

SIM 2017 / 14th International Symposium in Management

Life cycle sustainability assessment of products in the context of competitiveness

Raul Ambrus^a, Monica Izvercian^a, Larisa Ivascu^{a,*}, Alin Artene^a

^aFaculty of Management in Production and Transportation, Politehnica University Timisoara, 14 Remus Street, 300007 Timisoara, Romania

Abstract

Sustainability is a concept adopted and approached in public and private organizations as a guiding principle that contributes to organizational development. However, the greatest challenge for organizations is its real implementation and the steps to be taken in this respect. At the same time, another challenge is how this sustainable development performance can be measured (for products and processes). These concepts are addressed in a competitive business environment, where differentiation and attraction of customers are among the main directions of action. In this context, the present paper presents Life cycle sustainability assessment of products in the context of competitiveness. At the end of the paper, an approach for the interpretation of the results obtained from the Life cycle sustainability assessment is presented.

© 2018 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of SIM 2017 / 14th International Symposium in Management.

Keywords: life cycle assessment; life cycle costing; LCSA; S-LCA; E-LCA; LCC; sustainable development; competitiveness.

1. Introduction

The concept of sustainability is strongly debated and researched in the literature. As a direction of development, sustainability is being addressed by more and more national and international companies (Ivascu et al., 2014). Sustainability was adopted by the United Nations Environment Program (UNEP) in Rio de Janeiro in 1992 as the main political goal for future development in the world. In this context, sustainability and sustainable development should be the ultimate goal of developing and designing products. All products, including products and services,

* Corresponding author. Tel.: +0 40 256 404 308.

E-mail address: larisa.ivascu@upt.ro

should be sustainable and should meet the requirements of sustainable development. Defining the concept of sustainability in the Brudland report introduces the concept of sustainability as including three components: the environment, the economy and the social dimension. These sustainability responsibilities or "pillars" need to be properly assessed and balanced if a new product is to be designed or an existing one is to be improved. If these conditions are met then the products launched on the market can be considered as sustainable.

In this respect, for the development of sustainable products, the main responsibility of the research works is to present useful tools. Life cycle sustainability assessment (LCSA) of products refers to assessing the impact of environmental, economic and social responsibilities on each developed product. This impact may be positive or negative. This evaluation is considered in the decision making process and refers to the whole process of product development and design. LCSA is a decision making tool.

This paper presents in the first part the concept of competitiveness, then the Life cycle sustainability assessment in the context of competitiveness (including Environment - Life Cycle Assessment (E-LCA), Economic - Life Cycle Assessment (LCC), and Social-Life Cycle Assessment (S-LCA)). At the end of the paper, a framework for interpreting the results obtained for LCSA is presented.

2. Organizational competitiveness

In an earlier research (Ambrus et al., 2017), the authors presented the link between sustainable development and competitiveness. As presented in this research, there is an *ideal area* in which the two concepts of "sustainability" and "competitiveness" intersect. This ideal area is shown in Fig. 1. In this research we concluded that:

- A sustainable organization is not required to be competitive.
- A competitive organization is not required to be sustainable.

As a result, it comes to the idea that there is an "ideal area" that includes competitive and sustainable organizations with a high potential to achieve the set goals.

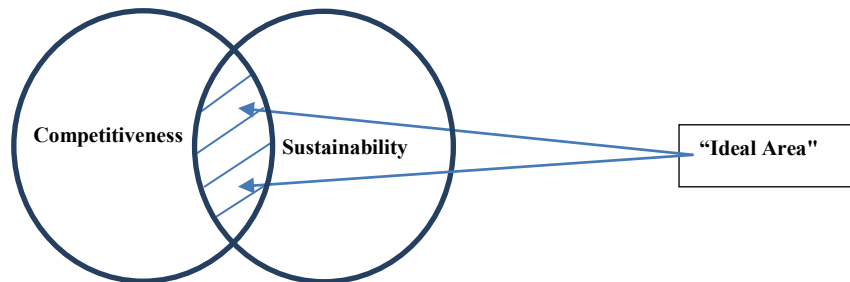


Fig. 1. The link between competitiveness and sustainability: "ideal area" (Ambrus, et al., 2017)

3. Life cycle sustainability assessment

3.1. Sustainable development goals

Agenda 2030 represents a shift from the current growth-based economic model to a new vision based on sustainable and equitable global economies and societies, and with public involvement in decision-making, in line with Principle 10 of the 1992 Rio Declaration. The main objective of this agenda is to replace unsustainable patterns of consumption and production with a sustainable lifestyle and beneficial living standards for all residents. The importance of this agenda lies in the fact that the idea that the increase of the individual's living standard and the sustainable development of the organization contributes to the well-being of the society, must be developed. Sustainable development is addressed at global, national, regional, cluster and organizational levels (Ivascu et al., 2014). In accordance with UNEP and the principles of Agenda 2030, the 17 objectives of sustainable development

are presented in Table 1. These objectives imply all dimensions that contribute to the well-being of individuals and the sustainable development of organizations (Ionescu et al., 2014).

