World Bank [1], since the country was promoted by 47 places (from 91st place in 2015 to 44th place in 2020), with major improvements regarding infrastructure (completed new 400 km of motorways, developed new logistics capacities throughout the country, implemented integrated border crossings and improved overall efficiency of customs procedures). However, countries in development (such as Serbia) have not yet fully recognized the importance of identifying and understanding key performance indicators to be able to offer guidance for companies doing business in the transport sector. When analyzing various aspects of doing business in road transport activities, there can be defined three main topics—business performance, operational performance, and influence on the environment, measured through air pollution levels.

Two assumptions remain unclear after the analysis of the existing literature—the first presents a dilemma regarding whether smaller transport companies are more focused on business (financial) and operational success (opposed to large logistics and distribution companies) than on environmental effects, and the second should reflect on whether internationalization of activities (import/export) can affect fleet modernization positively, in terms of ecological improvements—measured through CO_2 emissions decrease. This paper tries to further research these gaps by examining the annual income and profitability (as measures of business success), key operational indicators related to transport services (related to fleet, routes, etc.) and evaluate emissions of harmful gasses into the environment, as the main consequence.

More concretely, this research attempts to determine how company size and its performance differentiate regarding emissions of harmful gasses, between companies doing business only domestically and/or abroad. This was performed by using a sample of 1800 cargo and passenger line road transport companies, all registered in Serbia.

This paper is organized in the following manner. In Section 2 a summarization of existing literature has been provided, on determining key business and operational (technical) indicators, as well as indicators for measuring the environmental component of the sustainability of road transport companies. Section 3 displays methodology, framework, data acquisition, and processing. Section 4 displays findings of the quantitative research; and Section 5 includes a presentation of main conclusions, discussion with other previous relevant papers, and announcement of future projects.

2. Literature Review

Transport, as a very important and necessary logistics activity, aims to connect production and consumption, which are displaced from each other in most cases. Therefore, the modern approach to the topic of road transport company management is based on successful understanding and on determining its own performance.

This fact depends on several preconditions, such as a company size, fleet size, the number of routes, and the technical state of vehicles (trucks or buses).

2.1. Indicators of Business Performance

In the case of road transport companies, small profit margins and large competition cause a drastic increase (larger than ever before) in the number of routes driven and shipments being delivered. It often occurs that efficient fuel savings and emissions decrease are not prioritized at all in road transport companies [2], followed by the fact that there are no incentives helping haulers to become more efficient.

The largest share of freight transport in Europe is recorded in the case of road transport companies (among rail, air, water, and other types), with companies from Germany and

Italy who are recording the biggest turnovers [3]. When analyzing the largest road transport companies in Europe [4], two indicators are important—fleet size and size of business in terms of revenue. In terms of fleet size, Waberer and Girteka are considered as the largest fleet owners in Europe, having around 4000 trucks each.

Regarding size of business, six companies (DB Schenker, DHL, DSV, Dachser, Kuehne and Nagel, and Geodis) record annual revenue ranges from EUR 3 to 4.5 billion. When it comes to long distance bus transport companies, Eurolines and Flixbus are considered as the largest ones, responding to record demand for intercity transport in regular or special occasions, according to categorization made in [5].

These top tier transport companies list several of the most important indicators of business performance, such as annual total revenue, direct costs, gross profit, operational expenses, EBITDA, and EBITDA margin. The mentioned indicators have been broadly discussed worldwide, and this paper attempts to identify the most important ones for further analysis:

- Profitability measured through ROA or ROE (in case of the Czech transport companies [6], as well as [7] by analyzing the carriers from India.
- EBITDA margin analyzed in [8], determining that top tier truckers record an EBITDA that is 10 times their interest payments.
- Solvency, OPEX and CAPEX (studied in [9] in case of companies from Belgium, and in [10] by analyzing trends for leading transport companies worldwide.

Finally, studies show that top tier transport companies position their peak performance goals according to successful management of these indicators of business performance [11,12], but also in combination with all other important indicators, such as indicators of operational performance.

2.2. Indicators of Operational Performance

In [13], several of the most important indicators of operational performance were defined, divided by process—procurement, manufacturing, warehouse, distribution and transportation, delivery, and customer service. Previous research papers considered various indicators of operational performance, which can distinguish and measure success between transport and logistics operations. Batista [14] suggests that operational performance should be directed towards speed, flexibility, and lowering the costs as much as possible (which can be an issue regarding customs procedures on Serbian borders).

