

BULETINUL INSTITUTULUI POLITEHNIC DIN IAȘI  
Publicat de  
Universitatea Tehnică „Gheorghe Asachi” din Iași  
Volumul 66 (70), Numărul 3, 2020  
Secția  
CHIMIE și INGINERIE CHIMICĂ

## FUZZY LOGIC METHODOLOGY FOR ENVIRONMENTAL SUSTAINABILITY PERFORMANCE EVALUATION

BY

IONUȚ VIOREL HERGHILIGIU<sup>1,2,\*</sup>, IOAN BOGDAN ROBU<sup>2</sup>, MARIUS  
PÎSLARU<sup>1</sup>, ADRIAN VÎLCU<sup>1</sup> and ANCA LAURA ASANDULUI<sup>2</sup>

<sup>1</sup>“Gheorghe Asachi” Technical University of Iași,  
Faculty of Industrial Design and Business Management  
<sup>2</sup>“Alexandru Ioan Cuza” University of Iași,  
Faculty of Economics and Business Administration

Received: June 23, 2020

Accepted for publication: July 29, 2020

**Abstract.** Environmental sustainability performance evaluation has become a challenge even if the literature presents many associated researches. This challenge is a consequence of multiple measures that can be used to approach this phenomenon. The paper purpose is to improve the evaluation process associated to this pillar of organizational sustainability – environmental issue/ performance. Hence this paper aim to propose a suitable evaluation methodology, based on fuzzy logic, for environmental sustainability performance – focus on variables and associated dimensions of the proposed model.

**Keywords:** environmental performance; EMS; suitable evaluation methodology.

### 1. Introduction

Environmental sustainability represents a fundamental dimension associated to organizational sustainability; it's importance derives from the fact that “the incorporation of sustainability goals and taking sustainability

---

\*Corresponding author; *e-mail*: iherghelegiu@tuiasi.ro

initiatives within and outside the organizational boundaries (...) not only improve the ecological and social performance of organizations, but also increase their competencies and create a further competitive advantage for them” (Qorri *et al.*, 2018; Saeed and Kersten 2019; Saeed and Kersten, 2020).

Environmental sustainability is an organizational practice that target to conserve natural resources, reduces negative environmental impact and improve the human life quality (Brundtland, 1987; Jang *et al.*, 2017; Jang and Zheng, 2020; Pîslaru *et al.*, 2019). Hence practice implies some attribute categories such as: energy efficiency, material efficiency, water management, waste management, emissions, land use, environmental compliance and supplier assessment (Saeed and Kersten, 2020). Likewise, is related to “purchasing greener products, conserving energy and water, building green rooms or stores, reducing waste, and recycling (Jang *et al.*, 2017; Jang and Zheng, 2020).

Taking into account that “environmental responsibility is good for business” (Esty and Cort, 2017), the pursuit and development of a simple and reliable methodological framework to measure environmental performance is a necessity (Pîslaru *et al.*, 2019).

Literature presents that this sustainability dimension (environmental) “is moving beyond being just a legal obligation - it also stands out as a good business practice through the expansion of markets and the improvement of sales” (Curkovic and Sroufe, 2016; Angelakoglou and Gaidajis, 2020).

Regarding the evaluation process of environmental performance, the International Standard Organization (ISO) in ISO 14031 defines it as a “process to facilitate management decisions regarding an organization’s environmental performance by selecting indicators, collecting and analyzing data, assessing information against environmental performance criteria, reporting and communicating and periodically reviewing and improving this process” (Dias-Sardinha and Reijnders, 2001; ISO, 2013).

Various frameworks are used to evaluate and report environmental and sustainability performance. Scholars and international organizations have developed such frameworks. Efforts have been made to reduce instruments diversity. However, this diversity metrics remains large (Dias-Sardinha and Reijnders, 2001; Pîslaru *et al.*, 2019).

Antolín-Lopez *et al.* (2016) mention that (i) instruments diversity associated with the assessment of organizational sustainability dimensions and (ii) the low level of knowledge on this topic “create complexity and confusion for academics and practitioners” leaving it open to debate (Pîslaru *et al.*, 2019).

Concluding “much more focus needs to be given to what really matters in terms of environmental impacts - and the structure of metrics needs to be regeared to reflect this materiality analysis” (Esty and Cort, 2017; Pîslaru *et al.*, 2019).

