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Bojan Krstić, PhD
University of Niš, Faculty of Economics, Niš
Milica Tasić, MSc
Vladimir Ivanović
Niš

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LIFECYCLE ANALYSIS AS THE CORPORATE ENVIRONMENTAL RESPONSIBILITY ASSESSMENT TECHNIQUE

Abstract

Lifecycle analysis is one of the techniques for assessing the impact of enterprise on the environment, by monitoring environmental effects of the product along its lifecycle. Since the cycle can be seen in stages (extraction of raw materials, raw materials processing, final product production, product use and end of use of the product), the analysis can be applied to all or only some parts of the aforementioned cycle, hence the different variants of this technique. The analysis itself is defined in phases according to the of ISO 14040 standard series, and involves defining the objectives and scope of analysis, life cycle inventory data analysis, life cycle impact assessment and lifecycle interpretation. Although its use is characterized by certain disadvantages, it can be said that this is still a very valuable management tool without which one cannot imagine the process of effective environmental decision-making in the modern enterprise, and consequently the complete adoption of environmentally responsible way of doing business.

Keywords: *lifecycle analysis, ISO 14040, environmental responsibility*

JEL Classification: Q50, Q51, Q53

АНАЛИЗА ЖИВОТНОГ ЦИКЛУСА КАО ТЕХНИКА ПРОЦЕНЕ ЕКОЛОШКЕ ОДГОВОРНОСТИ ПРЕДУЗЕЋА

Апстракт

Анализа животног циклуса је једна од техника процене утицаја предузећа на животну средину, а кроз праћење еколошких ефеката производа дуж његовог животног циклуса. Како се циклус може посматрати етапно (екстракција сировина, прерада сировина у материјале, производња готових производа, употреба производа и завршетак употребе производа) тако се и анализа може односити на све или само неке делове поменутог циклуса, па отуд и различите варијанте ове технике. Сама анализа дефинисана је фазно према стандардима серије ISO 14040, па обухвата дефинисање циља и опсега анализе, анализу инвентара података, процену утицаја циклуса и интерпретацију добијених резултата. Иако њену примену карактеришу и одређени недостаци, може се рећи да је у питању ипак јако вредан управљачки алат без кога се не може замислити процес ефикасног еколошког одлучивања у савременом предузећу, па самим тим ни потпуно усвајање еколошки одговорног начина пословања.

Кључне речи: *анализа животног циклуса, ISO 14040, еколошка одговорност*

Introduction

Establishing environmental responsibility through the daily operations of a modern company, in terms of strengthening the global public pressure regarding more and more dramatic changes in the environment, seems to be the only acceptable solution for the whole business world. In this way it is possible to find support in a variety of methodological and solutions in the form of specific techniques of environmental impact analysis, such as Lifecycle analysis (LCA).

This paper examines the basic features, phases and variations of this technique, in order to determine its importance for the effective environmental performance management and establishing the environmentally responsible way of doing business. Thus, through the phases defined by ISO 14040 standard series, related to the goal and scope definition, lifecycle inventory data, lifecycle impact assessment and interpretation of all of the results obtained, the contribution of this technique to effective environmental decision-making at the corporate level is examined. The analysis, however, can cover all or only some parts of the lifecycle, hence the different variants of this technique.

LCA technique also shows some weaknesses. However, this work deals only with a good side of LCA, therefore the basic assumption is that this is a valuable tool for achieving and excellent indicator of the achieved level of environmental responsibility of an enterprise.

1. Importance of the lifecycle analysis for the corporate environmental management process

Lifecycle analysis (LCA) is a technique for determining the potential product impact on the environment that was created during its lifecycle. The product lifecycle consists of all of the stages from product “birth” to its “death” - from the raw materials extraction, material production and its processing to final product through product use until the end of use, with the transport activities connecting all these phases (Figure 1).