During the last 20 years, several authors analyzed the majority of important indicators of operational performance of cargo carriers, such as capacity and on time delivery [15], covered distance measured in kilometers, delivery frequency [16,17], and finally, productivity measured through the amount of transported cargo or number of passengers over time, as the lead time for the domestic market [18]. Heng [19] analyzed routes and delivery hotspots (as key indicators of operational performance) in the case of US cargo transport companies, finding that there is no significant difference in traditional and environmentally regulated routes regarding efficiency, finding that emission constraints of certain routes did not affect overall efficiency of transport companies. On the other hand, Martinez and Miranda [20] found, in the case of large trucks operating in Spain, that maximizing the gross load of vehicles (up to 44 tons per truck) causes a decrease in the number of deliveries, and indirectly influence lowering emissions into the air.

Inter-city bus operators can add or remove routes between cities relatively easy, allowing them to enter different European markets on a short-term test basis, or to modify the type of passenger transfer service rapidly as markets change and emerge. Holmgren [21] supports this correlation between attracting new passengers and increasing the number of totally new buses in the fleet. Manojlovic [22] analyzed if investments in bus fleet renewal can contribute to environment indicators (in case of the Serbian passenger line transport companies), concluding that fleet renewal (around 200 new buses annually, all with EURO V engine at least) unquestionably causes a decrease in emissions of harmful air pollutants.

Regarding operating costs, Ing Marie [23] used regression models to determine that operating costs caused by transport activities increase less than 1% in case when air polluting emissions increase by exactly 1%. Kang [24] conducted an efficiency evaluation of bus transport companies with and without taking into account environmental emissions, concluding that most research assumed that profit maximization strategy was limited by neither environmental emissions nor government regulations, and that efficiency measurement and productivity analysis have been rarely analyzed before.

It is not clear from the existing literature whether fleet size (number of road vehicles used for commercial purposes) is reversely proportional to environmental influence, or it should be further determined whether smaller transport companies are not oriented strategically towards emissions decrease, but rather on profit maximization.

Consequently, larger fleets (companies with more than 250 employees) are modernized quicker and more often (innovation cycle is shorter) and are indirectly causing decreased emissions towards the environment.

2.3. Indicators of Environmental Performance

In a study by Inkinen and Hamalainen [25], it is suggested that heavy-duty vehicles (cargo transport trucks) are one of the most significant contributors to emissions and air pollution in transport of goods outside cities (in contrast to light duty vehicles being the most common type). Additionally, heavy-duty vehicles are interesting for environmental topics also because of the type of cargo they are carrying, since dangerous cargo is entirely related with large trucks [26].

Fuel consumption per km presents on its own a very important indicator of influence towards the environment, and various efforts are made to improve that parameter, as previously analyzed by Watling [27], Nasir [28], and Fehrentz [29].

Another very important indicator (often avoided by business decision makers) includes emissions of CO_2 (measured in total number of kilograms per km). According to Enzmann [30], emissions of harmful gas such as CO_2 grew by 27% over the last 30 years, and account for the majority of all transport-caused emissions in the last few years.

Taking into account a wider time horizon, the situation regarding emissions of road transport carriers is even worse, since Sims and Schaeffer [31] have drawn attention to a record growth of emissions caused by road transport, from 59% of share in total emissions in 1970, to almost 75% in 2010.

Marginal cost analysis handled by Yedla [32] initiated a concern whether smaller road transport companies are even able to consider fleet modernization and investment in ecology projects. Overall (CO_2, NOx) emissions from worldwide road transport activities are projected to increase by 240% until 2050 [33], opposed to the fact that CO_2 emissions in Europe are predicted to drop 40% until 2030. In addition, near zero reduction in emissions is desired until 2050, and around 80% reduction from overall transport (commercial and private) [34].

Therefore, it is very clear from a strategic point of view that transport businesses need to align their investment plans with EU trends and predictions. For the purpose of this research, it is not clear whether it is easier to commit to environment protection goals when doing business at large, and hard to think about it when counting every penny spent and every mile crossed.

The projected situation is pretty much clear, as the road transport of cargo or passengers will continue to grow, and it will cause an increase in CO_2 emissions [35], which has been adequately displayed in Figure 1.

From existing literature it is not clear whether internationalized business efforts and the presence on EU markets can cause a shift in fleet structure of a road transport carrier. Additionally, the fact is that trucks and buses are predicted to cause more damage to the environment, yet it is not known whether trucks (hauling cargo transport) or buses (passenger line transport) are key responsible polluters, so these gaps should be examined via proper quantitative research.
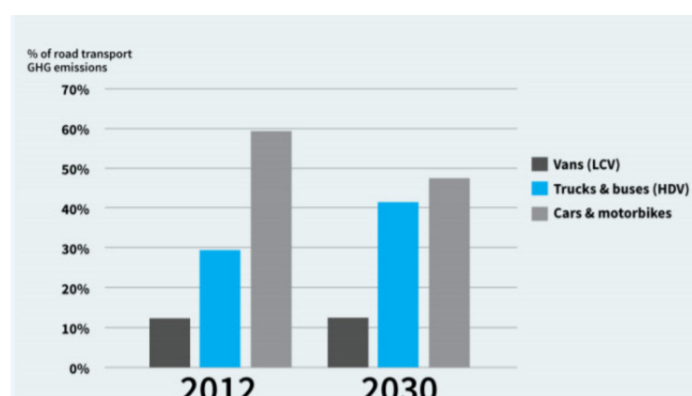
Figure 1. Trends on CO_2 emissions in Europe [36].