Table 1. The 17 objectives of sustainable development [UNEP, 2016].

Number of goals	Implications	Number of goal	Implications
Goal 1	Combating poverty globally	Goal 9	Sustainable infrastructure, inclusive and sustainable industrialization and stimulating innovation
Goal 2	Food safety and product ingredients improvement	Goal 10	Equality between states / countries
Goal 3	Promoting a healthy life and family welfare	Goal 11	Developing sustainable and resilient housing
Goal 4	Ensuring a quality education, based on individual development	Goal 12	Promoting responsible and sustainable consumption
Goal 5	Equal chances between men and women	Goal 13	Combating climate change
Goal 6	Sustainable water management taking into account the future	Goal 14	Conservation of oceans, seas and marine resources
Goal 7	Effective management of energy sources	Goal 15	Eco-efficient management of forests, combating destruction of trees
Goal 8	Promoting inclusive and sustainable economic growth, decent work and professional development	Goal 16	Ensure access to legislation for all and create secure, responsible and inclusive institutions at all levels
		Goal 17	Develop global partnerships for sustainable development

3.2. The concept of LCSA

Life cycle sustainability assessment refers to assessing the impact of environmental, social and economic responsibilities on the development of an organization's products (cioca et al., 2010). Therefore, LCSA can be systematized as in Figure 2. It is noted that the LCSA evaluation involves an environmental life cycle assessment (E-LCA), economic life cycle assessment (life cycle costing – LCC), and social life cycle assessment (S-LCA). E-LCA refers to environmental indicators and variables that contribute to the development of sustainable products. LCC refers to economic responsiveness that evaluates the costs of developing sustainable products. Finally, S-LCA assesses the social impact of the organization from the perspective of sustainable development of the organization (Finkbeiner et al., 2010).

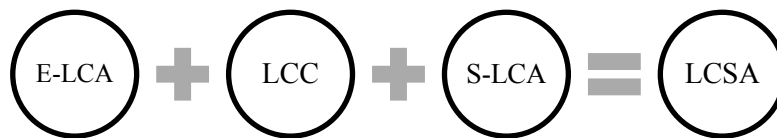


Fig. 2. The concept of Life cycle sustainability assessment [UNEP, 2012]

Among the benefits provided by LCSA to stakeholders, there are the following (Finkbeiner et al., 2010, Anex et al., 2014, Ghicajanu et al., 2016):

- Provides comprehensive environmental, economic and social information and data in a structured form that contributes to the objectives
- Provides a comprehensive picture of the positive and negative impacts along the life cycle of the product
- Show businesses how to become responsible taking into account the organization's development spectrum
- Promotes awareness of the benefits of sustainable development
- Support organizations to identify their deficiencies during the product development process

- Support decision-makers in prioritizing resources and optimizing their investment, thus having the chances of positive impact and fewer negative chances
- Contributes to the choice of innovative technologies to produce high quality products tailored to the needs and desires of customers
- Support customers in choosing environmentally friendly, healthy products whose negative impact has been reduced
- Stimulates innovation in enterprises
- Help increase organizational credibility for the target market
- Provides clear directions for achieving organizational goals.

The following sections will outline the technical capability regarding environmental responsibility (see Section 3.4.), economic responsibility (see Section 3.5.) and social dimension (see section 3.6.) of LCSA.

3.3. Pyramid of needs for life cycle sustainable assessment

Starting from the concept of Maslow's Pyramid in which needs are hierarchized in 5 levels (needs: fundamental, security, belonging, self-esteem and self-improvement), the Pyramid of needs for LCSA has been developed. Therefore, the basic concept of the life cycle and the approach to be promoted within each organization are essential. At the next level there are the carbon and water footprints. This is the first step to be taken after the awareness-raising phase of the sustainable development approach. Monitoring these footprints contributes to reducing greenhouse gas emissions and, implicitly, reducing the effects of climate change. At level 3, there is the economic evaluation of the impact of the development of the organization's products. Economic responsibility is part of the three responsibilities of sustainability (economic, social, and environmental). If economic costs were assessed, then the next levels are following, that of the E-LCA, and S-LCA. The two dimensions are part of the sustainability responsibilities. At the top of the pyramid there is the life cycle sustainable assessment that represents the organization's goal from a sustainable development perspective. This pyramidal approach contributes to the staging of the organization's actions in order to develop and design sustainable products. This approach is presented in Figure 3 (after Finkbeiner et al., 2010).

