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EMISSIONS OF CARBON DIOXIDE (CO_2) AND GROWTH THE TOURISM INDUSTRY: CASE STUDY OF LATVIA

Tamara Grizane[1], PhD.; **Gusca Julija**[2], Dr.soc.ing.; **Aija Sannikova**[3], Dr.oec. and **Inguna Jurgelane-Kaldava**[4], Dr. oec.
[1,2]Riga Technical University, VASSI; [3]University of Economics and Culture; [4]Riga Technical University

Abstract. In terms of Kyoto protocol, the reduction of CO_2 emissions of the transport used in tourism is an important goal for Latvia. Based on a top-down and a bottom-up approach, the CO_2 emissions of tourism transport and its types were estimated, while analysing the relation between the CO_2 emissions from tourism transport and the relevant input of the tourism transport as part of GDP and vice versa. The results concerning the period 2010 till 2017 showed that the CO_2 emissions caused by tourism transport rose from 996.8 x 10^3 kg/km to 1527.3 x 10^3 kg/km. The aviation transport associated with the increased tourism activity is the main cause for the increase of CO_2 emissions in Latvia. The connection between the CO_2 emissions from tourism and the contribution of tourism transport to GDP is linear. The trend in increase of CO_2 emissions in the tourism industry is similar to that of other industries.

Key words: CO_2 emissions, tourism, transport, GDP.
JEL code: Q350, L830, R4, EO10.

Introduction

The European Commission has set a goal to decrease the greenhouse gases (GHG) emissions of the transport sector in comparison to 1990 by at least 60 % until 2050 (European Commission, 2011).

Unfortunately, the tourism industry tends to be an increasingly important contributor to the GHG emissions. In these settings the tourism has to comply with the global system for reduction of negative effects set in the Kyoto protocol i.e. the growth of the tourism industry has to be sustainable (WTO, 1996, 21).

The analysis of the corresponding scientific literature indicates to one of the main impacts of the tourism industry: the CO_2 emissions associated with the transport contribute to 65-73 % of the overall energy consumption within the tourism industry (Pigram, 1980; Hunter, 1995; Butler, 2000; Gosslings, 2002; Becken et al., 2003; Holden, 2007).

There is a need to evaluate the CO_2 emissions of the tourism industry, connection between the development of tourism and the GDP, thus allowing the policy makers to make the most appropriate decisions when provided with a timely and precise information, and the public and private transport providers to reduce the CO_2 emissions.

The CO_2 emissions analysis of industries in Latvia does not separate the role of the tourism within from other industries, thus causing hardship for monitoring and policy of this industry in regards to emissions. Taking into account the lack of research on the connection between the CO_2 emissions and the development of tourism industry, the authors set the following **aim of the research:** to determine the CO_2 emissions (kg/km) of the tourism industry and their relation to the development of tourism industry in Latvia, i.e. the contribution of the tourism transport to the GDP growth. In order to reach this aim, the following tasks were set:

1) to determine the CO_2 emissions (kg/km) from the transport involved in provision of the tourism service;

2) to evaluate the connection between the CO_2 emissions (kg/km) tourism transport and the contribution of tourism transport in terms of GDP growth;

[1] tamara.grizane@inbox.lv
[2] Julija.Gusca@rtu.lv
[3] aija.sannikova@inbox.lv
[4] Inguna.Jurgelane-Kaldava@rtu.lv

3) to estimate the connection between the contribution of tourism transport in GDP and the CO_2 emissions (kg/km) from tourism transport.

The methods applied: The research is based on literature studies, the method of analysis as well as synthesis were used in the current study. The research methods are: monographic, comparison, abstract-logical method, synthesis and analysis, induction and deduction, statistic data analysis, top-down and bottom-up approach to determination of CO_2 emissions (kg/km) from tourism, correlation and regressions analysis.

Novelty of the study: Until now in Latvia No research has focused on CO_2 emissions (kg/km) in relation to transport vehicles utilized in tourism, as well as No study has been carried out on the interdependence between the CO_2 emissions and the number of tourists, as well as on the interdependence of CO_2 emissions and the corresponding GDP.