3. Methodology

Quantitative analysis displayed in this paper can be useful to managers doing business in transport activity, as well as government regulators in designing better incentives for eco-friendly investments (in the form of structured aid/loans for the renewal of the transport fleet, more efficient customs procedures, or the creation of new enabling international agreements).

In addition, this research is complementary for international academic readers by offering a new perspective from an EU candidate country such as Serbia.

Now follows a presentation of theoretical framework and the definition of research variables.

3.1. Theoretical Framework and Variable Operationalization

Based on the literature review, the specific framework was defined. Three constructs were analyzed and measured with appropriate statistics and tests:

- Identification of key indicators of performance in the case of road transport companies (business, operational, environmental), acquired through literature survey and measured through statistics tests.
- Analysis of key differences related to indicators of performance (business, operational, environmental), divided between companies by size and type of business activity (cargo or passenger line transport).
- Analysis of significance (between and within groups of road transport companies), in terms of domestic and international road transport companies, in terms of CO_2 emissions decrease.

The flow of research was initiated by determining correlations between independent variables and dependent variables, followed by elimination of low correlated business factors (independent and dependent variables, marked with green) from further research.

Consequently, differences between key indicators were analyzed within the sample of road transport companies from Serbia, which was divided by company size (large companies versus smaller transporters) and type of transport activity (transport cargo or people).

Finally, this research is concluded by analyzing the significance between companies doing business only within domestic borders and the companies doing business abroad to be able to test whether companies doing business abroad are more environment friendly than road transporters who operate only in Serbia.

Based on previous related research within Section 2 of this manuscript, multiple indicators of performance (environmental, operational, business) were formulated, which could provide a proper answer to the main research question.

The list of indicators to be used in this research is defined in Table 1, and this list is in accordance with the list of KPIs used by Al Haddad [37] in a similar case study conducted in Germany.

Table 1. Indicators of performance to be used in this research.

Performance	Key Indicators	Previous Related Research
Environmental	CO_2 emissions	Jones [38] Mckinnon and Piecyk [39] Manojlovic [22]
Operational (technical)	Fleet size (trucks, buses) Maximum gross weight per truck Transported cargo (domestic, import, export) Covered distance (km) Number of transported passengers (domestic, international) Number of deliveries (tours)	Radović et al. [40] Martinez and Miranda [20] McKinnon [41] Išoraite [42]
Business	Type of business activity (logistics, physical distribution, line transport of passengers) Number of markets (countries) Annual income Profitability EBITDA MarginInvestments in new fleet Operational costs	Juntunen [43] Yang [44] Hoffman [4] Arsić et al. [45]

These indicators should be adequate to analyze most road transport companies in Serbia, which can be divided into cargo transport companies and passenger line transport companies.

3.2. Sample Design

The main data points regarding indicators of performance in the sampled Serbian road transport companies were generated from multiple sources, which was necessary since there is no unique, integral source of raw data regarding the road transport companies doing business in Serbia.

Now follows a presentation of all sources of raw data (presented with Table 2) that have been processed to perform quantitative analysis of the displayed indicators.

Table 2. Sources of raw data generated for quantitative analysis.

Type of Raw Data	Source
CO_2 emissions	Annual internal company reports on sustainable growth (2020) Authors estimation
Fleet size (trucks, buses) in company Number of employees Maximum gross weight per truck Transported cargo (domestic, international-import/export) Covered distance (km) Number of transported passengers (domestic, international) Number of deliveries (tours) Number of markets (countries)	Annual internal company reports on sustainable growth (2020) Bureau of statistics of the Republic of Serbia [46] Ministry of Traffic, Construction and Infrastructure of the Republic of Serbia, Sector for road transport, roads and traffic safety [47]
Annual income from business operations Profitability EBITDA Investments in new fleet Operational costs Firm type (transport only or combined-logistics)	Agency for business registers of the Republic of Serbia [48]

Data was collected for the period of the last 6 years (from 2014 to 2019), where it was possible to perform the collection process. About 1800 companies were analyzed for the purpose of quantitative research, but it should be noted that currently in Serbia there are 30,500 registered transport companies, from which there are 14,000 active companies, which reported financial results to the relevant government agencies [49].

Most active road transport companies do not present all indicators of their performance, so this was an important fact to consider before conducting the analysis.

In addition, some companies which were contacted regarding annual reports on sustainable growth, reported back that their business was in the process of being closed or had already been shut down, so all further communication itself was disabled. Finally, few companies did not have a responsible contact, available at the time of research, due to being busy.

