LIFE CYCLE PERSPECTIVE – A NEW REQUIREMENT OF ENVIRONMENTAL MANAGEMENT SYSTEMS

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Summary: The intention of this article is to discuss a new requirement of environmental management systems (EMSs), which is the consideration of environmental aspects of an organisation from the life cycle perspective, resulting from the ISO 14001:2015 standard. Consequently, the key characteristics of the concept of life cycle perspective are described. Subsequently, the current level of implementation of this concept by Polish organisations, formally registered to Eco-Management and Audit Scheme (EMAS), is presented. Finally, the author provides theoretical considerations on the suitability of life cycle assessment (LCA) for identification and evaluation of environmental aspects from the life cycle perspective.

Keywords: environmental management, Eco-Management and Audit Scheme (EMAS), life cycle, life cycle assessment (LCA)

1. Introduction

In 2015, the new ISO 14001 standard concerning the implementation process of environmental management systems (EMSs) was announced. One of the main changes in the revised version of the ISO 14001 standard is life cycle perspective. Life cycle perspective requires organisations to control or influence the way their products and services are designed, manufactures, distributed, consumed, and end-of-life treated as to prevent environmental impacts from being shifted within the life cycle [1]. Organisations have a three-year transition period after the revision has been published as to ensure the compatibility of their EMS to the new edition of the standard. Considering the above, the prime aim of the article is to support the inclusion of the concept of life cycle thinking into organisations' day-to-day operations. And thus, the author discusses key requirements of EMSs on life cycle perspective, presents the current level of application of life cycle perspective amid Polish organisations and finally specifies potential tool to its implementation.

2. Key requirements of environmental management systems that refer to life cycle perspective

While implementing EMS organisations are required to identify environmental aspects that can be controlled and influenced, and to determine these that have a significant impact on the environment, from the life cycle perspective. According to the ISO 14001:2015 standard, environmental aspect is "an element of an organisation's activities or products or services that interacts or can interact with the environment". Environmental aspects cause environmental impacts, being the environmental consequences of organisation's operation. When determining environmental aspects, organisations ought to take into account:

– “changes, including planned or new developments, and new or modified activities, products and services,
– abnormal conditions and reasonably foreseeable emergency situations” [1].

Considering the ISO 14001:2015 standard requirements, the process of determining environmental aspects can be divided into four major stages, including:

– identification of activities, products and services that will be embraced by EMS,
– recognition of environmental aspects (inputs and outputs) related to them,
– identification of environmental impacts, adverse or beneficial, resulting from the determined environmental aspects, and finally
– evaluation of environmental aspects in order to determine the significant ones.

Essentially, environmental aspects are identified during the planning phase, which is the case of ISO 14001 certified organisations, or an initial environmental review, which is the case of EMAS registered organisations.

Addressing the concept of life cycle perspective by organisations means taking the responsibility for all stages of a product or service that can be controlled or influenced. Life cycle is defined as “consecutive and interlinked stages of a product or service, including raw material acquisition, design, production, transportation/delivery, use, end-of-life treatment and final disposal” [1]. By looking on its activities from the life cycle perspective, an organisation can potentially prevent or mitigate adverse environmental impacts during the above enumerated life cycle stages (see Fig. 1).

As to apply the life cycle perspective to products and services, organisations ought to consider a number of issues, including [3]:

– the life cycle of the given product or service,
– the stage in the life cycle their product or service is in,
– the degree of control or influence they have over the life cycle stages, and finally
– the possible influence on the supply chain.

The above is only possible by strong network co-operation across organisations, including suppliers, manufacturers, intermediaries, third-party service providers and customers [4].

3. The application of life cycle perspective amongst Polish organisations

Managing environmental aspects is a very complex issue and, therefore, for that purpose organisations apply EMSs. EMS can be defined as a problem identification and problem solving tool, which provides organisations with a method to systematically manage their environmental activities, products and services and helps to achieve their environmental obligations and performance goals [5]. ISO 14001 and Eco-Management and Audit Scheme (EMAS) are two the most important EMSs. Continual improvement, prevention of environmental pollution and legal compliance are the principles of EMSs. [6] Due to the fact that there is limited reliable data on organisations certified to ISO 14001, the level of application of life cycle perspective amid Polish organisations is discussed upon the official statistics of the General Directorate for Environmental Protection regarding organisations registered to EMAS.