Research sources and materials: the research includes documents from the European Commission, EUROSTAT, STATISTA, CSB of Latvia, international organizations, other statistical materials and research has been carried out. The research is based on previously published reports and analysis the official statistics, as well as author research on emissions of CO_2 and growth the tourism industry.

Research limitations: The following factors, the partial availability of data on tourism transport trip distance for transport by its type, as well as the incoherence of data units, were taken into account. Since in Latvia in terms of the water passenger transport the dominant type of transport is sea fares and there are No data available on the transportation of passengers in the inner waters, only data on the sea transport passengers was used. The overall number of tourists was selected out from the total number, based on the percentage distribution of tourists by means of transport from the year 2017. The research includes data on years 2010 till 2017.

1. CO_2 emissions and transport

The interrelationship between the transport and the tourism is one of the most important relations in tourism system (Lohmann, Duval, 2011). In Latvia tourists tend to use four types of means of transportation: (1) railway (*rail*); (2) aviation (*avio*); (3) sea transport (*sea*) and (4) road vehicles (*road*).

Railway connections (*rail*) are available from Russia, Belarus, Ukraine and Lithuania (LR Satiksmes ministrija, 2019a). Currently aviation is the mass transport industry which ensures connections between Latvia and the rest of Europe and other countries. The airport service (*avio*) in Latvia are carried out by the state capital company (SCC) „Starptautiska lidosta „Riga,", SCC „Latvijas gaisa satiksme" and other service providers (LR Satiksmes ministrija, 2019b).

The sea transportation (*sea*) fares in Latvia are mainly provided by the three largest harbours of Latvia in Riga, Ventspils and Liepaja. The main influx of tourists is provided by the ferries connecting Latvia with the harbours of Sweden and Germany (LR Satiksmes ministrija, 2019c). Regarding the road transport, the tourists mostly are transported by bus coaches, a segment in which from 2010 to 2017 in total of 28 companies 410-438 licenced tour-operators from Latvia were present (Autotransporta direkcija, 2019).

Since the CO_2 emissions cause serious risks for the environment, it is important to examine the amount of CO_2 emissions caused by the transport in tourism sector. The calculation of emissions commonly is pursued while following methods and parameters based on the guidelines by the *Intergovernmental Panel on Climate Change* (IPCC) (IPPC, 2018).

In order to estimate the quantity of CO_2 emissions being produced from transport in tourism industry, researchers had commonly used two approaches, namely, the top-down and the bottom-up (DEFRA, 2007; Perch-Nielsen, Sesartic, Stucki, 2010; Peeters, Dubois, 2010; Tao, Huang, 2014).

The authors chose to mainly use the bottom-up approach, i.e. to use the information acquired from the research area. The bottom-up approach allows for synthesis of the collected data from different regions when conducting similar studies in the future, which is important in Latvia's case. The top-down approach in the meantime allows to use the statistical data and other information based on European and global information sources and transport policy makers (Nicholls, Barnes, Acrea, Chen, Buluç, and Parker, 2015). The authors describe the proposed approach as a hybrid approach between the bottom-up and the top-down approaches.

Based on the analysis of literature, it was decided to estimate the CO_2 emissions by the transport in tourism while using the hybrid approach (top-down and bottom-up) and a modified formula, based on Chen, Thapa, Yan (2018). The formula for estimation of CO_2 emissions from tourism transport is as follows:

$$C_{s;t} = \sum_{s=1}^{n} D_{s;t} \times \beta_{s;t} \quad (1)$$

Where:

$C_{s;t}$ – the total CO_2 produced by the transport in tourism during time *t (year)* according to the type of transport *s* (*rail*, *air, road, sea*), kg/km;

$D_{s;t}$ – number of visitors (*tourist*) per each type of transport during time t *(year*) ;

$\beta_{s;t}$ – CO_2 emissions per one unit (per each type of transport), kg/pkm.

Explanation: Passenger kilometre (pkm, is a unit of measure that represents the transport of one passenger by a particular mode of transport (road, rail, air, sea, inland waterway, etc.) that exceeds one kilometre (EUROSTAT, 2016).