3.3. Research Hypothesis Formulation and Data Analysis

Key research goals were formulated, to be able to connect between literature and theoretical assumptions with real (historic) values of indicators of business, operational and environmental performance. The research goals related to cargo transport companies can be defined as the following:

- To determine the regression level of environmental parameters with business-operational parameters, distinction was made between small (the largest share in total number) and the largest companies (the largest revenue) dealing with domestic cargo transport,
- To determine the regression level of environmental parameter "CO_2 emissions" with business-operational parameters, distinction was made between the smallest (the largest share in total number) and the largest companies (the largest revenue) dealing with international cargo transport.

Therefore, it is possible to determine the first and second research hypotheses covering cargo road transport companies:

H1. *CO_2 emissions are directly correlated with business and operational performances, in the case of cargo road transport companies (of any size) doing business domestically;*

H2. *CO_2 emissions are highly correlated with business and operational parameters, in the case of cargo road transport companies doing business internationally, with a distinct difference between small and large companies;*

Additionally, two research goals were defined, dealing with passenger line (bus) transport companies:

- To determine the regression level of CO_2 emissions with business and operational indicators, by differentiating between small (the largest share in total number) and the largest companies (the largest revenue) dealing with domestic passenger transport,
- To determine regression level of CO_2 emissions with business-operational parameters, by differentiating between small (the largest share in total number) and the largest companies (the largest revenue) dealing with international transport of passengers.

Therefore, it is possible to determine the third and fourth research hypotheses:

H3. *CO_2 emissions are directly correlated with business and operational performances, in the case of passenger line road transport companies (of any size) doing business domestically;*

H4. *CO_2 emissions are highly correlated with business and operational parameters, in the case of passenger line road transport companies doing business internationally, with a distinct difference between small and large companies.*

Overall measure for calculating CO_2 emissions from freight transport (cargo transport companies) or passenger transport has been determined by ECTA [50], and therefore, energy based approach was applied, to calculate CO_2 emissions in case of companies with missing data about environmental indicators of performance (sustainability reports). The following formula has been used:

$$CO_2 \text{ emissions} = \text{fuel consumption} \times \text{fuel emission conversion factor}$$
$$[\text{Tonnes CO-emissions} = \text{litres} \times \text{kg } CO_2 \text{ per litre fuel}/1.000]$$

This research (in quantitative part) shall use the EU directives made by Persin [51], determining that EURO VI trucks consume up to 78,000 litres of fuel annually, to be able to travel 230,000 km on average (34 l per 100 km).

Manojlovic [20] measured fuel consumption made by buses, through an average lifecycle of 10 years of 800,000 travelled kilometres, determining that on average buses consume up to 37,000 litres of fuel annually to transport passengers between different cities.

In order to analyze data from different sources adequately, several tests and statistics were applied (results and analysis are displayed in Section 4.2 Findings). Firstly, all independent variables have been inspected for multicollinearity (see Appendix A Table A1), to avoid any duplication or making bad conclusions based on false correlations between data points. After that, dummy variables (see Appendix A Table A2) were created to standardize all research variables and to enable all statistical tests.

Pearson correlation tests were applied between all independent variables with a dependent variable, which enabled the selection of key correlations and elimination of those with low dependencies.

Testing of research hypothesis (in line with achieving research goals) has been carried out through Regression tests (simple linear and multiple), since limited availability of real data about CO_2 emissions imposed a simplified approach to analysis.

Finally, one-way ANOVA tests (in standard conditions- normality and homoscedasticity) were carried out to check for statistical significance of the sampled data, to determine the impact of one or more indicators (business, operational) by comparing the means of two different groups (cargo transport and passenger line transport companies).

4. Results

4.1. Sample Characteristics

On average, the sampled companies employed about 35 people (small companies) in 2019, with a clear increase in employment (compared to 2018) of an average of 1%. Considering the official division of companies by size (less than 10 employees—micro companies, from 10 to 49 employees—small companies, from 50 to 249 employees—medium companies), the distribution of the sampled companies in Table 3 was made depending on the number of employees:

Table 3. Sampled road transport companies.

Data	Response	Pct. of Sample (%)
	1–50	71.1%
Number of employees	51–249	16.7%
	250+	12.2%
Company type	Transport services only	80%
	Combined (logistics provider)	20%
	Only on the domestic market	40%
Presence on different markets?	Yes, on Serbian and foreign markets	50%
	Yes, on foreign markets only	10%

In Serbia during 2019, about 31,000 employees worked in transport companies. Most transport companies were entrepreneurial type (71%), followed by limited liability companies (28%).

The overall annual revenue amounts up to EUR 2.3 billion, while the profit margin equals EUR 62 million [49]. When compared with 2018, there was recorded a significant increase in the number of employees (20%), increase in annual revenue (around 18%), and a very large increase in overall profit—almost 49%.

