# COST ANALYSIS FOR IMPLEMENTING THE CONCEPT OF SUSTAINABLE DEVELOPMENT IN AN ENTERPRISE

*Magdalena Wojnarowska*[1]

**Abstract**

The activity of enterprises has a significant effect on the country's economic growth of domestic economy but on the other hand it can be the major cause of environmental hazards. In this context an approach of the government that should support and promote enterprise actions on sustainable development, and encourage and stimulate enterprises to undertake pro-ecological initiatives.

When planning an effective strategy for achieving sustainable development in an enterprise the three main pillars (spheres) should be taken into account, namely economic (financial), ecological (environmental) and social (human).

The achievement of sustainable development in an enterprise is connected with costs incurred for environmental management. The aim of this paper is to analyse costs borne by enterprises to improve environmental management efficiency. An analysis was carried out by using the AHP method.

**Key words:** sustainable development, cost analysis, AHP method.

https://doi.org/10.34808/reme.2016.01.001

## 1. Introduction

On the one hand the activity of enterprises has a significant effect on the country's economic growth of domestic economy but on the other hand it can be the major cause of environmental hazards. In this context an approach of the government that should support and promote enterprise actions on sustainable development, and encourage and stimulate enterprises to undertake pro-ecological initiatives.

The long-term strategy of sustained and balanced development "Poland 2025" adopted by the Polish government assumes that "according to the concept of sustainable and balanced development the socio-economic processes must not be carried

[1] Magdalena Wojnarowska, Ph.D., Department of Technology and Ecology of Products, Faculty of Commodity Science, Cracow University of Economics, Poland, wojnarom@uek.krakow.pl

out by the exhaustion and depletion of non-renewable resources and destruction of the environment, and the rights and opportunities of achieving their growth aspirations should be ensured for future generations". This policy may be achieved by (Ryszawska-Grzeszczak, 2002, pp. 364–365):

— reducing energy, material and water consumption in the economy,
— implementing low-waste and wasteless technologies, and waste recycling and processing,
— increasing the use of renewable energy resources,
— landscaping in compliance with recognised environmental capabilities, while considering socio-economic development.

One of the significant factors allowing achievement of sustained and balanced development is the ability to link the laws of ecology and economics in decision making processes. It is important that this process is carried out at all institutional levels, i.e. international country communities, enterprises and households (Nohatko, 2002).

The transfer of the concept of sustainable development to the enterprise level should be connected with (Adamczyk, 2001, p. 32).

— decreasing material and energy consumption in manufacturing,
— increasing productivity and social benefits from the use of the environment,
— reducing pollution emission.

It is important that such transfer takes place by achieving the enterprise's economic goals. The implementation of the concept of sustainable development is carried out by effective use of natural resources, thus reducing an adverse environmental impact. An enterprise that want to operate in accordance with the concept of sustainable development should pay attention to the following factors (Żelazko, 2009, pp. 270–271):

— environmental quality preservation, protection and improvement by, for example waste utilization, pollution emission and noise reduction in the manufacturing process,
— rational use of natural resources by, for example, reducing the use of raw materials used in the manufacturing process, limiting energy consumption from conventional fuels, and recycling,
— human health and life protection by providing work safety and hygiene,
— respecting and perception of human, consumer and employee rights by, among other things, preventing discrimination,
— product improvement to enhance its quality and durability.

When planning an effective strategy for achieving sustainable development in an enterprise the three main pillars (spheres) should be taken into account, namely economic (financial), ecological (environmental) and social (human).

However, it should be noted that the achievement of the concept of sustainable development at an enterprise is related also with environmental management costs.

Therefore, the aim of this paper is to analyse enterprise's costs borne for improving environmental management. An analysis was carried out by employing the AHP (Analytic Hierarchy Process) method.

For the purposes of this paper the material collected in the Research Project No. NN 115 436540 was used.

