

The Application of Multi-Criteria Analysis to Managing Human Resources on the Local Government Level in Environment Protection

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Abstract: This project investigates the hypothesis for keeping the environment safe by using human resources at the local government level. Strategic decision-making in the management of human resources in the field of environmental protection is crucial for the countries in transition. Lack of financial and technological resources can be compensated with other potentials. Therefore, it is necessary to emphasize the decision-making process. Optimization of the existing resources under real conditions is needed in order to get better results of the implementation of adopted strategies. As an example, the scheme of optimal solution based on PROMETHEE method (multi-criteria method of optimization) is given.

Key words: Ecological awareness, human resources, multi-criteria analysis.

1. Introduction

Every local government unit is somehow unique. Namely, their economic and social aspect vary from one to another requiring different alternatives to environment protection as well as its sustainability. The sustainable development, as the part of the strategic approach adopted by the Government of the Republic of Serbia, is no longer based on development and progress criterion only; namely, it implies the quality development, which cannot do without “the human capital”. The efficient resource managing, which is the central point of the national strategy for the sustainable development of the Republic of Serbia implies the human resources being used to the fullest in order to obtain the prosperity of present as well as future generations [1]. The environment protection issue and its sustainable development are extremely delicate managing problems, which is especially true

for countries in transition. There are numerous participants in the social development chain, starting with globalization, along with state and local level of action, all of these expected to provoke a more efficient ecological process, which will consequently lead to a more rational ecological practice. A great number of challenges that are present with managing systems of environmental protection indicate the necessity of the inclusion of the scientific knowledge into the horizons of planning and modeling sustainability [2].

The market regulation mechanism very often dominates the defined ecological criteria. These two should be equal, i.e. balanced yet they are opposed most of the time. The provisions’ aim is to lessen the difference between the two irreconcilable sides on one hand and to keep the environment safe on the other hand. Each and every country, local community as well as the individual ought to have the clear vision of living and working by which the ecological, economic, social and cultural development is satisfied. They all have to define and possess the implemented ecological criteria.

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Apart from the clearly defined principles, the sustainable development also focuses on the doers of the entire process as well as the developmental assumptions of the new human value system. The principles mentioned have one mutual aim, which is to be more efficient when the environment is in question. Management of human resources in the field of environmental protection has a great importance for the LDCs (Least Developed Countries) and developing countries. The lack of economic means can be compensated for human resources and additional environmental education. Looking at the impact and importance of the available alternatives for improvement of the environmental protection of local governments in countries in transition, human resources stand out as a significant developmental component towards achieving the goal of sustainability.

2. Making the Decision Process Related to the Environmental Issues on the Local Level

When discussing the environmental issues, one should first think of the global population. Major turbulences as well as changes in the economic and ecological field undoubtedly lead to serious concern about the environmental protection. The anticipation of the future under these conditions is highly unpredictable if the global population and overpopulation are considered, as well as the human need for more restricted resources. When all these facts are taken into the consideration, the conclusion is that human resources are developing ones. Thus, the accent has to be on their exploitation as such. One must keep in mind that the optimization of human resources involves the analysis of the management process as a strategic factor of stability [3], viewed in the context of complex decision-making with a goal of sustainable development of the countries [4]. The strategic approach to human resources managing is based on long-term orientation towards the environment protection through the development and exploitation of

those resources. This strategic approach implies the environment analysis and proper organization, which will lead to the strategy planning by which the formulation and the choice of the strategy are considered. This paper depicts the process of decision making of the strategy based on environment protection and development on the local level in accordance with the strategy of the sustainable development of the Republic of Serbia.

The alternative strategies of protecting the environment are as:

- Already applied strategies;
- New strategies;
- Special strategies.

Human resources managing is the new method of the environment protection issue which can give significant results at the local level when combined with the special strategies. This process also implies the methods of strategic conception being as:

- Optimization method;
- Forecasting method;
- Innovation and creativity method.

This paper mirrors the multi-criteria optimization method being applied. Knowing that the environment protection issue is dependent upon numerous circumstances, the decision-making criterion cannot be restricted to only one. Multi-criteria decision-making is made up of these phases:

- The identification of the problem;
- The definition of the problem;
- The analysis of the possible alternatives which can lead to the desired goal, the definition of the result;
- The choice of the optimal alternative needed for the problem solution.

