GREEN PROGRESS AS A MEASURE OF MUNICIPAL WASTE MANAGEMENT POTENTIAL

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ABSTRACT

The aim of this paper is to propose a conceptual model for calculation of Green Progress stipulated by the municipal waste management activities and empirically implement the model based on the case of Lithuania and its regions. The research methodology is comprised of the scientific literature analysis on waste management, gathering of statistical data on waste flows, inhabitants living in the regions of Lithuania and economic entities operating in these regions and creation of conceptual model of calculation of Green Progress stipulated based on literature review. The main results show that Klaipėda, Kaunas, Panevėžys and Telšiai regions have considerable improvement in the waste management practices, Vilnius, Utena, Marijampolė and Alytus regions have shown no improvement while Šiauliai and Tauragė regions have weakened waste management systems.

Keywords: Green Progress, valuation, performance, municipal waste management, circular economy.

INTRODUCTION

The growth of municipal waste around the world has now a major concern of the governments, policy makers, businesses and citizens of the cities. Differences in the waste management approaches create a clear need of evaluation of the waste management system's performance.

The aim of this paper is to propose a conceptual model for calculation of Green Progress stipulated by the municipal waste management activities and empirically implement the model based on the case of Lithuania's regions with obtained results which can be incorporated into financial or economic models, or be a part of a planning and decision-making process of government bodies on national or local level.

The article is comprised of the four sections: the first section investigates the importance of municipal waste management in the context of circular economy, the second section explains research methods and proposes the concept for the valuation of municipal waste, the third section introduces results and findings of the research and the fourth section provides conclusions and provides guidelines for further research and discussion points.

1. MUNICIPAL WASTE MANAGEMENT IN THE CONTEXT OF THE CIRCULAR ECONOMY

Municipal waste is a type of waste consisting of household waste, waste of the similar characteristics to the domestic, large urban waste, waste collected on the streets and in the parks (Medina-mijangos & Seguí-amórtegui, 2020). This type of waste is difficult to manage due to diverse number of components (Amasuomo & Baird, 2016). Municipal waste management is combination of systematic measures aimed to regulate the generation of municipal waste, it's collection, storage and treatment along with environmental, social and economic best-practice (Akbarpour Shirazi et al., 2016). The terms solid waste management and municipal waste management are often used as synonyms (Yu et al., 2021).

The principles of circular economy have direct relationship with municipal waste management practices. The 3R (reduce-reuse-recycle) principle of circular economy has been applied across the globe to deal with municipal solid waste challenges (Fei et al., 2018). The extension of above-mentioned principle of circular economy is 4R (reduce-reuse-recycle-recover) which incorporates resource management (Nazari et al., 2021). The 5R (rethink-reduce-reuse-repair-recycle) principle includes the awareness of the individuals of their actions towards environment (Tserng et al., 2021). The further development of the circular economy principles led to 7R (rethink-reduce-reuse-repair-recycle-resilience-regulate) which includes resilience and regulation standpoints (Xing et al., 2017). The circular economy principles evolved 10R (reduce-reuse-refuse-rethink-remanufacture-repair-refurbish-repurpose-recycle- recover) to address the manufacturing cycles within the circular economy principles (Modgil et al., 2021). As observed through circular economy principles, economic and environmental dimensions should be analysed at once when making sound decisions towards sound municipal waste management strategies. (Singh & Basak, 2018).

2. RESEARCH METHODS

A number of methods such as cost-benefit analysis, life cycle assessment and multi-objective approach has been proposed by the researchers to evaluate the

performance of municipal waste management systems (Fan et al., 2020). Other ways to assess the performance of municipal waste management systems includes the use of indicators (Rogge & De Jaeger, 2012).

The conceptual model for the calculation of Green Progress is comprised of three stages **(Fig. 1).** Firstly, statistical data on waste amounts generated in the 10 regions of Lithuania is collected along with data on the number of inhabitants and registered economic entities in the same regions. Herein, the data is collected from the Environmental Protection Agency of the Republic of Lithuania. Thus, data analysis is performed followed by the calculation of Green Progress.

The Green Progress concept includes the evaluation of the municipal waste management system referring to the municipal waste amounts generated within the area of investigation and during the specified period of time. Green Progress shows the "health" of municipal waste management system by evaluating the effects of waste management actions on high-level. Thus, the results of the calculation of the Green Progress can indicate that the waste management strategy needs to be reviewed and deeper analysis involving life cycle assessment, multi-objective approaches or indicators is necessary.

The formula for the calculation is based on the evaluation of the number of inhabitants and economic entities along with the amounts of waste generated by these two groups:

$$Green\ Progress = \frac{WCEE_t - WCEE_{t-1}}{WCEE_{t-1}}$$

where *WCEE* stands for the waste generated per capita and registered economic entities and *t* stands for the year of the observation. The results can span between negative, positive and zero values. The negative values actually indicate the positive performance of municipal waste management system, meaning that the waste amounts decreased in comparison to the number of inhabitants and registered economic entities. On the other hand, positive values show that there has been an increase in the waste amounts, and zero values indicate now change between variables.