All of this suggests that the transport sector in Serbia is in the phase of large expansion, and further positive news are expected. Table 4 displays trends regarding total turnover, investments, number of transport companies who can operate abroad, compared with total (measured and estimated) CO_2 emissions.

Table 4. Trends regarding sampled road transport companies from Serbia.

Year	Annual Total Turnover (in Mil Euro)	Investments (in Mil Euro)	Number of Transport Companies with International Permits	Total CO_2 Emissions Evaluation (in Tonnes)
2014	84	24.3	750	14,400
2015	83.1	23.2	863	16,520
2016	85.7	25.8	1011	16,890
2017	92.3	34.9	1224	16,760
2018	111.3	38.4	1315	16,120
2019	118.6	53.4	1420	16,060

It can also be concluded from Table 4. that investments, turnover growth in the road transport sector, as well as the significant growth of number of companies doing business home and abroad is not proportional to growth in CO_2 emissions.

This conclusion may be a consequence of different factors:

(1)   the estimation of CO_2 emissions is not precise enough,
(2)   the turnover growth is a consequence of more stable economy,
(3)   the fleet renewal is causing a larger share of vehicles with modern engine technology, thus decreasing emissions per vehicle,
(4)   the growth in number of international transporters may fall to regional market exchange (Balkans region) where transporters are not facing the same environment protection standards as in EU.

Sample representativeness of road transport companies (both cargo and passenger line companies) has been achieved, in terms of regional (all four regions are proportionally included) and industry aspects (there are examples of SMEs across most dominant industries in Serbia).

The overall population of active road transport companies in Serbia is estimated at around 14,000 and there is very little organized data about those companies.

From Table 5 it can be concluded easily that this sample offers a solid opportunity to compare road transport companies, which are a majority in overall road transport companies (but with the smallest fleet of trucks/buses), with top players who have more than 500 trucks/buses in the fleet and thus create the largest influence on the environment.

Table 5. Sample distribution between fleet size and transported cargo/passengers in domestic and international transport activity.

Fleet Size	Size	Domestic	Internationalized	Share of Total Sample	Number of Companies
Number of trucks	1–50	88%	12%	36%	648
	51–249	77%	23%	8.9%	160
	250–499	52%	48%	6.3%	113
	500+	32%	68%	1.5%	28
Number of buses	1–50	90%	10%	35.1%	632
	51–249	86%	14%	7.8%	140
	250–499	80%	20%	2.8%	50
	500+	76%	24%	1.5%	28
				100%	1800

Additionally, it appears that a significantly larger share of top size cargo transport companies is involved in international activities (as in the case of passenger transport).

All data points collected from multiple sources (displayed in Section 3.2) were processed using Stata v.16. All sources, references, and sampled raw data used in this research, have been read and analyzed multiple times.

Internal validity of the sample is based on the data gathered from different sources, as well as on the credibility of the publisher (company or government agency).

4.2. Findings

Pearson correlation tests were conducted (results can be observed in Table 6) to perform the initial check whether the theoretical background and selected indicators are adequate for further analysis in the case of Serbia, which was performed within this section of the paper. Correlation tests were performed in Stata 16, for all 1800 road transport companies covering a period of six years (from 2014 to 2019).

Table 6. Correlations between dependent variable (CO_2 emissions) and all independent variables.

	Independent Variable	Y_1—CO_2 Emissions
X_1	Fleet size (number of trucks)	0.48
X_2	Fleet size (number of buses)	0.36
X_3	Maximum gross weight per truck	−0.13
X_4	Doing business home (cargo)	−0.51
X_5	Doing business abroad (cargo)	−0.45
X_6	Covered distance (km)	0.17
X_7	Doing business home (passengers)	0.46
X_8	Doing business abroad (passengers)	0.44
X_9	Number of deliveries	0.21
X_{10}	Number of markets	0.09
X_{11}	Annual income from business	0.21
X_{12}	Profitability (in euro)	0.32
X_{13}	EBITDA margin	0.19
X_{14}	Investments in new fleet (in euro)	−0.44
X_{15}	Operational costs (in euro)	0.37

Since independent variables "fleet size number of trucks", "fleet size number of buses" are correlated with another independent variable, "number of employees", the latter has been removed because of multicollinearity.

In addition, multicollinearity was recorded in case of transported cargo/transported passengers with the variable "Type of business activity" (all cases of multicollinearity tests have been displayed in Annex). These two variables were deleted from further analysis.

By analyzing data presented in Table 6, it can be concluded that the dependent variable "CO_2 emissions" is under moderate or high influence (at least 0.3 and higher) of a number of independent variables, therefore, regression testing presents itself as the next step.

All variables that have recorded correlations with an absolute value under 0.3 have been removed from further analysis, since those variables do not impact the decrease of CO_2 emissions as an effect of road transport activities. Now follows further analysis of correlated variables, before conducting regression tests.