The environment protection and development issue on the local level belongs to those problems that require a long-term solution. It is rather a difficult task having in mind the lack of motivation for human resources exploitation as well as financial restriction where the average amount of money intended to improve the environment as a whole is far under the

amount assigned to the same problem in developed countries. That is why this lack of financial support has to be compensated by using available intelligence, knowledge, skills, abilities and motivation through human resources so as to achieve the strategic goal of protecting the environment on the local level. It is crucial that the local resources mirrored in knowledge, capability, talent, creativity, innovation and motivation of the employees are being fully exploited. Making the strategy without the human resources management is almost impossible and unreal. The long-term plan for human resources is the inevitable point in every local government's agenda. By doing this, the term "human resources" has to be transformed into "The human capital" as the key activator and key resource since the other financial aspects are excluded. However, it is necessary to make the strategy first—such a strategy which is based on human values, for the way of managing human resources determines the strategic choices concerning not only these resources but also the strategic decisions. When making the long-term decisions on the environment, local government has to take into consideration their effects and consequences on every participant of the community and even wider. This requires the estimation of decisions made concerning the sustainable development having in mind that the whole new sets of alternatives are offered at the local level. These alternatives are mirrored in new options derived from the human activities that have nothing to do with the market, yet these can provoke the ecological prosperity presenting the decision set closely bounded within themselves. This bundle of categories can be used as a frame for making strategic decisions by connecting local government goals as well as by ranking the alternatives by the proper criterion. Criteria present the attributes that make up different dimensions from which the potential means of protecting the environment are observed. Naturally, the decision-making process is completely up the individual himself. That is why the competence in human resources is needed, mirrored in knowledge

concerning the environment, its developmental and sustainability issue, as well as the future global impact on it. The personal aspect of decision-making can have an impact on the method chosen as well as the criterion by which the alternatives will be evaluated. The problem of bringing a multi-criteria decision on the election and the importance of alternatives in the field of environmental protection can be solved by using PROMETHEE method [5]. However, the choice of the preferential function is one of the problems of PROMETHEE method [6, 7]. The aim of PROMETHEE method described in this paper is to rank the alternatives by criteria defined, in order to find the most suitable solution which will, by using the current human resources and circumstances, eventually provide the implementation of the strategies adopted in Serbia.

3. The Application of Promethee Method to Ranking the Alternatives Concern in the Environment Protection

Ranking the alternatives by using PROMETHEE method is based on giving the multi-criteria preference index to the alternatives compared. The preference index of the alternative a over the alternative b , (a, b) can be expressed as Eq. (1) [8]:

$$\pi(a,b) = \frac{1}{\sum_{h=1}^n Z_h} \sum_{h=1}^n P_h(a,b) \cdot Z_h$$

$$0 \leq \pi(a,b) \leq 1 \quad (1)$$

Whereas Z_h stands for the relative significance of the criterion with a different significance, then (a, b) is regarded as weighted, not simple arithmetic mean. $P_h(a, b)$ is the preference function which is for (a) in relation to (b) expressed as Eq. (2):

$$P(a,b) = \begin{cases} 0, & \text{if } f(a) \leq f(b) \\ p[f(a) - f(b)] & \text{if } f(a) > f(b) \end{cases} \quad (2)$$

Some authors have applied the criteria optimization [9].

Four alternatives concerning the investment (a_1, a_2, a_3, a_4) evaluated in system made up of 4 different criteria (f_1, f_2, f_3, f_4) expressed by different units, with different significance (Z_h), and different demand for maximization and minimization were compared, as shown in Table 1.

The problems discussed above are presented by using PROMETHEE decision criteria. Criteria needed for this method are as:

- f_1 —education;
- f_2 —expenses;
- f_3 —implementation;
- f_4 —the time needed.

The following alternatives being defined:

- a_1 —human recourses;
- a_2 —a higher level of the ecological awareness among citizens;
- a_3 —the additional ecological education;
- a_4 —ecological friendly production.

In order to make the final hierarchy of the alternatives compared, Table 2 is formed by making the choice as the preference functions and parameters are defined.