## 2. Methodological Framework Associated to Environmental Performance Evaluation Based on Fuzzy Logic

In the assessment associated to organizational sustainability dimensions/ pillars are used instruments as “... Kinder, Lydenberg and Domini (KLD), Morgan Stanley Capital International (MSCI), Dow Jones Sustainability Index (DJSI), United Nations Global Compact (UNGC), ISO 26000, Global Reporting Initiative (GRI) and B-Corporation (B-Corp)” (Pîslaru *et al.*, 2019). However, in the literature “inconsistent methodologies as expounded” (Font and Harris, 2004; Acquaye *et al.*, 2017).

The models used to assess “different aspects of sustainability development are the quantitative models ... that addresses economic models ..., simulation models ..., policy models ..., and fuzzy logic models” (Pîslaru *et al.*, 2019).

To contribute, clarify and simplify the methodological approach regarding this topic, this paper aim is to improve the evaluation process associated to this pillar of organizational sustainability – environmental issue/ performance. Hence, this research main objective to propose a suitable evaluation methodology, based on fuzzy logic, for environmental sustainability performance – focus on the dimensions and the aspects viable for the model.

### 2.1. Fuzzy Logic Approach

The fuzzy algorithms, presents advantages, as simple calculation, high robustness, transfer functions (Yager and Filev, 1994). Fuzzy approach consider that knowledge is encoded in antecedent-consequent structure form (Tanaka, 1997).

Fuzzy models have ability to represent a process with different types of data. Fuzzy modeling approach is able to build models dealing with concepts of uncertainty, including probabilistic logic definitions (Phillis and Kouikoglou, 2009). The fuzzy inference system is a computing framework based on concepts of fuzzy set theory, fuzzy if-then rules and fuzzy reasoning (Kandel, 1992).

A block diagram of the Fuzzy Inference System (FIS) (Phillis and Kouikoglou, 2009), is shown in Figure 1 that consists of four main modules: the fuzzifier, inference engine, defuzzifier, and the fuzzy system definition.



Fig. 1 – Block diagram of the Fuzzy Inference System (FIS).

Fuzzy methods are an alternative design for complex processes and systems. Operations performed with fuzzy variables and associated fuzzy rules are based on the understanding physical phenomena (Cartwright, 2008).

The purpose of a fuzzy inference system is to deduce a conclusion based on the possibly uncertain information (Yager and Filev, 1994).

A fuzzy modeling process has the following features (Castillo and Melin, 2008):

- the rule structure of a fuzzy inference system; incorporate human expertise associated to target system directly into the modeling process;
- conventional system identification techniques can be used for fuzzy modeling, when the input-output data is available; the use of numerical data also have an important role in fuzzy modeling.

The fuzzy modeling algorithm implies the following steps (Pîslaru *et al.*, 2019; Herghiligiu *et al.*, 2019): (i) fuzzification, (ii) rule evaluation, (iii) rule outputs aggregation, (iv) defuzzification.

## 2.2. Proposed Methodological Framework to Environmental Performance Evaluation Based on Fuzzy Logic

Proposed/ developed evaluation model [hierarchical structure] of environmental sustainability performance can be seen in Fig. 2.

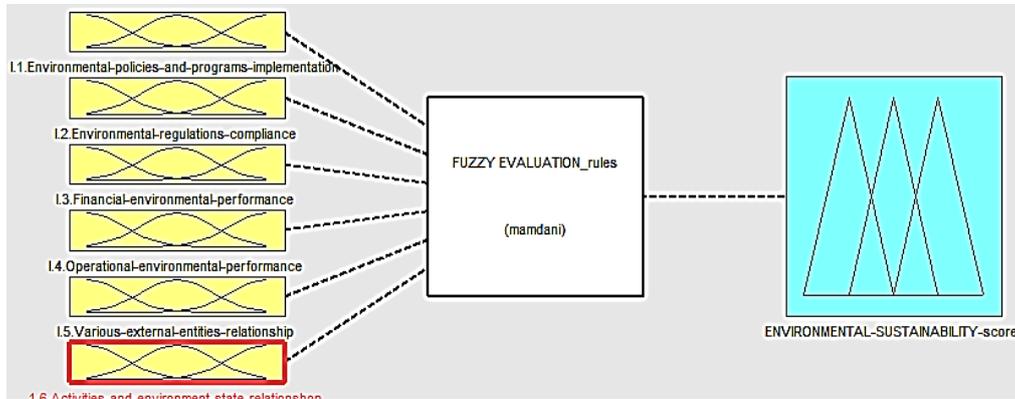


Fig. 2 – Theoretical evaluation model associated to environmental sustainability performance.

