Chapter 19
Transport Optimization and Estimation of Reduced CO₂ Emissions

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ABSTRACT

The chapter deals with the road transport optimization and estimation of reduced CO₂ emissions. To reduce the latter, several approaches were adopted, like alternative technologies, sustainable community changes, and changes in driving behavior. Another possible approach is to reduce the vehicle miles of traveled (VMT) by the means of transport optimization. In this chapter, the heuristic optimization approach for VMT reduction is firstly presented and tested for the case of School Bus Routing Problem. Afterwards, main focus is dedicated to the models for estimation of reduced CO₂ emissions. Herein, MEET emission model is integrated into the Monte Carlo based scenario playing algorithm, which calculates the total CO₂ emissions in the dependence of the randomly independently changing average speeds of the vehicles of the driving fleet. This algorithm is applied to the optimized situation, and the calculated results are compared with the unoptimized case. Results show that the applied optimization concept can significantly reduce the CO₂ emissions compared to unoptimized conditions.

INTRODUCTION

The global greenhouse gas (GHG) emissions grew up essentially in the last four decades, which means almost 70% increase between years (1970-2004) (Metz, Davidson, Bosch, Dave & Meyer, 2007). The
human actions related to the economic activities are in general mostly responsible for this increase, which is also detected in the rise of atmospheric GHG based concentrations.

Among industrial sectors, the transportation economic sector is one of the biggest generators of GHG emissions, besides the energy supply sector. Unfortunately, the emissions related to transportation, particularly produced by the road transport, are still rising (Chapman, 2007). Therefore, the urgent need to reduce the GHG emissions produced by the transport, mainly carbon dioxide based emissions, is not surprising.

Despite a significant number of different measures and policies related to the climate change and sustainable development, which were adopted in all major economic sectors of developed countries, these counteractions are still not enough to prevent the global increase in GHG emissions. So the scientists predict that regardless of the current policies related to the climate change mitigation, the global emissions will continue their rising in the following decades (Metz et al., 2007).

The introduced work in this chapter represents the continuation of the extensive research, whose previous stages have been already presented in the contributions (Dragan, Kramberger & Lipičnik, 2011; Kramberger, Dragan & Prah, 2013; Dragan, Kramberger & Prah, 2014). To reduce the CO2 emissions generated by the road transport, several different approaches were adopted in the last decades, such as the use of alternative technologies, sustainable community changes, changes in driving behavior, and so (Kramberger et al. 2013; Dragan et al., 2014). The approach in our work is based on the road transport optimization in order to reduce the “Vehicle Miles Traveled” (VMT). The previous research has proven that the VMT reduction in principle also leads to the reduction of CO2 emissions (Kramberger et al., 2013; Dragan et al., 2014). Optimization concept in our research is based on the composite of different heuristic techniques, which are applied via several stages. Additionally, the well-known Geographical Information Systems (GIS) technology (Heywood, Cornelius & Carver, 2011) is also conducted in research.

Unexpectedly, it was detected in the existing literature that not much attention has been devoted to the VMT reduction, which is based on the transport optimization (Kramberger et al., 2013). Even less attention has been dedicated to the studying of the estimation of CO2 emissions when optimization based VMT reduction is applied (Dragan et al., 2014). Since those detected gaps in the existing researches are relatively significant, we believe that the work introduced in this chapter might represent a certain contribution to the field.

In order to illustrate, how the optimization based VMT reduction can also enable a noticeable reduction of CO2 emissions, the School Bus Routing Problem (SBRP) (Park & Kim, 2010) was applied to one municipality located in Slovenia. Herein, the optimal determination of bus stops was employed at first. Afterward, the optimal driving routes, driving fleet and driving schedules were determined. Finally, in the last phase of the optimization procedure, the calculation of VMT of driving fleet was carried out for the simulated optimal situation.

The latter means that the driving kilometers under the optimized conditions were estimated by the means of simulations based on the GIS software (Heywood et al., 2011) and its extension Arclogistics (Prasertsri & Kilmer, 2003; Weigel & Cao, 1999). Naturally, to enable the comparison of the driven kilometers for the real (unoptimized) and simulated (optimized) situation, the information about the real VMT generated in the observed school year was also obtained. The latter was possible since the municipality authorities asked us to offer our research experience to help them solve their SBRP problem.

After completion of the optimization procedure, the research redirects its focus exclusively to the studying of the complex relationships between the produced VMT on one side, and the resulting CO2