According to the database of the General Directorate for Environmental Protection, there were 70 organisations in Poland formally registered to EMAS by the end of 2016 (see Tab. 1) [7]. The first formal EMAS registration was in 2005 and since then EMAS shows a dynamic increasing trend. Although the predominant part of organisations comes from the

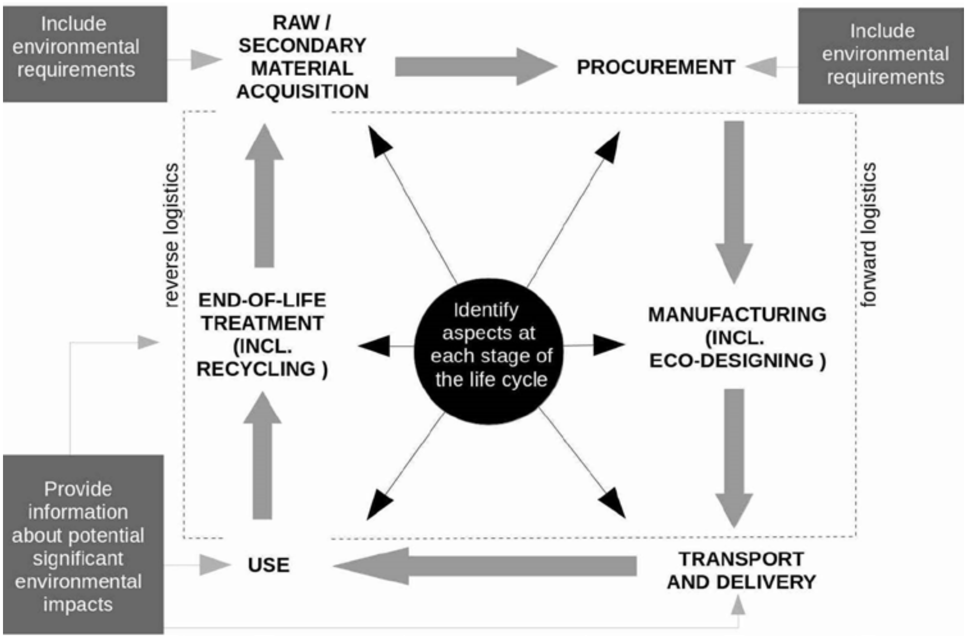

Fig. 1. Model of life cycle and ISO 14001:2015 requirements
Source: Own research, based on [2]

industrial sector (involved in manufacturing), recently organisations from the service sector and authorities have been joining the scheme too.

Tab. 1. Growth of EMAS registered organisations in Poland from 2005 to 2016

	2006	**2008**	**2010**	**2012**	**2014**	**2016**
NO. OF EMAS REGISTERED ORGANISATIONS	2	12	18	32	41	70
GROWTH RATE [%]		500	50	78	28	71

Source: Own research, based on [6]

The core of EMSs is the continual improvement circle called also as “Plan-Do-Check-Act (PDCA)” circle [1]. The PCDA circle is an iterative process, which crucial elements are developing an environmental policy and planning, and implementing it. Subsequently the system is checked to make sure it is functioning as planned and if necessary corrective actions are introduced. Finally, top managers review the system at planned intervals. If any of these elements is missing, the continual improvement is very difficult to achieve.

Although the steps to having EMAS in place are basically parallel to the ISO 14001 system, it includes few other specifications for continual improvement, such as an initial environmental review, an active involvement of employees, a documented legal compliance and finally the publication of an environmental statement [8]. The initial environmental review being a comprehensive analysis of the environmental impacts (direct and indirect), caused by an organisation's activities, products and services is a fundamental EMAS requirement regarding the application of the concept of life cycle perspective. Direct environmental aspect are associated with these activities, products, and services of organisation, over which it has direct management control, whereas indirect environmental aspects are associated with the activities, products, and services of organisations it co-operate with through production stages, transportation and supply chain and thus cannot be fully controlled [9]. Use of raw materials and natural resources, including water, energy and heat, emissions to air, water and land, and finally generation of waste are sample direct environmental impacts.

To explore the application of the concept of life cycle perspective while determining environmental aspects and their consequences to the environment amid Polish organisations registered to EMAS cluster analysis was used. Consequently, exemplary organisations were chosen for the analysis representing the industry, services and public administration. Despite the fact that their environmental declarations constituted an essential source of information, the author investigated a number of other EMAS related documents to have a broader view on the research issue.

The analysis of environmental declarations proved that Polish organisations do not apply life cycle perspective while determining environmental aspects. Instead, they still apply production or service oriented method and rely on traditional, very often subjective, approaches and criteria when assessing their influence on the environment. Consequently, Polish organisations confront their business or statutory performance, first of all, against legal requirements, expectations of interested parties and environmental factors (probability of occurrence within organisation's processes, duration of impact or range of impact), less frequently costs and image.