Therefore, Table 7 displays a crosstabulation of six indicators (business, operational, size) determining sampled road transport companies, to provide an understanding of what combination of indicators influences the overall decrease in CO_2 emissions. Values (in percentage) displayed in the table, signify the distribution share of companies where

high correlation could be established between an increase in business and/or operational indicators with decrease in CO_2 emissions.

Table 7. Share of sampled road transport companies with high correlation between indicators of business performance and CO_2 emissions, divided by indicators of operational performance (fleet size, doing business home/abroad).

Doing Business Home/Abroad	Fleet Size	Business Perf. Indicator Correlated with CO_2 Emissions		
		Profitability	Fleet Investments	Operating Costs
% of Domestic companies	Number of trucks	77%	48%	33%
	Number of buses	62%	32%	24%
% of International companies	Number of trucks	82%	91%	69%
	Number of buses	44%	56%	24%

It can be concluded from Table 7 that the majority of sampled cargo transport companies who are doing business abroad increase their fleet size, profitability (82%), and new fleet investments (91%), which is highly correlated with CO_2 emissions decrease, while this is not so evident in the case of internationalized passenger transport companies.

4.3. Testing of Research Hypotheses

Regression tests (considering all four research hypothesis as defined in Section 3.3) were performed using Simple Linear regression in Stata (Table 8), to determine whether CO_2 emissions (estimate) can be modelled according to the recorded annual values of several indicators of business and operational performance. This will enable testing of all four hypotheses adequately.

Table 8. Simple linear regression tests with dependent variable CO_2 emissions.

	Y_1-CO_2 Emissions				
	Independent Variable	Adj R^2	*p*-Value	Slope	Standard Error
X_1	Fleet size (number of trucks)	0.65	<0.001	−0.25	2.20
X_2	Fleet size (number of buses)	0.28	<0.001	0.54	0.05
X_4	Doing business home (cargo)	0.41	<0.001	0.19	1.50
X_5	Doing business abroad (cargo)	0.76	<0.001	−0.33	1.90
X_7	Doing business home (passengers)	0.32	<0.001	0.06	2.10
X_8	Doing business abroad (passengers)	0.31	<0.001	−0.12	0.55
X_{12}	Profitability (in eur)	0.49	<0.001	−0.05	1.54
X_{14}	Investments in new fleet (in eur)	0.33	<0.001	−0.01	1.88
X_{15}	Operational costs (in eur)	0.12	<0.001	0.22	2.22

From Table 8 it can be deduced that independent variables X_1 and X_5 may present an adequate starting point for further analysis of influence on CO_2 emissions (dependent variable), based on the simple linear regression test values (Adj R^2, *p*-value, slope, and standard error).

Since the main idea is to determine the combined effects of different indicators on the decrease of CO_2 emissions, it can be concluded that if a company increases its number of trucks by 1, that will influence a decrease in the Y1 variable with a minimum of −0.25, but this information is not sufficient to learn whether this influence is perhaps a consequence of additional variables (such as growth in profitability for instance).

The stated weakness of linear regression is compensated for by multiple regression (by introducing additional variables explaining business or operational dimension of performance). Therefore, multiple linear regression tests were performed, and the results are displayed in Table 9.

Table 9. Multiple linear regression tests on related hypotheses.

Hypothesis	Adj R^2	Subgroup of Independent Var.	Regr. Coeff (Slope)	*p*-Value	*t*-Test
H1	0.56	Fleet size (number of trucks)	−0.54	<0.01	1.98
		Doing business home	0.33	<0.01	0.96
		Profitability	0.65	<0.01	1.34
H2	0.78	Fleet size (number of trucks)	−1.09	<0.01	2.12
		Doing business abroad (trucks)	0.88	<0.01	1.94
		Profitability	−1.42	<0.01	1.33
H3	0.54	Fleet size (number of buses)	0.79	<0.01	2.20
		Doing business home (buses)	0.51	<0.01	1.12
		Profitability	−0.06	<0.01	1.54
H4	0.24	Fleet size (number of buses)	0.09	<0.01	0.68
		Doing business abroad (buses)	0.03	<0.01	0.59
		Profitability	−0.01	<0.01	0.44

From Table 9. it can be analyzed that apart from fleet size (trucks, buses), the most important indicators are doing business home/abroad and profitability, all of which produce combined effects on CO_2 emissions decrease.

Hypotheses H1–H3 are confirmed in terms of Adjusted R^2, regression coefficient (negative value indicates that emission decrease is under influence of fleet size increase and/or profitability increase).

p-value is in all cases lower than 0.05 and *t*-test displays initial significance of variable regarding regression test within hypothesis testing.

Also, from Table 9 it can be concluded that Hypothesis H4 cannot be accepted, since the adjusted R squared value is too low, and regressor (slope) within Hypothesis H4, for all three variables are also too low.