Figure 1 - Stages of the product lifecycle

Source: Marcel Gómez Consultoria Ambiental (2013) *Life Cycle Assessment consultancy services*, viewed 25.12.2013. <http://www.marcelgomez.com/eng/?page_id=1604>

International Organization for Standardization (ISO) defines LCA as a technique assessing the environmental aspects and potential impacts associated with the product.[1] It is a targeted process of reviewing the "environmental burden" of the product, process or activity, by identifying the amount of energy and matter taken from, and the amount of waste and pollution thrown into the environment, but also the assessment of opportunities for improvements in the area of corporate environmental responsibility.[2] The purpose of this technique is, by using a holistic comparative analysis of the environmental effects of products and services through their "lifetime", to examine the possibility of improving the production process, to support the environmental strategy of the company and to improve the decision-making process, which ultimately leads to its environmental management improvement. It is actually possible to talk about the following objectives of this technique:[3]

- providing the complete picture of the enterprise interaction with the environment;
- to aid in understanding the comprehensive and interdependent character of the environmental consequences of human activity;
- to provide information to decision-makers which determine the environmental impact of business operations and identify possible opportunities of improving corporate environmental responsibility.

It is the last of these goals that can be considered as critical for success in the correct anticipation of the importance of establishing an environmentally responsible way of doing business. However, the gained information is intended not only to producers and their management team, but also suppliers, customers and all of other stakeholders. All of them together, thanks to this technique, can improve the environmental performances of their products in any segment of product lifecycle, can identify the relevant indicators and measures, and "green" their marketing.

Finally, it is possible to speak about the basic characteristics of this technique: [4] a) LCA makes evaluation systematically through the inclusion of all aspects and impacts on the environment, b) it refers to the functional parts of the product, c) the depth of analysis and the time needed to finalize it, depend on the goal of the analysis, d) depending on its application, LCA ensures the needed level of confidentiality and copyright, d) it is open to new knowledge and application of new methods and techniques, f) where appropriate, it includes specific requirements (especially for public use of the product), e) although there is no uniform method of its application, this technique is flexible enough to adapt to each product, f) it differs from other techniques with similar purposes but it connects to them through shared information and g) it does not predict an absolute or precise impacts on the environment. All this indicates the importance of this technique in terms of proper identifying the relations between company and environment, and thus the recognition of possible directions for the

1 International Standardisation Organisation (ISO) (1996), *Environmental management – Life cycle assessment – Principles and framework – ISO 14040*, ISO, Paris

2 Fava J., et al. (eds.). (1991) *A Technical Framework for Life Cycle Assessment*, SETAC and SETAC Foundation for Environmental Education Inc., Washington, pp. 160-165.

3 SETAC (1993) *Guidelines for Life−cycle Assessment: A "Code of Practice"*, SETAC workshop in Sesimbra, Portugal, 31 March−3 April, pp. 7-9.

4 Arsovski, S., Grubor, S., Tonić, N., Koki Arsić, A., Kanjevac Milovanović, K. (2011) 'Postupak ocenjivanja životnog ciklusa proizvoda', *Festival kvaliteta - FK2011 - 6 - Nacionalna konferencija o kvalitetu života*, Beograd, Srbija, str. B131-B136.

development and/or further improvement of corporate environmental responsibility, and above all, by providing the necessary information that support the process of environmental decision-making, and even beyond – corporate environmental management.

2. Lca elements according to iso 14040 standard series

Procedure and phases of the lifecycle analysis are part of the ISO 14040 standard series (Environmental management - LCA). These are the standards that explain in detail the basic phases of LCA, and its methodological structure.[5] Thus it is possible to speak about the following standards:

- ISO 14040:2006 - principles and framework;
- ISO 14041:1998 - defining the scope and objectives and inventory analysis (first and second phase);
- ISO 14042:2000 - lifecycle impact assessment (third phase);
- ISO 14043:2000 - lifecycle interpretation (fourth phase);
- ISO 14044:2006 - requirements and guidelines;
- ISO 14047:2003 - illustrative examples of the ISO 14042:2000 application;
- ISO 14048:2002 - format of LCA data documentation and
- ISO 14049:2000 - illustrative examples of the ISO 14041:1998 application.