The preference alternative index a_1 in relation to alternative a_2 :

$$\pi(a_1.a_2) = \frac{1}{\sum_{h=1}^4 Z_h} \sum_{h=1}^4 P_h(a_1.a_2) \cdot Z_h$$

$$\frac{1}{0.3+0.4+0.2+0.1} (1 \cdot 0.3 + 1 \cdot 0.4 + \frac{10^3}{1000} \cdot 0.2 + 0) = 0.9 \quad (3)$$

The preference alternative index a_2 in relation to

alternative a_1 :

$$\pi(a_2.a_1) = \frac{1}{\sum_{h=1}^4 Z_h} \sum_{h=1}^4 P_h(a_2.a_1) \cdot Z_h =$$

$$1 \cdot (0 + 0 + 0 + 1 \cdot 0.1) = 0.1 \quad (4)$$

The values of the preference alternative index are listed in Table 3.

According to PROMETHEE method I and both required conditions, Table 4 has been formed with the partial hierarchy (Fig. 1).

By applying PROMETHEE method II, the final hierarchy is obtained by using the “pure stream” relation $\phi(a) = \phi + (a) - \phi - (a)$, show in Table 5 and illustrated in Fig. 2.

By applying the PROMETHEE methods I and II, the ranking of the alternatives compared has been completed where the superiority of the alternative a_1 over other alternatives given is emphasized. This proves the great importance of alternative a_1 (human resources) in relation to all other ones taken into consideration. Each of the criteria shows the evident advantage of this alternative compared to all the other ones. Therefore, under environmental protection at the local level, the greatest attention should be paid to human resources (a_1). Management of human resources in environmental protection creates the possibility for optimization of all processes of environmental protection of the countries in transition, limits the negative impacts of humans on the environment, compensates for unavailable resources in the environment protection and ultimately the development of social responsibility.

Table 1 Baseline data.

Index	Criteria		Alternatives			
	Relative significance (Z_h)	Demand max-min	a_1	a_2	a_3	a_4
f_1	0.3	max	80	40	60	50
f_2	0.4	min	40	70	50	80
f_3	0.2	max	90	80	80	50
f_4	0.1	min	60	30	70	40

Table 2 The type of preference function.

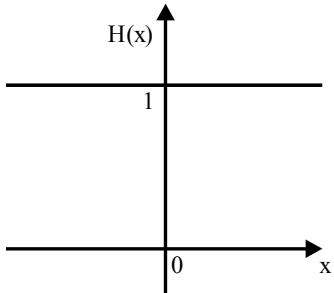
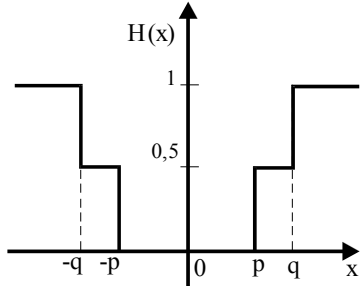
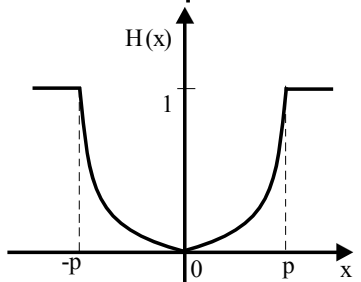
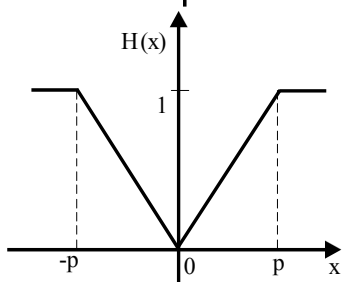
Criteria	The type of preference function	Relative significance	Demand max-min	Parameter	$x = f(a) - f(b)$	$P_i(x)$
f_1		0.3	max	-	$x \leq 0$ $x > 0$	0 1
f_2		0.4	min	$p = 10$ $q = 20$	$x < 10$ $10 \leq x < 20$ $x \geq 20$	0 0,5 1
f_3		0.2	max	$\alpha = 10$ $p = 10$	$x \leq 10$ $x > 10$	$\frac{x^3}{1000}$ 1
f_4		0.1	min	$p = 15$	$x \leq 15$ $x > 15$	$\frac{x}{15}$ 1

Table 3 Indexes preference for each pair of alternatives.