3. RESEARCH RESULTS

The proposed conceptual model provides results of the calculation of the Green Progress for the 10 regions of Lithuania **(Table 1).** Green Progress in the regions have been calculated for the period of 2015-2019. Results imply that Klaipėda region has been improving the performance of municipal waste management two years in a row. Kaunas, Panevėžys and Telšiai regions have considerable decrease in generated waste compared to the number of inhabitants and registered economic entities. Vilnius, Utena, Marijampolė and Alytus regions have shown no improvement in 2019 in comparison to 2018. Šiauliai and Tauragė regions have an increase of waste amounts per capita and registered economic entities in 2019.

The variations in the results of the Green Progress calculation can be explained through the analysis of the statistical data related to waste and inhabitants. The Green Progress in Klaipėda region in the year 2015 can be explained by the increase in the amount of collected waste and decrease in the number of inhabitants and economic entities. In Marijampolė region the value of the indicator has reached 88% in 2018 which can be explained by decrease of inhabitants and economic entities from 276 749 in 2017 to 148145 in 2018 while the amount of waste generated only decreased by 291 ton.

CONCLUSIONS

Understanding the performance of the municipal waste management systems plays an important role in the development of waste management strategies. The conceptual model for calculation of the Green Progress is empirically implemented on the regional-level

Fig.1. Conceptual model of Green Progress calculation (compiled by authors)

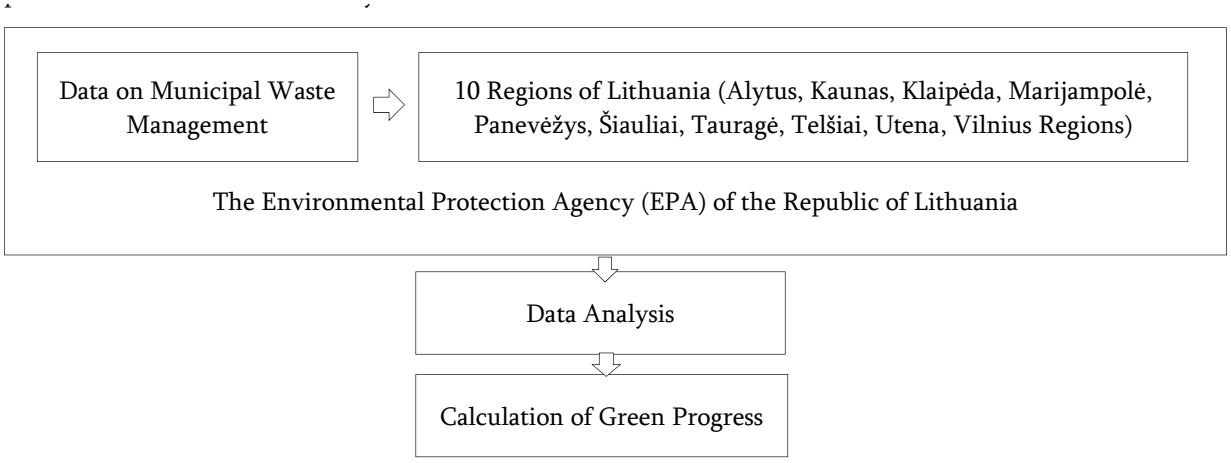

Table 1. Results of the Green Progress calculation of the 10 regions of Lithuania (compiled by authors)

Region	2015	2016	2017	2018	2019
Alytus region	3 %	3 %	9 %	8 %	0 %
Kaunas region	-8 %	6 %	6 %	7 %	-5 %
Klaipėda region	95 %	-46 %	2 %	-5 %	-5 %
Marijampolė region	4 %	-12 %	-9 %	88 %	0 %
Panevėžys region	5 %	-13 %	3 %	13 %	-10 %
Šiauliai region	19 %	-14 %	8 %	-11 %	11 %
Tauragė region	29 %	0 %	-20 %	8 %	9 %
Telšiai region	0 %	-6 %	17 %	1 %	-25 %
Utena region	3 %	3 %	-6 %	-41 %	0 %
Vilnius region	-25 %	6 %	3 %	-18 %	0 %

data. Results imply that Klaipėda, Kaunas, Panevėžys and Telšiai regions have considerable improvement in the waste management practices in 2019, while Vilnius, Utena, Marijampolė and Alytus regions have shown no improvement in 2019. Šiauliai and Tauragė regions have weakened waste management systems in 2019.

The proposed conceptual model and the Green Progress concept can be extended with other environmentally-significant variables, such as recycling rates, as it will provide more robustness in the valuation of performance of municipal waste management. The further research can be extended by the investigation of Green Progress on a country-level and also on country and regional levels of various countries.

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