For the evaluation model also it's necessary to specify that the fuzzy modeling algorithm involves several main phases:

**(1) fuzzification:** fuzzy sets are based on a fundamental concept - the linguistic variable. A fuzzification tool converts numeric (normalized) inputs into linguistic variables through appropriate membership functions (Bottani *et al.*, 2017; Pîslaru *et al.*, 2019; Zadeh, 1975).

It's considered appropriate the trapezoidal function ( $\mu(x)$ ). Likewise, a 4-points linguistic scale is considered relevant, as follows (Bottani *et al.*, 2017):

- (i) very good – VG: 70%-100%, were  $\mu(x) = 1$ , if  $x \geq 0,75$ ;
- (ii) good – G: 45%-75%, were  $\mu(x) = 1$ , if  $0,5 \leq x \leq 0,7$ ;
- (iii) low – L: 20%-50%, were  $\mu(x) = 1$ , if  $0,25 \leq x \leq 0,45$ ;
- (iv) very low – VL: 0%-25%, were  $\mu(x) = 1$ , if  $0 \leq x \leq 0,2$ .

(2) **inference** – the process is based on a series of rules that link fuzzy inputs and outputs, as follows (Bottani *et al.*, 2017):

*IF x is A AND y is B (premises) THEN z is C (conclusion).*

were *A, B* and *C* are linguistic values defined by fuzzy set associated to *X, Y* and *Z* analysis universe.

(3) **defuzzification**: is the last phase of fuzzy inference process in order to obtain a generalized result. Implies two steps (Bottani *et al.*, 2017):

(i) choosing the defuzzification method; the most common used, simple and effective procedure is fuzzy average [FA]; therefore, it's recommended the use of FA.

(ii) the final score normalization.

In the proposed model also it's recommended to be used certain representative variables and dimensions (associated to organizational environmental performance) (adapted after Herghiligiu, 2013; Herghiligiu, 2019), as it follows:

**I.1.** for the variable: "Implementation of environmental policies and programs" four dimensions were taken into account – Table 1.

**Table 1**  
Variable "Implementation of the Environmental Policies and Programs"  
Source: Herghiligiu, 2013; Herghiligiu, 2019

No.	Variable name	Associated variable dimensions	Selective literature
I.1.	"Implementation of the environmental policies and programs"	I.1.1. General environmental objectives and targets I.1.2. Environmental policy I.1.3. The suggestions of the employees/ management team/ shareholders/ suppliers/ customers/ representatives of various public institutions with which the organisation interacts/ representatives of NGOs aiming at the improvement of the environment quality I.1.4. The implemented actions regarding the environmental pollution prevention	Lupu <i>et al.</i> 2006; Teodosiu, 2005; Ionescu, 2000; Link and Naveh, 2006; Christman and Taylor, 2006; Naveh <i>et al.</i> 2006; Zutshi and Sohal, 2004

This variable has been taken into account because it reflects through its component (the environmental policy, the general environmental objectives and targets, the suggestions of the stakeholders, the implemented actions regarding the environmental pollution prevention) the design essence organizational environmental orientation (institutionalized and thus operationalized through environmental management system - EMS). The development of its dimensions implies a logical reasoning process, starting from the existence of a clear and properly formulated environmental policy, the general environmental objectives and targets development manner, the implemented actions that target the protection of the environment (which represents the “starting up” of the environmental objectives and targets) and the factors that could determine the quality of the elaboration, and respectively, of the operation of what was previously reminded (the stakeholders of the organization) (Herghiligiu, 2013; Herghiligiu, 2019).

**I.2.** for the variable: “Compliance with the environmental regulations” four dimensions were taken into account – Table 2.