Literature studies indicated that for estimation of CO_2 emissions the average emissions per one unit (transport vehicle) in g/km or kg/km can be used (Defra, 2007; Smith, Rodger, 2009). How ever based on information on the differentiation of the incoming international tourisms by types of transport the following percentage can be used: *avio* – 57 %, road – 37 %, sea – 4 % and rail – 2 % (Statista, 2017).

2. CO_2 emissions and growth the tourism industry

In the energy economics, especially in countries like China, which was responsible for almost 50 % of total global increase of CO_2 emissions in 2018, the connection between the tourism growth and CO_2 emissions is studied (CarbonBrief.org., 2018; Chen, Thapa, Yan, 2018). The studied literature indicate that there are different causality types: (1) unidirectional causal flow from tourism to economic growth (the tourism-led growth hypothesis); (2) unidirectional causal flow from economic growth to tourism (the growth led tourism hypothesis); (3) neutrality, where neither of the variables influences the other and (4) bidirectional causal relationship exists between tourism and economic growth, which is known as the feedback hypothesis (Squalli, 2007).

Examples of the first type are as follows: Arslanturk and Atan (2012) use input-output analysis to examine the tourism and economic growth in Turkey. The study gives evidence that tourism significantly contributes to the growth of the economy. The study of Chiu and Yeh (2016) investigated the tourism development–economic growth nexus and found a linear positive impact of international tourism receipts on economic growth, which confirms evidence of the tourism-led growth hypothesis. However, the fourth types are the most commonly used (Table 1).

Table 1

Summary of main studies on carbon emission and tourism growth relationship

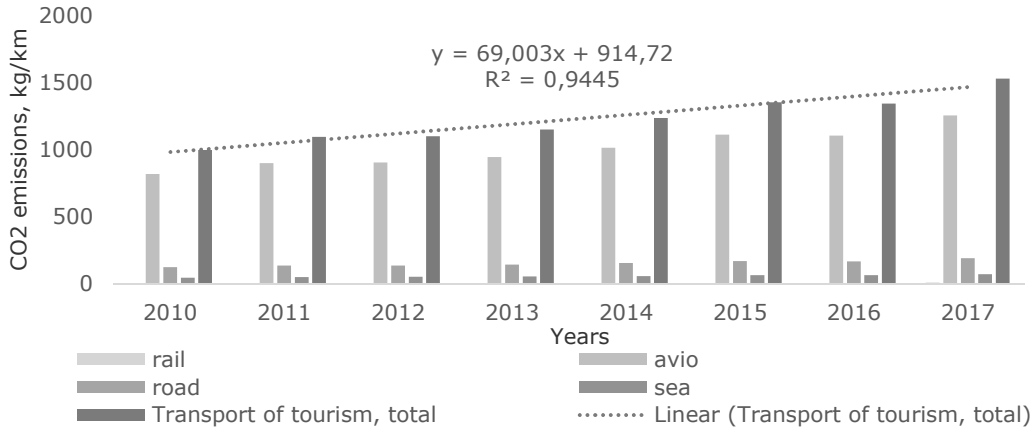
Authors	Variables	Causality
Lee, Brahmasrene (2013)	• CO_2 emissions • Tourism growth	bi-directional
Katircioglu et al. (2014)	• CO_2 emissions • Energy Consumption • Tourism growth	bi-directional
Paramati, Samsul, Lau (2018)	• CO_2 emissions • Economic growth	bi-directional
Chen, Thapa, Yan (2018)	• CO_2 emissions • Tourism growth • Economic growth	bi-directional
Tuggu, Topcu (2018)	• CO_2 emissions • Tourism growth	bi-directional

Source: author's extrapolated based on Lee, Brahmasrene, 2013; Katircioglu et al., 2014; Chen, Thapa, Yan, 2018; Paramati, Samsul, Lau, 2018; Tuggu, Topcu, 2018.