Notwithstanding of the type of organisation, they recognise direct and indirect environmental aspects having input, output or other (qualitative) character (see Tab. 2). The most often occurring inputs are water, energy, heat, paper and other natural resources consumption, whereas the most often occurring outputs are emissions to air (CO_2, NO_x, SO_2), water pollution and waste generation. Although the occurrence of inputs and outputs is relatively balanced, 30 – 53% in the case of manufacturing company, 50 – 40% in the case of service company and 41 – 53% in the case of public administration, the research proved that the output-based environmental aspects do not have sometimes their counterparts in the inputs used. However, organisations determine environmental aspects independently and there are also good examples. This is the case of manufacturing organisation where inputs and outputs are assigned separately to each unit process, taking place in the company.

Finally, despite the fact that the identification of environmental impacts resulting from determined environmental aspects has a character of cause-and-effect relationship, it is solely expressed at the level of man-made interventions on the environment. Therefore, natural resources depletion, air pollution and water pollution are the most frequently occurring environmental impacts in Polish organisations registered to EMAS. Unfortunately, none of them convert inputs and outputs into category indicators representing environmental mechanisms such as climate change, acidification or eutrophication.

Tab. 2. Characteristics of environmental aspects amongs Polish organisations formally registered to EMAS (three examplary organisations)

TYPE OF ACTIVITY	TOTAL NUMBER OF SIGNIFICANT ENVIRONMENTAL ASPECTS		CHARACTER OF ENVIRONMENTAL ASPECTS		
	THEREIN DIRECT	THEREIN INDIRECT	INPUTS [%]	OUTPUTS [%]	OTHER [%]
MANUFACTURING	16	7	30	53	17
SERVICE	8	2	50	40	10
PUBLIC ADMINISTRATION	8	9	41	53	6

Source: Own research

4. Life cycle assessment (LCA) and its role in implementing the concept of life cycle perspective

The ISO 14001 standard does not recommend a single method for determining environmental aspects considering life cycle perspective, however, it obligates organisations to take into account "the inputs and outputs that are associated with its current and relevant past activities, products and services; planned or new developments; and new or modified activities, products and services" [1]. Moreover, organisation ought to consider emissions to air, releases to water, releases to land, use of raw materials and natural resources, use of energy, energy emitted, generation of waste and by-products and use of space, which corresponds to their environmental aspects. Considering the above, a performance of life cycle assessment (LCA) while identifying environmental aspects seems to be a reasonable solution.

Life cycle assessment (LCA) is one of techniques of life cycle management (LCM) that evaluates the environmental aspects and potential environmental impacts of a product system (i.e. any goods, production process or service) throughout its life cycle, from raw material acquisition, through production, distribution and use, up to end-of-life treatment [10, 11]. Depending on the end-of-life treatment, LCA is defined as the cradle-to-cradle analysis, in case of reuse and recycling, or the cradle-to-grave analysis, in case of disposal. LCA is regulated by the series of ISO 14040 standards, which Polish equivalents are:

- PN-EN 14040:2009 Environmental management – Life cycle assessment – Principles and framework, and
- PN-EN 14044:2009 Environmental management – Life cycle assessment – Requirements and guidelines.

The methodology of LCA is structured along a framework that is the subject of worldwide consensus and forms the basis of a number of ISO 14000 standards. This framework divides the entire LCA procedure into four distinct phases [12]:

- goal and scope definition,

– life cycle inventory analysis (LCI),
– life cycle impact assessment (LCIA), and
– interpretation.

Goal and scope definition is the first phase of LCA. It incorporates a number of successive operations, including the formulation of the goal of the analysis, the determination of a product system and its functional unit, and finally the definition of the system boundaries [13]. The goal of the study ought to be formulated transparently, not only in terms of what is to be done, but also of the reasons for executing the study [12]. The product system is a set of material, product and energy connected unit processes that fulfil one or more defined functions. Unit process is the smallest part of the product system for which the environmental data are collected. The system boundary is a set of criteria specifying unit processes being a part of a product system (see Fig. 2) [14].