**Table 2**  
*Variable “Compliance with the Environmental Regulations”*  
*Source: Herghiligiu, 2013; Herghiligiu, 2019*

No.	Variable name	Associated variable dimensions	Selective literature
I.2.	“Compliance with the environmental regulations”	I.2.1. Compliance with the environmental regulations I.2.2. Legal liability regarding the compliance with environmental regulations I.2.3. Internal findings regarding the environmental aspects I.2.4. The analyses that were performed regarding the environmental impact induced by the specific activities	Welch <i>et al.</i> , 2000; Darnall, 2001; Darnall, 2003; Lupu <i>et al.</i> , 2006; Zobel and Burman, 2004

The chosen component for the dimensions of the variable: “Compliance with the environmental regulations” presents several aspects that should offer a global vision on the problem of environmental regulations. Therefore, in the development of the variable, the essential connection is the starting point: the observance of the legal environmental regulations, towards the micro: the practical implications of observing the regulations, more concretely the

dynamics of the quantification regarding the impact induced on the environment as an effect of the performed activities (Herghiligiu, 2013; Herghiligiu, 2019).

**I.3.** for the variable: “Environmental financial performance” four dimensions were taken into account – Table 3.

**Table 3**  
Variable “Environmental Financial Performance”  
Source: Herghiligiu, 2013; Herghiligiu, 2019

No.	Variable name	Associated variable dimensions	Selective literature
I.3.	“Environmental financial performance”	I.3.1. The (a. operational and b. capital) costs associated to the environmental aspects corresponding to the performed activities I.3.2. The research and development funds associated with environment management (for various environmental projects) I.3.3. The legal liability associated to the financial management corresponding to the environmental management (for various environmental projects) I.3.4. The environmental benefits (direct and indirect benefits)	Lupu <i>et al.</i> , 2006

The environmental financial performance at the organization’s level represents an extremely important component of the environmental performance because it approaches the operational and capital costs associated to the activities performed, the funds managed in environmental projects performed at an organization’s level, the way in which the legal liability of managing this type of funds is approached and not least, the various environmental benefits that could be obtained (Lupu *et al.*, 2006; Herghiligiu, 2013; Herghiligiu, 2019).

**I.4.** for the variable: “Environmental operational performance” eight dimensions were taken into account – Table 4.

**Table 4**  
*Variable “Environmental Operational Performance”*  
*Source: Herghiligiu, 2013; Herghiligiu, 2019*

No.	Variable name	Associated variable dimensions	Selective literature
I.4.	“Environmental operational performance”	I.4.1. reported to the materials I.4.2. reported to the services (by third parties) that support the organisation’s activities I.4.3. reported to the used energy I.4.4. reported to the fixed assets and equipment I.4.5. reported to the product/ service/ supply process I.4.6. reported to products I.4.7. reported to waste I.4.8. reported to emissions	Wahba, 2008; Heras-Saizarbitoria <i>et al.</i> , 2011; Watson <i>et al.</i> , 2004; González-Benito and González-Benito, 2005; Canon and Garcés, 2006; Menguc and Ozanne, 2005

The environmental operational performance is defined differently by authors in scientific articles, being qualitatively analyzed from several points of view. Despite these, when analyzing the operational environmental performance, in the specialty literature there are two categories: (i) the first category approaches the concept by means of the performance indicators that involve the resources used, the resulting waste, the emissions, the water consumption, and so on – concrete aspects from ISO 14001/ 14031; (ii) the second category defines the operational performance as being the expression of different environmental benefits (Nawrocka and Parker, 2009; Herghiligiu, 2013; Herghiligiu, 2019).

**I.5.** for the variable: “The relationship with various external entities” three dimensions were taken into account – Table 5.

**Table 5**  
*Variable “The Relationship with Various External Entities”*  
*Source: Herghiligiu, 2013; Herghiligiu, 2019*

No.	Variable name	Associated variable dimensions	Selective literature
I.5.	“The relationship with various external entities”	I.5.1. The relation with the state institutions that monitor the compliance with the environmental regulations I.5.2. The relation of the organisation with the local community I.5.3. The relation of the organisation with the interested parties (the internal/ external stakeholders)	Darnall, 2001; Welch <i>et al.</i> , 2000

The variable “The relationship with various external entities” was chosen because, through the dimensions taken into account, it reflects indirectly the mainly external effects. As an internal development of the variable, the following aspects are followed: (i) the degree of the connection between the organisation and the competent institutions in the environmental issues (the Environmental Protection Agency/ Environmental Guard), (ii) the organisation’s involvement in various projects that are linked to the local community, (iii) the interest balance in the environmental issues between the shareholders and/ or the top management of the organisation and the external stakeholders (Herghiligiu, 2013; Herghiligiu, 2019).