## 2. Method

The Analytic Hierarchy Process is a versatile approach to make complex decisions (Saaty, 2001). The AHP decision making model is a symbolic model presented in a hierarchic way thus enabling complex problems to be solved. By combining mathematical and psychological concepts, the AHP method is employed in many other areas to help decision making. The AHP method is based on the following three axioms:

1. Reciprocal axiom – reverse judgement logistics (brings much more accurate and better results than direct solution indication).
2. Uniformity (homogeneity), i.e. when constructing a hierarchy one should remember to make an appropriate choice and group comparable elements that not differ by too much.
3. The priorities of the elements in a hierarchy do not depends on lower level elements.

The AHP model construction is based on blocks (elements), that are interrelated in a specified way. The elements in a hierarchy may be everything, e.g. institutions, people, animals, plants, objectives, things, features, ideas etc. These elements can be arranged into specified sets. The AHP can be generally defined graphically as a multi-level system of relationships between elements and groups of elements (Prusak, Stefanów, 2014, p. 38).

A graphical model of AHP is presented in Figure 1. The four-level structure is most often used to present a complex decision problem, although more complex models are also built (however this entails a time-consuming and highly complicated computational procedure and obliterates the sense of obtained decision priorities).

The construction of hierarchical model is the key and most difficult stage of the analytic hierarchy process, as it requires intuition, creativity, logical thinking, experience and linking various fact as well as other significant skills from a decision making person. It is very difficult to design a proper hierarchy as well as to choose a proper analysis of the decision-making process. Thus, when developing and analysing hierarchical structure, expert knowledge in an area under investigation, and therefore collaboration with experts in various areas is an important element (Prusak, Stefanów, 2014, p. 39).

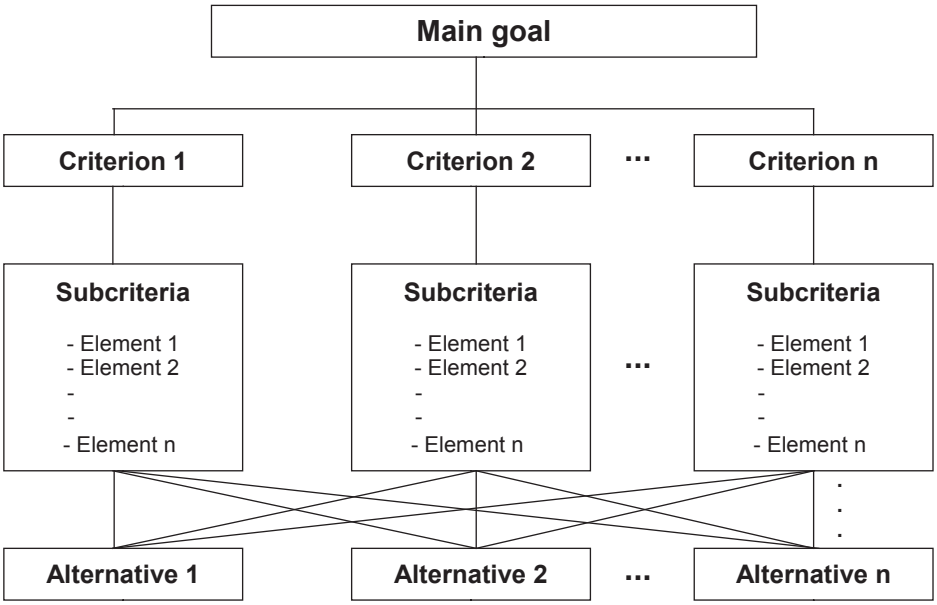


**Fig. 1.** AHP decision making hierarchy
*Source*: Prusak, Stefanów (2014).

An analysis of decision-making process by using this method essentially consists of two phases, i.e. developing a hierarchical structure for a given problem (to do it all significant system elements should be identified and grouped according to a specified hierarchy remembering that higher-level elements have an impact on lower-level elements), and judging the groups of elements. Such judgement is made by pairwise comparisons of all combinations of elements at a given level of the hierarchy from the point of view of each higher-level element (Cabała, 2014, p. 108).

