Technical-economic and environmental analysis of re-designed products from recyclable waste in the context of circular economy

E.D. Comăniță [(1)], T. Câmpean [(1) (2)], M. Gavrilescu[(1) (3)]

[(1)] "Gheorghe Asachi" Technical University of Iasi, Faculty of Chemical Engineering and Environmental Protection, Department of Environmental Engineering and Management, 73 Prof. dr. doc. Dimitrie Mangeron Street, 700050 Iasi, Romania
Phone: +40744 237487, e-mail: comanita_elena_diana@yahoo.com
[(2)] Rondocarton SRL, Cluj-Napoca, 2 Aviatorilor Street, Sânnicoară-Apahida, 407042, Cluj-Napoca, Romania
[(3)] Academy of Romanian Scientists, 54 Splaiul Independentei, RO-050094 Bucharest, Romania

1. Introduction – The production processes are in a close connection with the environment regarding resource consumption and waste generation [1]. It is obvious that generation of waste in manufacturing processes is the consequence of an inefficient and unsustainable use of natural resources and energy and can determine manufacturers to adopt the principles of circular economy to improve the eco-efficiency [2]. In this context, the present study has developed an analysis of the eco-efficiency for two re-designed products using the production waste resulted during corrugated board and cardboard box manufacturing as raw material, in an "in-plant" reuse approach. The analysis was developed in the frame of eco-innovation and eco-design concepts and took into account economic, technical, and environmental criteria by applying Multicriteria Decision Analysis (MCDA).

2. Experimental - This investigation is useful in the decision making process in terms of optimal allocation of resources, so as to maximize the anticipated output for the given input. The selected boundaries for the two series of alternatives are: production of a re-designed product using small-dimensions (shredded) production waste (**Process 1**), and production of a re-designed product using larger-size production waste (**Process 2**), both waste categories resulted during corrugated board and cardboard box manufacturing. Two approaches will be considered: (i) Analytical Hierarchy Process (**AHP**) method; (ii) the outranking approach – Elimination et Choix Traduisant la Realité (**ELECTRE**) method. All steps of **ELECTRE** and **AHP** methods have been completed. For the correct assessment of eco-efficiency, three groups of sustainable development indicators addressing economic, environmental and technical issues were considered (Image 1).

3. Results and Discussion - The results of our analyses based on various optimization algorithms allowed us to rank options, select a single optimal alternative or differentiate between acceptable and unacceptable alternatives in product eco-innovation and eco-design, in order to make the best decision in the context of multiple assessment criteria.

4. Conclusions - Data and information gathered in our study can be used as a support for decision-making in the frame of knowledge transfer between research and industry on the valorization of waste from cardboard packaging process to close the production cycle.

5. Acknowledgement: This work was supported by a grant of the Romanian National Authority for Scientific Research, CNCS – UEFISCDI, project number PN-III-P2-2.1-BG-2016-0130, Contract 64BG/2016

6. References

[1] C.D. Heaney, S. Wing, R.L. Campbell, D. Caldwell, B. Hopkins, D. Richardson, *Environ. Res.* **111**(2), (2011) p. 847–852.
[2] G. De Feo, S. De Gisi, I.D. Williams, *Waste Manage.* **33**(2), (2013) p. 974–987