**I.6.** for the variable: “The relation between the organizational (organization’s) activities and the state of the environment” six dimensions were taken into account – Table 6.

**Table 6**  
*Variable “The Relation between the Organizational Activities  
and the State of the Environment”*  
*Source: Herghiligiu, 2013; Herghiligiu, 2019*

No.	Variable name	Associated variable dimensions	Selective literature
I.6.	“The relation between the organizational activities and the state of the environment”	I.6.1. The quality (state) of the environmental factor – AIR I.6.2. The quality (state) of the environmental factor – WATER I.6.3. The quality (state) of the environmental factor – GROUND I.6.4. The relation organisation – human population I.6.5. The relation organisation – flora I.6.6. The relation organisation – fauna	Zobel and Burman, 2004; Lupu <i>et al.</i> , 2006; Schoffman and Tordini, 2000

The development of this variable mainly took into account from the point of view of its dimensions just the main environmental factors (air, water, ground), plus the effects of these environmental factors concretized in the relations: organization – human population, flora, fauna (Herghiligiu, 2013; Herghiligiu, 2019).

### 3. Conclusions

This paper presents a simple and effective theoretical framework (a fuzzy model), based on fuzzy logic, that has as main purpose to improve the evaluation process associated to the environmental sustainability performance.

The proposed framework attempts to sustain a more proactive approach, by integrate in it the variables associated to the most performant organizational sustainability vector – the environmental management system.

Indeed, the proposed model is the subject to improvement by adding new parameters, variables, associated dimension, or by setting new rules, but for practitioners of researcher could be an effective managerial instrument.

The paper limits are reflected by the lack of empirical approach, but the future direction is to test it through a study case, and next by using a much larger sample.

**Acknowledgements.** This work was co-financed from the European Social Fund, through the Human Capital Operational Program, project number POCU / 380/6/13/123623 <<Doctoral students and postdoctoral researchers ready for the labor market! >>.

This work was supported by a grant of the Romanian Ministry of Education and Research, CNCS - UEFISCDI, project number PN-III-P1-1.1-TE-2019-1642, within PNCDI III.

## REFERENCES

- Acquaye A., Feng K., Oppon E., Salhi S., Ibn-Mohammed T., Genovese A., Hubacek K., *Measuring the Environmental Sustainability Performance of Global Supply Chains: A Multi-Regional Input-Output Analysis for Carbon, Sulphur Oxide and Water Footprints*, Journal of Environmental Management, **187**, 1, 571-585 (2017).
- Angelakoglou K., Gaidajis G.A., *Conceptual Framework to Evaluate the Environmental Sustainability Performance of Mining Industrial Facilities*, Sustainability, **12**, 2135 (2020).
- Antolín-Lopez R., Delgado-Ceballos J., Montiel I., *Deconstructing Corporate Sustainability: a Comparison of Different Stakeholder Metrics*, J. Clean. Prod. **136**, 517, Part A (2016).
- Bottani E, Gentilotti M.C., Rinaldi M., *A Fuzzy Logic-Based Tool for the Assessment of Corporate Sustainability: A Case Study in the Food Machinery Industry*, Sustainability, **9**, 583 (2017).
- Brundtland G.H., *Our Common Future: World Commission on Environment and Development*, Oxford, UK: Oxford University Press, 1987.
- Canon J., Garcés C., *Repercusión Económica de la Certificación Medioambiental ISO 14001*, Cuadernos de Gestión, **6**, 1, 45-62 (2006).
- Cartwright H., *Using Artificial Intelligence in Chemistry and Biology*, CRC Press. New York. USA, 2008.
- Castillo O., Melin P., *Type-2 Fuzzy Logic: Theory and Applications*, Springer-Verlag Berlin Heidelberg, 2008.
- Christman P., Taylor G., *Firm Self-Regulation through International Certifiable Standards: Determinants of Symbolic versus Substantive Implementation*, Journal of International Business Studies, **37**, 6, 863-878 (2006).