All phases of this analysis are interrelated and interdependent (Figure 2). The first phase of LCA involves clearly defining the goals and scope of analysis, which is essential if you want to avoid inaccurate and erroneous results.[6] Already at this stage, you should know the purpose of this procedure, its temporal and spatial extent, which functional units will be evaluated, what is the group of selected targets, which will decisions will analysis results support as well as which will the scope of those decisions be. Based on the defined goal and scope of the analysis, the second phase determines the inventory of all input/output data related to the flow of matter, energy, and pollution of the observed system (Lifecycle Inventory Analysis - LCI). All the named data are crucial in achieving the objectives defined by the previous phase and the accuracy of the entire LCA depends on their accuracy, and this is because this phase defines the system to be included in the analysis as well as its limitations. The third phase refers to the actual lifecycle impact assessment (LCIA), which assumes the determination of impact categories, classification and characterization of environmental impacts, all based on the results of the first two phases. The determination of impact categories in direct relation depends on the selected goals of the analysis, while bearing in mind some general categories such as health, resource depletion etc, where they are further operationalized through specific impacts in the form of global warming, ozone depletion etc. Then the impacts are being analyzed, quantified and their value calculated, which requires significant knowledge of the cause-effect relation observed in the previous phase. Therefore, this phase is realized as an iterative process for the previous two phases, in the case of a change of objectives, scope, and data sources.[7] Finally, the fourth phase by which the whole analysis is being

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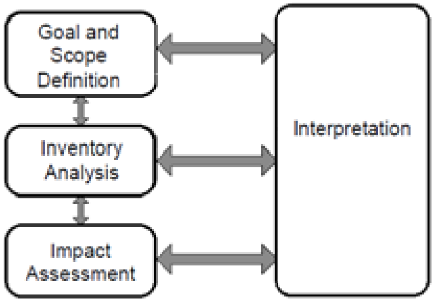
[5] Stevanović Čarapina, H., Mihajlov, A., Stepanov, A. (2010) 'Uspostavljanje održivog sistema upravljanja otpadom - primena koncepta LCA (analiza životnog ciklusa)', *Međunarodni 5. simpozijum "Reciklažne tehnologije i održivi razvoj"*, Soko Banja, Srbija, str. 22-29.

[6] Frankl, P. & Rubik F. (2000), *Life Cycle assessments in Industry and Business, Adoption Patterns, Applications and Implications*, Springer, Berlin, pp. 9-51.

[7] Arsovski, S., Grubor, S., Tonić, N., Koki Arsić, A., Kanjevac Milovanović, K. (2011) 'Postupak

terminated, refers to the interpretation of the results obtained under the previous two phases. The results are summarized and used as a basis for conclusions, recommendations and decisions in accordance with the goals and scope of the analysis, which by standards should be communicated transparently. For the "confidence limits" of the results it is necessary to take the economic and environmental perspective into consideration. If it is determined that such limits during the analysis were considerably exceeded, the ultimate conclusion of the analysis and on it based decisions will be called into question.[8]

Figure 2 - Phases of lifecycle assessment (LCA)



Illustrated according to: EN ISO (2006) *Environmental management – Lifecycle assessment – requirements and guidelines,* ISO 14044: 2006, NSAI, Dublin, pp. 1-46.

This analysis also has certain drawbacks.[9] Thus, it may be objected that it does not have a pre-defined framework, which always takes place and in every situation, so if, for example, the observation boundaries of the system or a spatial component change, that will lead to quite different results. This analysis also lacks the comprehensive data as inputs at start of the process, and very often brings into question the reliability of other data in the analysis. It is a technique that often ignores the economic and social effects, tangents only potential and not the actual impacts, technique that is too slow to be applied in the design process, or in dynamic markets and technologies changes monitoring. However, LCA is the only technique that examines the environmental impact of a product across its lifecycle, it is standardized according to ISO rules, provides important information needed in the environmental decision-making, which consequently affects the character of the environmental responsibility of an enterprise, and can be considered as one of the most important techniques of environmental management at a corporate level.