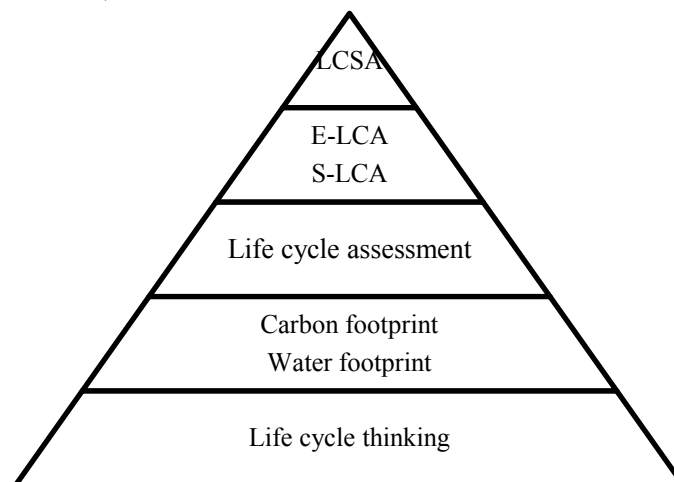


Fig. 3. Maslow's pyramid adapted to the needs of sustainable development

3.4. Environmental Responsibility

Life Cycle Assessment (LCA) is the current technique for assessing the environmental impact of a product taking into account all the life stages of the product, from raw material extraction through the processing, manufacturing,

distribution, use, repair and maintenance of materials, disposal or recycling of materials. International standards ISO 14040 and 14044 are now the main reference system for performing LCA (ISO 14040; ISO 14044).

The main features of LCA and differentiation from other methods include:

- *Life cycle dimension*: taking into account the entire life cycle of the product, from material extraction to launch, growth, maturity and decline.
- *Life cycle resources*: taking into account both input and output resources for the development of a product.

ISO 14040: 2006 describes the principles and framework for Life Cycle Assessment (LCA), including: defining the purpose of LCA, Life Cycle Analysis (LCI), Life Cycle Impact Assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA limitations, relationship between LCA phases and conditions of use of various optional elements.

In addition to these standardization bodies, the UNEP / SETAC Life Cycle initiative has a relevant role in the application and dissemination of LCA. These principles can be applied to identify the LCA assessment capacity (UNEP, 2016).

3.5. Economic Responsibility

For the assessment of economic responsibility of sustainability, there are a number of approaches to cost and performance calculation. This economic assessment takes into account, usually, the manufacturing costs and the related life cycle costs. Life cycle costs are the total costs of a system or product over a defined lifetime (Bubeck, 2002). Total life cycle costs indicate that all costs are covered. These cost estimates can be made before the product is developed, hence we talk about pre-calculation. This cost estimation (precalculation) can record differences compared with post-product costing evaluation of a product (Verboncu et al., 2016).

An example of life cycle costing is compiled by Bubeck, which considered the costs of a post-calculated product as a reference item and can be considered at the stage of developing the new product. This approach is based on a cost structure based on life cycle stages, concentration on money flows (in analogy with material and energy flows) and consideration of product usage conditions.

To estimate LCC costs, there are a number of tools in the literature. Among these tools, the European Commission, presents a tool for LCC that assesses environmental impact in four directions: human health, ecosystem, resource availability, and climate change. Each of these categories is individually assessed and estimates the environmental impact as real as possible (European Commission, 2015).

3.6. Social Responsibility

Social responsibility for sustainability refers to the impact of an organization, product or process on society. Social

benefits can be estimated by analysing the organization's impact on stakeholders at local, regional, national and global level (Ionescu et al., 2014). For this responsibility there are indicators that measure the extent to which social values and objectives can be achieved and how the organization is actively involved. Indicators of this size are not easy to quantify (Anex et al., 2014; Popescu et al., 2016)). Therefore, this assessment is based on a qualitative assessment of the organization's activities. Indicators refer to social issues (remuneration system, employee involvement, labour force, etc.).

In this regard, there is the standardization system of the International Organization for Standardization (ISO), ISO 26000 : 2010 - Guidance on Social Responsibility (ISO, 2016). This standard provides action directions for organizations, regardless of their size and location. This standard also includes the following important directions:

- Concepts, terms, conditions of social responsibility
- Terms for identifying the actions of the organization
- Develop, implement and promote socially responsible behaviour throughout the organization through its policies and practices in its sphere of influence.