The detailed hierarchical structure is developed in the following stages (Gręda, 2013. p. 125):

1. To identify the top goal.
2. To identify sub-goals.
3. To establish criteria to be fulfilled by sub-goals.
4. For each criterion – to establish sub-criteria for better understanding a given problem.
5. To identify "actors" involved in the decision-making process.
6. To identify objectives adopted by actors and their strategy.
7. To identify alternative problem solutions, i.e. variants of decision.

After the hierarchical model is designed it should be subject to proper analysis. This is carried out by pairwise comparisons of all possible combinations of pairs of elements created in individual groups. Therefore, at first place all possible

pairs within particular groups of the hierarchical model are set up (by creating an appropriate questionnaire), and then experts analyse elements by paired comparison. Each element is evaluated by comparing it to a higher-level one. Relations between individual elements are determined by using the Saaty's nine point scale: 1 – equal importance; 3 – somewhat more important; 5 – much more important; 7 – very much more important; 9 – absolutely more important; 2, 4, 6, 8 – intermediate. By using this scale the respondent indicates which of two elements being compared and possessing the same property is favoured with respect to this property.

At final stage the obtained results of comparisons are entered into a matrix of elements (ratings) $a_{ij}$ are numbers reflecting preferences of a decision maker. For example, if an experts indicates that element X is absolutely more important than element Y, then after conversion into numerical value, the number 9 is entered into the square comparison matrix.

Priorities can be computed manually (by using appropriate mathematical procedures) or by using computer software, e.g. Super Decision, Expert Choice or Decision Lens.

## 3. AHP application in cost analysis for environmental tools

### 3.1. Description of survey

The survey was performed within the framework of research project being carried out at the Department of Product Technology and Ecology at the Cracow University of Economics. The survey was based on free software Lime-Survey TM and GNU General Public License. The questionnaire included 11 subject groups, in total 96 questions. The survey was carried out on the sample of 56 enterprises (N=56). Among respondents the groups of medium- and large-sized enterprises predominate (33.9 % each). The survey included also small-sized (19.6%) and micro-sized enterprises (12.5%). The vast majority of responding companies (83.9%) represented sector 2, i.e. industry and building engineering. The others (16.1%) were from sector 3 Services. The survey did not include companies connected with sector 1 (agriculture, forestry, fishery). The largest group of respondents were international enterprises (69.6%). The second most numerous group comprised local companies (12.5%). This research included also enterprises province-wide and nation-wide enterprisers. The size of these groups was 8.9% each. In this study the responding companies were also asked to indicate their organizational-legal form. The most common business structure was limited liability companies (39.3%). It should be emphasized that 25% of the survey respondents choose "other" indicating: sole corporation, co-operative or capital group. The next group consisted of joint stock companies (19.6%) and general partnership (8.9%). The lowest number of indications was gained by civil partnerships and associations limited by shares (3.6%. each). It was also important in the questionnaire to indicate foreign capital in enterprises.

The most part of respondents indicated a lack of foreign capital in their companies (71.4%) and the total foreign capital share (21.4%). Enterprises with such capital share up to above 50% participate in 3.6% each.

## 3.2. An empirical analysis by using the AHP method

To process the questionnaire responses the multi criteria decision making method – Analytic Hierarchy Process (AHP) was employed. By using this method an analysis of enterprise activity in strive for improving the efficiency of environmental management in terms of related costs incurred with the SuperDecison software. In the structure of the model the top goal (mentioned above), general objectives, sub-criteria, sub-sub-criteria and alternatives in the form of environmental management systems and its tools being the most commonly implemented (Figure 2). Thus, the solution obtained from this model should indicate which of environmental management systems implemented by responding companies are the most costly ones.