ANOVA tests have been carried out to confirm the significance of sampled companies, with connection to confirmed Hypotheses H1–H3 in terms of sample variability between and inside different groups of data.

Results of ANOVA test in the case of cargo transport companies are displayed in Table 10.

The highest score for ANOVA (the most substantial difference of variability), was recorded in relation to whether a cargo road transport company was internationalized or not (Table 10). In the case of cargo transport companies doing business domestically there is a lower difference in variability, but it may represent the result of other (undiscovered) interdependencies.

Undoubtedly, after analysing test results regarding cargo transport companies, it can be concluded that there is a significant relationship between variables (the F statistics value is much larger than "1", RSE (residual sum of error) is slightly above the standard deviation level, and the *p*-value is smaller than 0.05).

Table 10. ANOVA test (overall significance of sample) in case of cargo transport companies.

Dependent Variable	Cargo Transport Companies	ANOVA (Sources of Variability Inside and Between Groups)				F Test p-Value
		Sum of Squares		Mean of Squares		
		Between Groups	Within Groups	Between Groups	Within Groups	
Y_1 CO_2 Emissions	Doing business abroad	444,054	285,105	256,183	8073	F 20.34 p-value 0.01
	Doing business domestically	313,727	245,837	126,605	240,247	F 11.45 p-value 0.01

Additionally, ANOVA tests display the significance of parameters covering Hypothesis H3, and the results of variability tests within and between groups are displayed in Table 11.

Table 11. ANOVA test (overall significance of sample) in case of passenger line transport companies.

Dependent Variable	Passenger Line Transport Companies	ANOVA (Sources of Variability Inside and Between Groups)				F Test p-Value
		Sum of Squares		Mean of Squares		
		Between Groups	Within Groups	Between Groups	Within Groups	
Y_1 CO_2 Emissions	Doing business abroad	453,667	142,853	188,605	140,247	F 10.99 p-value 0.01

It can be deduced from Table 11 after analyzing test results regarding passenger line transport companies, that there is a significant relationship between variables (F statistics is much larger than 1, *p*-value is smaller than 0.05).

ANOVA test results regarding both groups of transport companies (cargo or passenger line) clearly show that the two sampled company groups (within and between groups) are sufficiently representative to be tested for correlations.

Following analysis of the sample, considerable variability was described within independent variables (based on the values of the sum of squares and mean of squares, which are significantly larger than zero).

It is 95% certain that CO_2 emissions are under direct influence of the type of business (cargo or passenger transport) and doing business only within national borders or internationally. All significance tests were conducted on short-listed values within the experimental region, based on real values of variables.

It can be concluded that from the perspective of statistical significance, three confirmed research hypotheses may be accepted, or, that there is a statistically significant correlation between the CO_2 emissions, with indicators of business performance (profitability) and operational performance (in the case of large cargo transport companies doing business home and abroad, as well as passenger line transport companies doing business internationally).

5. Discussion

5.1. Discussion and Conclusions

This paper examined whether key business and the operational performances of a road transport company (cargo or passenger line) can influence the environmental effects, measured through CO_2 emissions. Difference was made depending on company size (largest companies versus small transporters), and on the fact whether a company is doing business only within domestic borders or internationally. Considering everything analyzed throughout this paper, to comprehensively understand the problem, the existing ratio-

nale about influences on CO_2 emissions can be adequately expanded with the following conclusions and directions:

- Better business (financial) and operational performances, alongside the fact of doing business abroad, significantly affects the decrease in CO_2 emissions made by road transport companies, thus contributing to fulfilment of environment protection goals.
- Key indicators of business performance influencing CO_2 emissions are profitability and investments in new fleet (buses or trucks). Mixed with key indicators of operational performance (fleet size and doing business abroad), findings show that smaller companies tend to be oriented towards profitability (with less investments in a new fleet), while larger companies are focused on fleet modernization and achieving greater success on international markets (all of this leads to significant decrease in CO_2 emissions, compared to companies doing business only in Serbia);
- A statistically significant correlation can be found in analyzing business performance between road transport companies dealing with cargo transport, which are doing business both at home and abroad, with a decrease in CO_2 emissions. Additionally, passenger line transport companies do not show the same correlation;
- Efforts towards business sustainability observed through profitability, are more successful in road transport companies with larger fleet size, which are doing business mostly within foreign borders;
- There is no statistically significant difference in operational costs (indicator of business performance) in terms of business type (cargo or passenger transport) or even the main market (home or abroad). This indicator is only relevant to fleet size, in cases where large companies find ways to decrease operating costs per vehicle, while smaller ones do not have that possibility.

This research helps in partial closing of the research gap regarding influence of key indicators of business and operational performance on CO_2 emissions. Some similar attempts about this topic were previously made by Zimon and Zimon [52], regarding key influences between profitability and operational performances in transport activities, as well as by Haas [53] regarding key efficiency and effectiveness indicators of road transport companies.