-	a_1	a_2	a_3	a_4
a_1	-	0.9	0.7	0.9
a_2	0.1	-	0.1	0.4
a_3	0.1	0.7	-	0.9
a_4	0.1	0.3	0.1	-

Table 4 Calculated values.

-	a_1	a_2	a_3	a_4
$\phi^+(a_i)$	2.5	0.6	1.7	0.5
$\phi^-(a_i)$	0.3	1.9	0.9	2.2

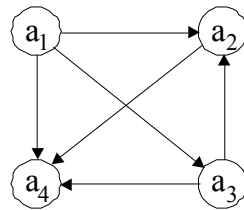


Fig. 1 The partial order of compared alternatives.

Table 5 A complete ranking of alternatives.

-	a_1	a_2	a_3	a_4
$\phi(a_i)$	2.2	-1.3	0.8	-1.7

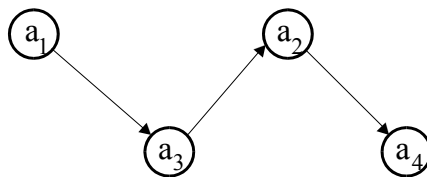


Fig. 2 A complete ranking of alternatives.

4. Conclusion

The multi-criteria decision-making process is eventually success when finding the best solution in this turbulent surrounding which requires various criteria to be involved. Once the estimation of the local community the care of the environmental development is taking place, the ranking of all alternatives has been done by criteria defined. The results obtained show the superiority of the alternative a_1 , which is the contribution of human resources to the environment protection. Therefore, under today’s contemporary circumstances, the only realistic solution concerning the environment protection on the local level would be the developmental one. By applying it, local units in the Republic of Serbia would provoke a more efficient practice and humane attitude towards the environment. However, to achieve this goal and to implement this idea, the policy on the local level should be consistent in applying the national strategy for sustainable development as well as the Agenda 21.

References

[1] Government of Republic of Serbia. 2008. “National Sustainable Development Strategy.” Accessed January 10, 2017. [http://www.zurbnis.rs/zakoni/Nacionalna%20strategija%](http://www.zurbnis.rs/zakoni/Nacionalna%20strategija%20odrzivog%20razvoja.pdf)

20odrzivog%20razvoja.pdf.

[2] Huang, I. B., Keisler, J., and Linkov, I. 2011. “Multi-criteria Decision Analysis in Environmental Sciences: Ten Years of Applications and Trends.” *Science of the Total Environment* 409 (19): 3578-94. doi:10.1016/j.scitotenv.2011.06.022.

[3] Momcilovic, O., Dudic, M., Nikolic, M., Grbic, N., and Kostic, I. 2009. “Analysis of the Processes of Management and Decision-Making of the Active Entrepreneurs as a Strategic Stability Factor of Companies.” *Technics Technologies Education Management-TTEM* 4 (2): 163-8.

[4] Saviano, M., and Di Nauta, P. 2011. “Project Management as a Compass in Complex Decision Making Contexts: Aviable Systems Approach.” In *Proceedings of the 12th International Conference on Product Focused Software Development and Process Improvement*, 112-9.

[5] Podvezko, V., and Podvezko, A. 2010. “Dependence of Multi-criteria Evaluation Result on Choice of Preference Functions and Their Parameters.” *Technological and Economic Development of Economy* 16 (1): 143-58. doi:10.3846/tede.2010.09.

[6] Nesic, Z., Radojicic, M., Zizovic, M., Kahrovic, E., Dehari, S., Dehari, D., et al. 2010. “Some Considerations of a Criteria Dependency Problem in Multi-criteria Decision Making.” *Technics Technologies Education Management, TTEM* 5 (4): 792-8.

[7] Padt, F., Opdam, P., Polman, N., and Termeer, C. eds. 2014. *Scale-sensitive Governance of the Environment*. Minneapolis: John Wiley & Sons.

[8] Lipovac, D., Radojčić, M., and Letić, D. eds. 2001.

Optimization Models: Higher Technical School for Industrial Management. Belgrade: Izdavački centar za industrijski menadžment.

[9] Radojicic, M., Zizovic, M., Nestic, Z., and Vasovic, J. V.

2013. "Modified Approach to PROMETHEE for Multi-criteria Decision-making." *Maejo International Journal of Science and Technology* 7 (3): 408. doi:10.14456/mijst.2013.34.