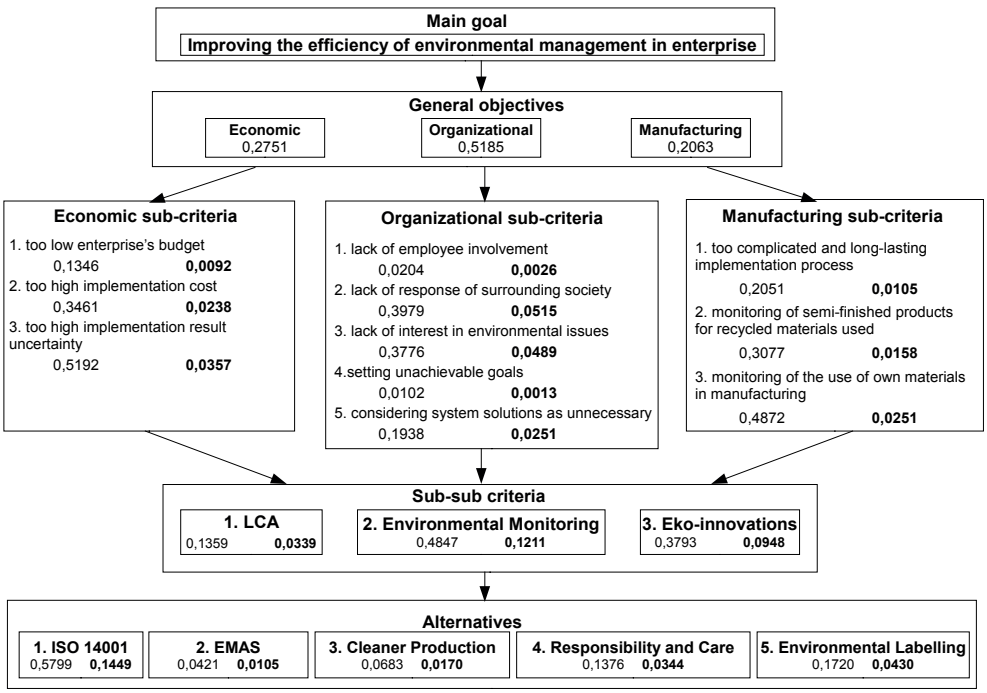


**Fig. 2.** AHP decision hierarchy

*Source*: Wojnarowska (2013, p. 145).

Based on our knowledge and the survey the five environmental management systems and its tools being most commonly used were identified:

— ISO 14001,

— EMAS,
— Cleaner Production,
— Responsibility and Care,
— Environmental Labelling.

The main criteria included economic, organizational and manufacturing factors. To evaluate more precisely which factors cause the highest costs in the aspect of the implemented environmental management systems they were assigned some sub-criteria. There are the following economic sub-criteria:
— too low enterprise's budget,
— too high implementation cost,
— too high implementation result uncertainty.

The set of organizational sub-criteria included such factors as:
— lack of employee involvement;
— lack of response of surrounding society;
— lack of interest in environmental issues;
— setting unachievable goals;
— considering system solutions as unnecessary.

Whilst manufacturing sub-criteria included:
— too complicated and long-lasting implementation process;
— monitoring of semi-finished products for recycled materials used;
— monitoring of the use of own materials in manufacturing.

The sub-criteria mentioned above are influenced also by tools being used by enterprises, e.g. LCA, environmental monitoring, eco-innovations included into sub--sub-criteria.

The respondents revealed that the highest costs incurred by enterprises to improve effectiveness of environmental management within main criteria was organizational area. Due to the value of local priority (0.5185) this area prevailed over other criteria, i.e. economic and manufacturing ones, for which the values of priority were 0.2751 and 0.2063, respectively.

When analyzing in detail all factors responsible for costs in individual criteria it was found that within the organizational criteria the examined enterprises bore the highest expenditures because of lack of response of surrounding society (local priority was 0.3979) and lack of interest in environmental issues (0.3776). The other factors within the specified sub-criteria involve much less costs.

Within economic criteria the respondents considered too high implementation uncertainty as a key cost with priority at 0.5192. This may indicate a high anxiety of the implemented environmental management systems in the context of costs of the risk incurred when the systems are implemented improperly. In addition, this is supported by the next highly rated factor considered by respondents, namely high implementation costs of environmental management systems. The value of priority

for this factor was 0.3461. It could be quite surprised that the lowest value of local priority 0.1346 was recorded for too low budget of responding enterprises (within economic criteria). Thus, one may conclude that by increasing environmental awareness in examined enterprises in the aspect of environmental management systems and by eliminating factors causing an implementation uncertainty, the systems will be implemented more frequently in enterprises.