- Curkovic S., Sroufe R., *A Literature Review and Taxonomy of Environmentally Responsible Manufacturing*, *Am. J. Ind. Bus. Manag.*, **6**, 323-346 (2016).
- Darnall N., *Adopting ISO 14001: Why Some Firms Mandate Certification while Other Encourage it*, 23<sup>rd</sup> Public Policy Analysis and Public Policy: Making the Connection, 1-22, Washington, DC, USA, 2001.
- Darnall N., *Motivations for Participating in a Voluntary Environmental Initiative: The Multi-State Working Group and EPA's EMS Pilot Program*, *Research in Corporate Sustainability*, Editor Eduard Elgar Publishing, 123-154 (2003).
- Dias-Sardinha I., Reijnders L., *Environmental Performance Evaluation and Sustainability Performance Evaluation of Organizations: an Evolutionary Framework*, *Eco-Mgmt. Aud.* **8**, 71-79 (2001), <https://doi.org/10.1002/ema.152>.
- Esty D.C., Cort T., *Corporate Sustainability Metrics: What Investors Need and Don't Get*, Yale University, 2017, Retrieved July 28, 2019 from, <https://corporatesustainability.org/wp-content/uploads/Corporate-Sustainability-Metrics.pdf>.
- Font X., Harris C., *Rethinking Standards from Green to Sustainable*, *Ann. Tour. Res.* **31**, 4, 986-1007 (2004), <http://dx.doi.org/10.1016/j.annals.2004.04.001>.
- Gonzalez-Benito J., Gonzalez-Benito O., *Environmental Proactivity and Business Performance: An Empirical Analysis*, *Omega*, **33**, 1-15 (2005).
- Heras-Saizarbitoria I., Molina-Azorin J.F., Dick G.P.M., *ISO 14001 Certification and Financial Performance: Selection-Effect versus Treatment-Effect*, *Journal of Cleaner Production*, **19**, 1, 1-12 (2011).
- Herghiligi I.V., *Researches Regarding Environmental Management System as a Complex Process at the Organizational Level*, Doctoral Thesis, University of Angers, France, "Gheorghe Asachi" Technical University of Iași, Romania (2013).
- Herghiligi I.V., *Environmental Management: EMS as Organizational Complex Process*, Ed. Tehnica-Info, Chisinau, Moldova, 2019.
- Herghiligi I.V., Robu I.B., Pislaru M., Vilcu A., Asandului A.L., Avasilcai S., Balan C., *Sustainable Environmental Management System Integration and Business Performance: A Balance Assessment Approach Using Fuzzy Logic*, *Sustainability*, **11**, 5311(2019).
- Ionescu C., *Cum să contruim și să implementăm un sistem de management de mediu în conformitate cu ISO 14001*, Publishing House: Economică, Bucharest, Romania, 2000.
- Jang Y.J., Zheng T., *Assessment of the Environmental Sustainability of Restaurants in the U.S.: The Effects of Restaurant Characteristics on Environmental Sustainability Performance*, *Journal of Foodservice Business Research*, **23**, 2 (2020), <https://doi.org/10.1080/15378020.2019.1691416>.
- Jang Y.J., Zheng T., Bosselman R.H., *Top Managers' Environmental Values, Leadership, and Stakeholder Engagement in Promoting Environmental Sustainability in the Restaurant Industry*, *International Journal of Hospitality Management*, **63**, 101-111 (2017).
- Kandel A., *Fuzzy Expert Systems*, CRC Press, Inc., Boca Raton, FL, 1992.
- Link S., Naveh E., *Standardization and discretion: Does the Environmental Standard ISO 14001 Lead to Performance Benefits?*, *IEEE Transactions on Engineering Management*, **53**, 4, 508-519 (2006).