Summary of main studies on CO_2 and tourism growth relationship (Tabula 1) indicate of an existing causality between the economic growth and CO_2 emissions depending on the level of interdependence of the causality feedback. According to the tourism growth hypothesis, the tourism is the key growth component which should manifest in GDP growth. In order to check this assumption, the total amount of CO_2 emissions from tourism transport in Latvia was calculated (Fig. 1).

Research results and discussion

The total changes to CO_2 emissions (kg/km) from 2010 to 2017 were linear, which is depicted in (Fig. 1) the regression equation. The Fig. 1 shows an annual growth in CO_2 emissions (kg/km) in sectors of tourism growth, with the exception of a moderate decrease in 2016, when in comparison to 2015, when due to economic factors the number of foreign tourists decreased by 0.7 %. The largest reduction in 2016 in number of tourists by countries was observed in tourists from Sweden (-37 %), Belgium (-34.6 %), the Czech Republic (-23.4 %) and Russia (-20.3 %) (LR CSB, 2016).



Source: author's calculations based on Defra, 2007; Smitt, Rodger, 2009; UNWTO, 2011, 2017; Statista, 2017; Autodirekcija, 2019; LR CSB, 2019; LR SM, 2019; World Bank Group, 2019

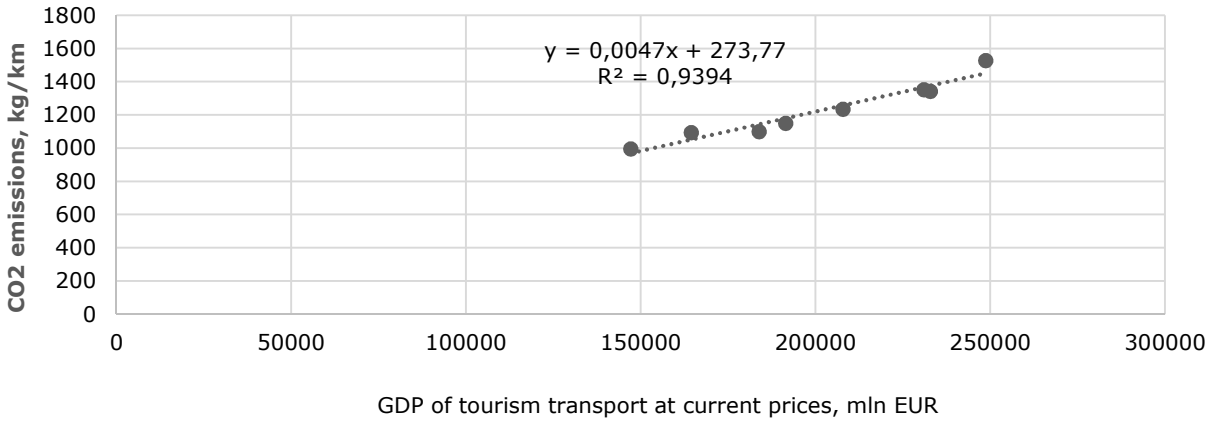
Fig. 1. **CO_2 emissions from tourism transport in Latvia from 2010 to 2017, kg/km**

The changes to CO_2 emissions (kg/km) in tourism transport field in an annual comparison tend to be sTable – in 2013 in comparison with 2012 the increase in CO_2 emissions (kg/km) in *rail was* 4.49 %, *avio* – 4.54 %, *road* – 4.54 %, while *sea* – 4.53 %. In 2017 in comparison with 2016 the CO_2 (kg/km) increase in *rail* was 13.69 %, *avio*- 13.66 %, *road* -13.66 %, while *sea* – 13.64 %. This

can be explained by not only the increase in number of tourists, but also with the comparably similar modernization trends in the given transport type industry. Meanwhile in 2016 in comparison to 2015 CO_2 emissions (kg/km) decreased in every transport type industry on average by 0.65 %, which can be explained by the decrease in the total number of tourists 0.65 %.

In comparison with the 2010, in 2017 the total number of tourists using every type of transport increased by 53.20 %, meanwhile over this period the CO_2 emissions (kg/km) increased by 53.22 %. In addition, the changes to both the number of tourists and the CO_2 emissions were almost equal. Thus it can be concluded that the changes in number of tourists impact the total CO^2 emissions (kg/km) by different types of transport.