An analysis of manufacturing sub-criteria indicates that the respondents link the highest costs to performed monitoring of the use of own products in manufacturing. However, it should be noted that such activities may lead in the future to reduced material and energy consumption, for example by recycling of own products. The lowest value of local priority (0.2051) within manufacturing criteria was recorded for too complicated and long-lasting implementation process.

The values of global priorities at the sub-criteria level indicate that the highest costs for achieving the top goal of this model are incurred by enterprises under investigation due to lack of response of surrounding society, lack of interest in environmental issues, and too high implementation uncertainty. The responders considered at similar level unnecessary system solutions, monitoring of the use of own materials for manufacturing purposes and high implementation costs for environmental management systems. The mentioned factors prevailed significantly over the other items of the survey, namely: too low budget, lack of employee involvement and setting unrealistic goals. It should be emphasized that the budget of examined enterprises creates no implementation barrier for environmental management systems.

## 4. Concluding remarks

In the light of the survey presented above one may conclude that the highest costs were born by the responding enterprises to increase performance of environmental management for implementation of ISO 14001. Next, the costs resulted from implementation of Labelling and Responsibility and Care program. The values of local priorities indicate that the enterprises under examination born the lowest costs for adaptation to the Cleaner Production program.

### References

1. Adamczyk J. (2001): *Koncepcja zrównoważonego rozwoju w zarządzaniu przedsiębiorstwem*, Kraków: Wydawnictwo Akademii Ekonomicznej w Krakowie.
2. Cabała P. (2014): *Podejmowanie decyzji w warunkach niepełnej informacji*, Kraków: Wydawnictwo Uniwersytetu Ekonomicznego w Krakowie.
3. Gręda A. (2013): *Wielokryterialne problemy decyzyjne w proekologicznych działaniach produktowych przedsiębiorstw*, [w:] Adamczyk W. (red.): *Działania ekologiczne w polityce produktowej przedsiębiorstw*, Kraków: Wydawnictwo Naukowe „Akapit".
4. Nohatko S. (2002): *Podstawy ekologicznego zarządzania przedsiębiorstwem*, Bydgoszcz: Oficyna Wydawnicza Ośrodka Postępu Organizacyjnego.

5. Prusak A., Stefanów P. (2014): *AHP – analityczny proces hierarchiczny. Budowa i analiza modeli decyzyjnych krok po kroku*, Warszawa: Wydawnictwo C.H. Beck.
6. Ryszawska-Grzeszczak B. (2002): *Kształtowanie zachowań i postaw proekologicznych w gospodarstwie domowym*, Wrocław: I-BiS.
7. Saaty T.L. (2001): *Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World*, Pittsburgh: University of Pittsburgh, RWS Publications.
8. Wojnarowska M. (2013): *Modelowanie efektów zarządzania środowiskowego w przedsiębiorstwie*, [w:] Adamczyk W. (red.): *Działania ekologiczne w polityce produktowej przedsiębiorstw*, Kraków: Wydawnictwo Naukowe „Akapit".
9. Żelazko B. (2009): *Biotechnologie a zrównoważony rozwój*, Warszawa: Szkoła Główna Handlowa w Warszawie – Oficyna Wydawnicza.

## ANALIZA KOSZTÓW REALIZACJI KONCEPCJI ZRÓWNOWAŻONEGO ROZWOJU W PRZEDSIĘBIORSTWIE

### Streszczenie

Realizacja koncepcji zrównoważonego rozwoju w przedsiębiorstwie związana jest z kosztami ponoszonymi na zarządzanie środowiskowe. Za cel artykułu przyjęto przeprowadzenie analizy kosztów przedsiębiorstwa ponoszonych na wzrost efektywności zarządzania środowiskowego. Analizę przeprowadzono z wykorzystaniem metody AHP.

**Słowa kluczowe:** zrównoważony rozwój, analiza kosztów, metoda AHP.