This research expands on these studies, by focusing and exploiting the differences between business type (cargo transport or passenger transport), and by comparing companies who are doing business only within national borders with ones that are fully internationalized.

Regarding the variable considering maximum weight per truck, there is a somewhat objective constraint for realization of any changes. A proposition to regulatory bodies in Serbia is that maximum gross weight per truck should be increased, to indirectly cause a decrease in the number of deliveries (per principal buyer), since there are a number of positive examples such as Spain, Belgium, and the Nordic countries [44].

Since the findings from this paper suggest that investments in a new fleet are positively affecting profitability while decreasing CO_2 emissions, support for these claims can be found in a previous study by Meszler [54], who predicted that incentivized fleet modernization of the EU transport companies can produce about 44% reduction of fuel consumption of heavy-duty trucks within the next 10 years, which can potentially lead to lowering harmful emissions per vehicle.

This can be a good explanation why investments in new vehicles can add value to the transport company and acquire new business opportunities throughout the EU, for external (third country) road transporters.

5.2. Limitations and Future Research

The limitations of this research are linked to the data availability. Namely, only a minority of road transport companies in Serbia gather data about emissions or publish their sustainability reports, therefore indicators of environmental performance (such as CO_2 emissions made by buses or trucks had to be estimated via formula).

Additionally, business, operational, and environment indicators data was only available for the last six years, which made it harder to perform multiannual trend analysis, such as performed by Ozcan [55].

Three related extensions for future research can now be foreseen, and those extensions involve the matters of scope, new indicators, and new countries. The first one is related to widening the scope of research by including companies doing business in transit through Serbia, as an important generator of emissions.

The second one is to investigate the possibility of including new indicators (such as used by Banister [56]) or even involving a small one-to-one survey with road transport company owners.

New indicators could include (1) technical characteristics of road transport vehicles (such as maximum load capacity defined by vehicle design versus reported total freight volume on annual basis) as offered by Zhang [57], and (2) environmental parameters (such as PAHs and their derivatives) with road-side pollution as the important source of air and water pollution (Kim [58]; Keyte [59], Cambridge Press study [60]), while the impacts of noise as a pollutant cannot be neglected either [61].

In a previous study by Matić Bujagić [62], it was shown that one of the ways for numerous emerging contaminants to enter the aquatic environment can be atmospheric deposition of exhaust gasses and fuel combustion products.

The third and final extension lies in including all other EU candidate countries in the Balkans regions (Montenegro, Northern Macedonia, Albania, Turkey), considering the availability of all performance measures and indicators observed (in the case of Serbia) within this research paper.

Appendix A

Table A1. Inspection of multicollinearity between independent variables.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
X_2		1	0.01	0.01	0.01	0.01	0.11	0.02	0.01	0.1	0.01	0.01	0.01	0.01	0.01
X_3			1	0.01	0.01	0.01	0.05	0.06	0.01	0.02	0.04	0.01	0.01	0.01	0.01
X_4				1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.10	0.11	0.01
X_5					1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.11	0.02	0.01
X_6						1	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
X_7							1	0.01	0.01	0.01	0.01	0.1	0.1	0.01	0.01

Table A1. *Cont.*

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_8								1	0.01	0.01	0.01	0.01	0.01	0.01	0.01
X_9									1	0.01	0.01	0.01	0.01	0.01	0.01
X_{10}										1	0.01	0.01	0.01	0.01	0.01
X_{11}											1	0.01	0.11	0.01	0.01
X_{12}												1	0.01	0.01	0.01
X_{13}													1	0.01	0.01
X_{14}														1	0.01
X_{15}															1

Table A2. Dummy variables definition.

Indepen. Variables	Possible Values of Independent Variables	Values of Standardized Variables	Dummy Variable
Type of business	Cargo transport	$x = \begin{cases} 1, & \textit{if type of business} = \textit{cargo transport} \\ 0, & \textit{if type of business} = \textit{else} \end{cases}$	business_type
	Passenger line transport	$x = \begin{cases} 1, & \textit{if type of business} = \textit{passenger line transport} \\ 0, & \textit{if type of business} = \textit{else} \end{cases}$	
Fleet size (number of vehicles)	Small	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Fleet_small
	Medium	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Fleet_medium
	Large	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Fleet_large
Company size (employees)	Small	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Size_small
	Medium	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Size_medium
	Large	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Size_large
Doing business abroad (cargo)	Home and abroad	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Doing_business_abroad_cargo
	Only domestically	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Doing_business_home_cargo
Doing business abroad (passengers)	Home and abroad	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Doing_business_abroad_pass
	Only domestically	$x = \begin{cases} 1, & \textit{if true} \\ 0, & \textit{else} \end{cases}$	Doing_business_home_pass

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