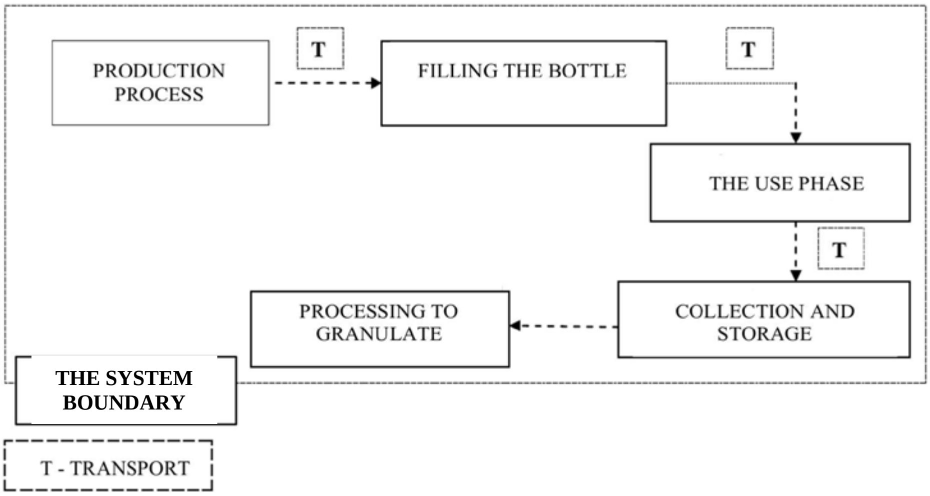

Fig. 2. A simplified product system for PET bottle
Source: Own research, cf. [15]

Life cycle inventory (LCI) is the second phase of LCA. It covers the collection and quantification of inputs and outputs, assigned to each unit process individually, for a given product system throughout its life cycle [13]. Inputs cover two types of data, i.e. inputs from nature (resources) and inputs from technosphere (materials, fuels, electricity and heat). Outputs cover all emissions (to air, water and soil), waste and non-material emissions (radiation, noise) (see Fig. 3). Depending on the goal and scope, the LCA analysis can rely on foreground data and/or background data.

Life cycle impact assessment (LCIA) is the third phase of LCA. It defines the relationship between the environmental inventory (environmental aspects) and defined impact categories, and category indicators (environmental impacts) at the midpoint level and areas of protection at the endpoint level. The mandatory elements of LCIA are the selection of impact categories, category indicators and characterisation models, classification (assignment of LCI results to the impact categories) and characterisation (calculation of category indicator results) [13]. The optional elements of LCIA are normalisation (calculating the magnitude of the category indicator results relative to reference values) and weighting (assigning weights to different impact categories). Due to the complexity of the LCIA phase, there is a range of sophisticated LCIA methods, including: Eco-indicator, ILCD, IPCC, CML, ReCiPe, to support LCA practitioners.

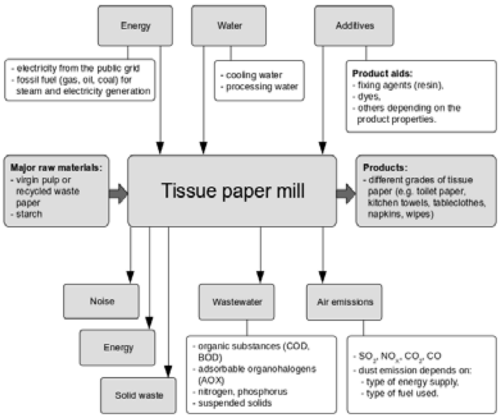

Fig. 3. An exemplary general scheme of LCI for tissue paper production
Source: Own research, cf. [16]

Life cycle interpretation is the last phase of LCA. It ought to enable the evaluation of results, as to their consistency and completeness, an analysis of achieved results, in terms of soundness and robustness and the formulation of conclusions and recommendations regarding the reduction of environmental impacts [12].

Considering the above, the primary responsibilities of LCA that predispose this technique to implementing the concept of life cycle perspective by organisations are [17, 18]:

- the identification and assessment of inputs and outputs of both direct and indirect environmental aspects and related to them environmental impacts,
- the documentation of potential environmental aspects of the product during all stages of its life cycle,
- the analysis of the possibility of occurrence of interrelated environmental impacts as to avoid the transfer of pollution,
- recognition of the character of changes in the environment by including several impact categories at the midpoint and endpoint level, and finally
- the prioritization of improvement, by the evaluation of environmental impacts and thus it enables organisations to concentrate their endeavours on activities, products or services that need the greatest control or influence.

Last, but not least important strength of the LCA technique is the availability of standardized, scientifically based and software supported methodology for it performance that brings reproducible results.

As every method, LCA is not free of limitations from the point of the considered applications, which are a relatively high complexity, time consumption and cost requirements [19]. They stem primarily from the following facts: necessity to collect extensive foreground environmental data, purchasing LCA software and training or hiring employees. Despite these weaknesses, LCA proves high potential in implementing the concept of life cycle perspective.

5. Conclusions

The life cycle perspective is a step change in the approach to environmental management systems and thus determining environmental aspects. Polish learning organisations will soon understand it and turn towards innovative methods supporting their continual improvement. Consequently, it can be expected that in the near future, LCA become a common practice amid ISO 14001 certified and EMAS registered organisations.

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