4. Assessment approach for the Life Cycle Sustainability Assessment

After evaluating the three dimensions of the life cycle (E-LCA, LCC, S-LCA) a multi-criterion assessment of the importance of sustainability responsibilities and indicators of each responsibility is required (Finkbeiner et al., 2010). So for LCSA it is necessary to solve two levels of shares:

- Assigning the share of the three responsibilities (environment, economic, and social) depending on the importance for the analysed organization, and
- Assigning the share of indicators identified under each responsibility.

Following this approach, the sustainability assessment can be considered as in Figure 4. In order to identify the sustainable development level, the categories for the obtained scores can be established. Depending on these categories, improvements, future actions and strategies can be proposed.

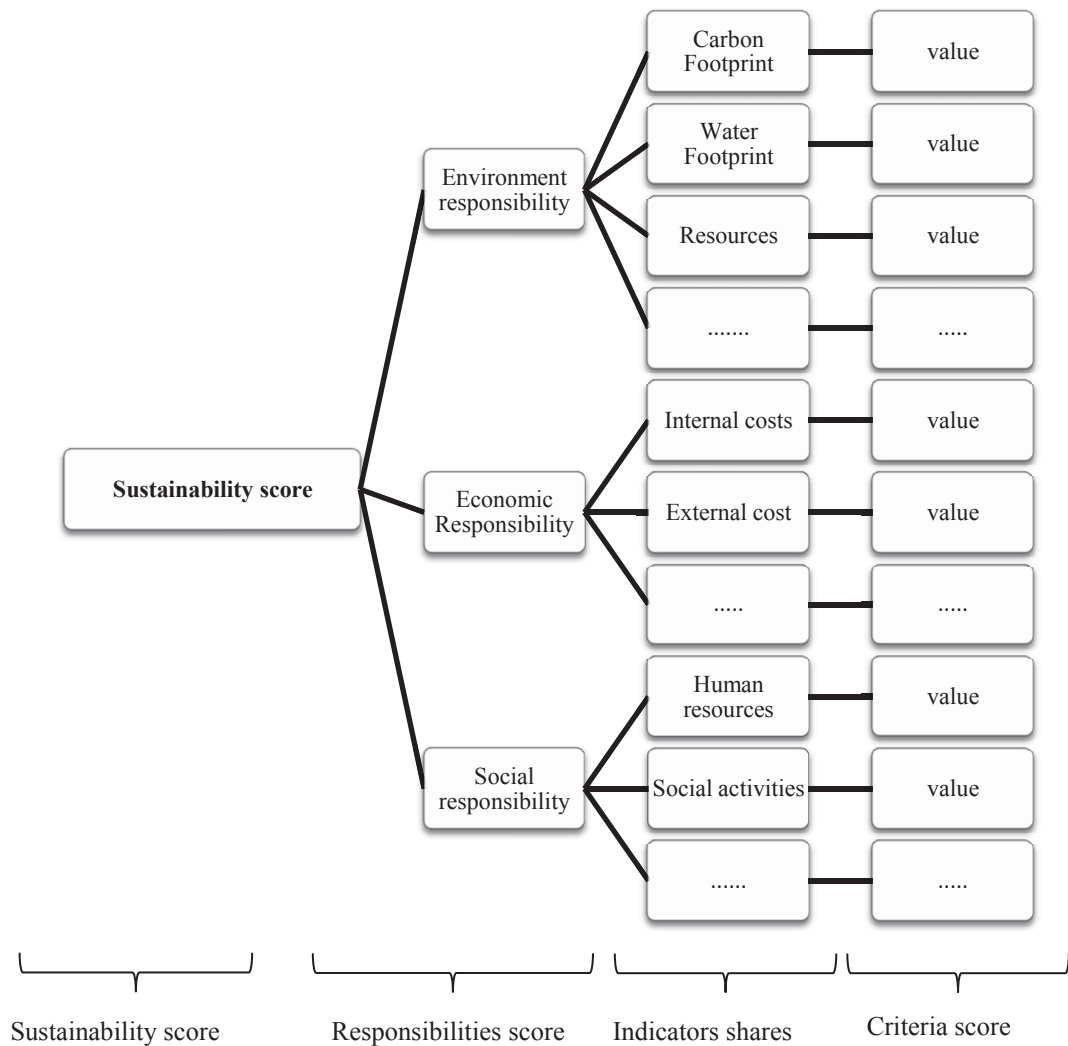


Fig. 4. LCSA scheme for organization assessment

This LCSA assessment scheme can be adapted to each organization according to the indicators considered in the assessment of each responsibility. So LCSA can be written as equation (1)

$$\text{LCSA} = \sum_{i=1}^n (RC_E * I_{E_i}) + \sum_{j=1}^m (RC_{Ec} * I_{Ec_j}) + \sum_{k=1}^p (RC_S * I_{S_k}) \quad (1)$$