3. LCA variants

There are several variants of this technique, as seen from the perspective of their range within the lifecycle, namely the stages that their analysis applies:[10] "cradle to

ocenjivanja životnog ciklusa proizvoda', *Festival kvaliteta - FK2011 - 6 - Nacionalna konferencija o kvalitetu života*, Beograd, Srbija, str. B131-B136.

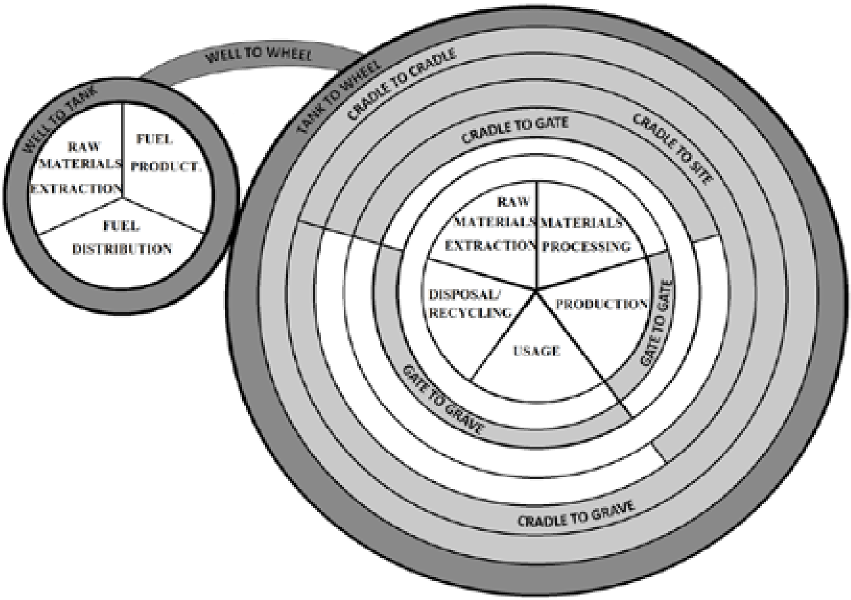
[8] Schaltegger, S. (1996), *Life cycle assessment (LCA) – quo vadis?*, Birkhäuser, Basel, pp. 11-27.

[9] Johnson, U. (2003) *Fundamentals of LCA*, InLCA/LCM Conference Seattle Center, Seattle, Washington, pp. 1-27.

[10] Schenck, R. (2009) *Introduction to Life Cycle Assessment Scoping & Inventory,* US EPA Region

grave” and “cradle to cradle” approach, “cradle to gate”, “gate to gate” and “gate to grave” approaches, “cradle to site” and “well to wheel” approach (Figure 3).

Figure 3 - Different variations of lifecycle analysis



“Cradle to grave” is the entire product lifecycle analysis, from the raw materials extraction (“the cradle”) to the waste disposal, which according to this approach considers to be the end of the cycle (“the grave”). It is based on the eco-efficiency principle and is currently one of the most common variants of product lifecycle analysis in the world. However, apart from this one, another variant of LCA is also often used - “the cradle to cradle” approach. It is a specific type to the previous variant access, since what is in “the cradle to the grave” analysis seen as the end of the cycle (“grave”) according to this newer approach, and thanks to the modern waste management systems, here is actually seen as a new cycle starting point (the new “cradle”). It represents the approach to minimizing the negative environmental impacts of businesses, primarily through the sustainable production systems development, new waste management approaches and through the inclusion of social responsibility dimension in the product development, which emphasizes the eco-efficiency principle.[11] What is interesting for this approach is that it makes an analogy with natural processes. The artificially created materials, as one of the results of the industrial processes, are considered analogous to the nutrients that circulate endlessly in a healthy metabolism of a living organism, so this way the concept of infinite lifecycle of non-living things modeled by the living world is being created (the technosphere is equal to the biosphere, and the waste = food in this analogy). It is also interesting that the “cradle to cradle” approach classifies all materials/raw materials used

X, American Center for Life Cycle Assessment, Washington, pp. 1-51.