When determining the interrelation between the CO_2 emissions (kg/km) of tourism transport and the GDP of tourism transport growth (Fig. 2), i.e., between the factorial and resulting indication functionally strong linear connection was estimated (R^2=0.939; R=0.969; F=93.042; p= 0.000) (Fig. 2). Thus 93.9 % of total changes to CO_2 emissions from the tourism transport emissions can be explained by a linear regression model, however since the F-test p-value is 0.000, then it can be concluded that the model is statistically relevant at the significance of 99.9 %.



Source: author's calculations based on Defra, 2007; Smitt, Rodger, 2009; UNWTO, 2011, 2017; Statista, 2017; Autodirekcija, 2019; LR CSB, 2019; LR SM, 2019; World Bank Group, 2019

Fig. 2. **Relationship between CO_2 emissions (kg/km) of tourism transport and GDP of tourism transport at current prices (mln EUR) in Latvia from 2010 to 2017**

As a result, the dependence of CO_2 emissions (kg/km) (Fig. 2) from the GDP of tourism transport growth can be expressed by the equation (1):

$$Y_t = 273.77 + 0.0047\chi_t\,, \tag{2}$$

Where:

Y_t – CO2 emissions in t (year) period, kg/km;

χ_t - GDP of tourism transport growth in t period at current prices, mln euro;

R – determination coefficient.

When determining the causality between the GDP increase the tourism transport growth and the CO_2 emissions caused by the tourism transport, the causality between the variables can be observed in a linear equation:

$$Y_t = -42135.487 + 198.362\chi_t \tag{3}$$

Where:

Y_t – CO_2 emissions in t (year) period, kg/km;

χ_t – GDP of tourism transport growth in t (year) period at current prices, mln euro;

R – determination coefficient.

Despite the fact that the model indicates of an existing linearity, however when analysing the significance level of the free coefficient and regression coefficient it was determined that the value for the free coefficient p =0.148>0.05. Thus it is to be concluded that the coefficient does not sufficiently explain the causality and further CO_2 emissions estimations should be made.

Such a causality found in this research gives evidence to the assumption that the GDP is an economic growth indicators, which was indicated by multiple authors, but which did not comply to a previously diagnosed causality (Table 1). Thus the acquired results on the causality further base the tourism growth hypothesis (Lee, Brahmasrene, 2013). Previous research indicates that the growth of tourism industry increase the CO_2 emissions (Katircioglu, 2014). The results of this research did not prove the given assumption. Therefore, it is necessary in the future research to examine the reasons for such incompliance.

However, although the increase in the number of tourists using transport vehicles increase the CO_2 emissions, there are multiple ways for them to be reduced. The authors believe that due to the diversity and use of multiple research limitations and the use of specific methodology, that in the results could vary in different settings, however the research indicated the development trends and new field for possible future research. Altogether this research indicates of a necessity for the tourism policy planners to pay larger attention to the reduction of CO_2 emissions in terms of development tourism transport policy.

Conclusions, proposals, recommendations

1) Based on the case study of Latvia, this quantitative research estimated the CO_2 emissions (kg/km) from the use of transport vehicles utilized within the tourism industry and it's dynamic from 2010 to 2017, which accounted for 996.8 x 10^3 kg/km until 1527.3 x 10^3 kg/km. The avio transport was the main source of increase in terms of CO_2 emissions in Latvia. The CO_2 emissions increased due to the increase in the number of tourists and possibly due to the lack of renewal of transport vehicles.
2) When analyzing the causality between the CO_2 emissions from the tourism transport and the investments of tourism within the GDP a strong linear causality was observed – the increase of tourism contribution to the GDP increases the CO_2 emissions (R^2=0.939). The research approved that the increase of number of tourists in the use of transport further the increase of CO_2 emissions in tourism transport.
3) The policy planners of tourism should pay more attention to the impact of CO_2 emissions when preparing tourism development policy papers, thus ensuring a timely change for the use of less CO_2 emissions intensive vehicles within the tourism industry.

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