Where,

RC_E = Environmental responsibility score

RC_{Ec} = Economic responsibility score

RC_S = Social responsibility score

I_{E_i} = share of indicator i within environmental responsibility

I_{Ec_j} = share of indicator j within economic responsibility

I_{S_k} = share of indicator k within social responsibility

n = the number of environmental responsibility indicators

m = the number of economic responsibility indicators

k = the number of social responsibility indicators

Discussion and conclusions

As the current paper emphasizes, sustainable development has a number of benefits for organizations. Addressing sustainability in the context of competitiveness contributes to the development of an area called "ideal area" within which sustainable companies are also competitive. For the assessment of sustainable development, the concept of life cycle sustainability assessment was presented in this paper. Within this concept we evaluated:

- Environment – life cycle assessment (E-LCA)
- Economic - life cycle assessment (LCC)
- Social - life cycle assessment (S-LCA)

Future research will address assessment methods for E-LCA, LCC, and S-LCA. Thus, these researches represent support for organizations in order to approach sustainable development.

References

- Ambrus, R., Izvercian, M., Ivascu, L., Artene, A. (2017). The link between competitiveness and sustainability of enterprises, 4th BE-ci International Conference on Business & Economics, Brno, Cehia.
- United Nations Environment Programme (UNEP) (2012). Social life cycle assessment and life cycle sustainability assessment, Available online on <http://www.unep.org/> (accessed on 10 June 2017).
- Ivascu, L., and Cioca, L. I. (2014). Opportunity Risk: Integrated Approach to Risk Management for Creating Enterprise Opportunities, The 2nd International Conference on Psychology, Management and Social Science, Psychology, Management and Social Science. *Advances in Education Research*, 49, 77-80.
- Ionescu, G., Rada, E.C., Cioca, L.I. (2014). Municipal solid waste sorting and treatment schemes for the maximization of material and energy recovery in a latest eu member, 10th International Conference on Environmental Legislation, Safety Engineering and Disaster Management, *Environmental Engineering and Management Journal*, 14(11), 2537-2544.
- Environmental Management—Life Cycle Assessment—Principles and Framework (ISO 14040); ISO: Geneva, Switzerland, 2006.
- Environmental Management—Life Cycle Assessment—Requirements and Guidelines (ISO 14044); ISO: Geneva, Switzerland, 2006.
- United Nations Environment Programme - UNEP/SETAC Life Cycle Initiative; UNEP: Nairobi, Kenya, 2016; Available online: <http://lcinitiative.unep.fr> (accessed on 10 June 2017).
- Finkbeiner, M., Schau, E.M., Lehmann, A., Traverso, M. (2010). Towards Life Cycle Sustainability Assessment, *Sustainability Journal*, 2, 3309 – 3322.
- Cioca, L.I., Moraru, R.I. (2010). The importance of occupational health and safety in the framework of corporate social responsibility, *Management of Sustainable Development*, 2(2), 71-77.
- Bubeck, D. (2002). Life Cycle Costing (LCC) im Automobilbau; Verlag Dr. Kovac: Hamburg, Germany.
- International Organization for Standardization (ISO), Available online: <https://www.iso.org/standard/42546.html> (accessed on 5 May 2017).

- Ghicajanu, M., Irimie, S., Marica, L., Munteanu, R. (2014). Criteria for Excellence in Business. 2nd Global Conference on Business, Economics, Management and Tourism, 23, 445-452.
- European Commission (2015). Life-Cycle Costing (LCC) calculation tool. Available online: http://ec.europa.eu/environment/gpp/pdf/09_06_2015/Life_cycle_costing_calculation_tool.pdf (accessed on 20 May 2017).
- Anex, R., Lifset, R. (2014). Life Cycle Assessment - Different Models for Different Purposes, *Journal of Industrial Ecology*, 18(3), 321-323.
- Popescu, D. E., Bungău, C., Prada, M., Dpmuta, C., Bungau, S. , Tit, D. M. (2016). Waste Management Strategy at a Public University in Smart City Context, *Journal of Environmental Protection and Ecology*, 17(3), 1011-1020.
- Verboncu, I., Irimie, S., Zeininger, L., Mihai, M. (2016). A Snapshot over Dynamics of Innovation in Romanian SMEs. Vision 2020: Innovation Management, Development Sustainability, and Competitive Economic Growth, I – VII, 1400-1406.