[11] Cradle-to-cradle design is a protected brand by the consulting firm MBDC (McDonough Braungart Design Chemistry), which owners are also the creators of the mentioned design.

in industrial processes into only two categories:[12] technical food (technical nutrients), which includes non-toxic, safe synthetic materials that do not have negative impact on the natural environment and that still maintain their properties, and biological food (biological nutrients), which refers to organic matter that, after use, can be returned to any type of natural environment, which part they became and thus provide food for microorganisms without affecting the environment.[13]

The "cradle to gate" approach is a partial analysis of the product lifecycle, because it relates only to the stages from raw material extraction ("cradle") to the start of production ("gate"), so it excludes all the stages of post-production. It is used in the creation and issuance of environmental product declarations, and it is also important for the enumeration and quantification of raw materials and energy inputs in production processes. This because it is based on an isolated observation of certain phases of the lifecycle, which levels up the accuracy of the entire analysis. However, it is possible to include the transport to the production process as well as the production process itself in this analysis, and examine the whole process of creating product value before its delivery to customers.[14] If the analysis is expanded even to the stage of the final products production, we get a "cradle to site" approach.

In contrast to "cradle to gate" approach, "gate to gate" analysis has the more narrow aspect of observation, because it applies only to the production process within the "factory gates", regarding the value creation only in the final products production process, which makes the analysis even more precise. Lifecycle stages after which product exceeds "the factory gates" is being analysed by the "gate to grave" approach.

Well to wheel is a specific application of this analysis for understanding the functions of transport and fuel used along the way. Therefore it is often divided into two sub-phases: the "well to tank" phase, which includes all activities related to the extraction of raw materials, production and distribution of fuel and "tank to wheel" phase, which is related to activity of transport itself. It is the consideration of energy consumption, efficiency of energy conversion and environmental impact of emissions created by transportation process, which is very important when you take the level of pollution that is created thereby into account.

LCA, therefore, can serve as a powerful tool for the corporate environmental impacts analysis, and thus a very important instrument for environmental management of an enterprise. Its basic starting point is that the corporate actions have an environmental restrictions, so the enterprise should find out what is the source of conflicts between the its product and the environment. Therefore it can be concluded that the primary role of LCA is to identify, in ecological terms, the dominant phase of the product lifecycle, but also to help environmental management contribute to the conflict arising moments and situations resolution, thus contributing to a more efficient development of corporate environmental responsibility.

[12] McDonough, W. & Braungart, M. (2002) *Cradle to Cradle: Remaking the Way We Make Things,* North Point Press, New York, pp. 22-25.

[13] Both of these types of materials, follow their lifecycle in the regenerative economic systems that was set up by McDonough and Braungart.

[14] Franklin Associates - A Division of Eastern Research Group (2010) *Cradle-to-gate Life Cycle Inventory of Nine Plastic Resins and Four Polyurethane Precursors*, The Plastics Division of the American Chemistry Council, Kansas, pp. 7-9.

Conclusion

Lifecycle analysis has proved to be a valuable technique for supporting environmental decision-making in an enterprise and in relations with all of its stakeholders. Its main task is related to assessment of the product/process impact that is made along the lifecycle - from its “birth” to its “death”.

The application of this technique in the field of strategic planning, environmental policy formulation, marketing and quality and design improvement, is carried out through several stages defined by ISO 14040 standard series. Through these phases the potential environmental impacts of a product are revealed, with emphasis on those that are negative. As the analysis is carried out through stages of the lifecycle, it is possible to act preventive, ex ante, and not to wait until the product reaches the end of its lifecycle in order to establish that along this way any negative environmental effects have occured. This is particularly important from the perspective of decision-maker, for whom are timely and reliable information base for further business improvements.

Thus, this technique can prevent the emergence of a number of problems in the relations between the companies and the environment, as well as sanctions regarding the same. Also, this technique can reveal that the process of “greening” was successfully carried out, so any significant environmental problem along product lifecycle will not occur. Therefore, it is concluded that LCA can serve as a tool for building corporate environmental responsibility, but also as a great confirmation of its results.

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