- Lupu M.L., Oniciuc N., Rusu B., Rusu C., *Sistemul de indicatori de performanță de mediu*, Publishing House: Performantica, Iași, Romania (2006).
- Menguc B., Ozanne L., *Challenges of the "Green Imperative": A Natural Resource-Based Approach to the Environmental Orientation-Business Performance Relationship*, Journal of Business Research, **58**, 430-438 (2005).
- Naveh E., Meilich O., Marcus A.A., *The Effects of Administrative Innovation Implementation on Performance: An Organizational Learning Approach*, Strategic Organization, **43**, 275-302 (2006).
- Nawrocka D., Parker T., *Finding the Connection: Environmental Management Systems and Environmental Performance*, Journal of Cleaner Production, **17**, 601-607 (2009).
- Phillis Y.A., Kouikoglou V.S., *Fuzzy Measurement of Sustainability*, Nova Science Publishers, Inc., New York, 2009.
- Pîslaru M., Herghiligiu I.V., Robu I.B., *Corporate Sustainable Performance Assessment Based on Fuzzy Logic*, Journal of Cleaner Production, **223**, 998-1013 (2019).
- Qorri A., Mujkić Z., Kraslawski A., *A Conceptual Framework for Measuring Sustainability Performance of Supply Chains*, J Clean Prod. **189**, 570-584 (2018), <https://doi.org/10.1016/j.jclepro.2018.04.073>.
- Saeed M.A., Kersten W., *Drivers of Sustainable Supply Chain Management: Identification and Classification*, Sustainability, **11**, 4, 1137 (2019), <https://doi.org/10.3390/su11041137>.
- Saeed M.A., Kersten W., *Sustainability Performance Assessment Framework: a Cross-Industry Multiple Case Study*, International Journal of Sustainable Development & World Ecology, **27**, 6 (2020), <https://doi.org/10.1080/13504509.2020.1764407>.
- Schoffman A., Tordini A., *ISO 14001: A Practical Approach*, New York: Oxford University Press, Inc., 2000.
- Tanaka K., *An Introduction to Fuzzy Logic for Practical Applications*, Springer-Verlag, New York, USA (1997).
- Teodosiu C., *Management integrat al mediului*, Second Edition, Publishing House: Ecozone, Iași, Romania, 2005.
- Wahba H., *Does the Market Value Corporate Environmental Responsibility? An Empirical Examination*, Corporate Social Responsibility and Environmental Management, **15**, 2, 89-99 (2008).
- Watson K., Klingenberg B., Polito T., Geurts T.G., *Impact of EMS Implementation on Financial Performance*, Management of Environmental Quality, **15**, 622-628.3 (2004).
- Welch E., Mazur A., Bretschneider S., *Voluntary Behavior by Electric Utilities: Levels of Adoption and Contribution of the Climate Change Program to the Reduction of Carbon Dioxide*, Journal of Public Policy Analysis and Management, **19**, 3, 407-425 (2000).
- Yager R.R., Filev D.P., *Essentials of Fuzzy Modeling and Control*, John Wiley & Sons, New York, USA, 1994.
- Zadeh L. *The Concept of a Linguistic Variable and its Application to Approximate Reasoning-I*, Inf. Sci. **8**, 199-249 (1975).
- Zobel T., Burman J., *Factors of Importance in Identification and Assessment of Environmental Aspects in an EMS Context: Experiences in Swedish Organizations*, Journal of Cleaner Production, **12**, 13-27 (2004).

---

Zutshi, A., Sohal, A.S., *Adoption and Maintenance of Environmental Management Systems: Critical Success Factors*, Management of Environmental Quality: An International Journal, **15**, 4, 399-419 (2004).

\* ISO 2013, ISO 14031: *Environmental Management – Environmental Performance Evaluation – Guidelines*, ISO: Geneva.

METODOLOGIE DE EVALUARE A  
PERFORMANȚEI SUSTENABILITĂȚII DE MEDIU PE  
BAZA FUZZY LOGIC

(Rezumat)

Evaluarea performanței sustenabilității mediului a devenit o provocare chiar dacă literatura prezintă multe cercetări asociate. Această provocare este o consecință a multiplelor modalități de evaluare ce pot fi utilizate în abordarea acestui fenomen. Scopul lucrării vizează îmbunătățirea procesului de evaluare asociat acestui pilon al sustenabilității organizaționale - problema de mediu/ performanță de mediu. Pe cale de consecință, această lucrare își propune să prezinte o metodologie de evaluare adecvată, bazată pe logica fuzzy, pentru performanța sustenabilității mediului – focalizând pe variabilele și dimensiunile asociate modelului propus.

