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SOCIAL LIFE CYCLE ASSESSMENT: A CONCEPTUAL NOTE

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ABSTRACT

Life Cycle Assessment (LCA) is a science-based, comparative analysis and assessment of the environmental impacts of product systems. It is distinguished from other environmental assessment methods by two constitutive and unique features: the analysis from 'cradle-to-grave' and the 'functional unit'. A social life cycle assessment (S-LCA) is a method that can be used to assess the social and sociological aspects of products, their actual and potential positive as well as negative impacts along the life cycle. This looks at the extraction and processing of raw materials, manufacturing, distribution, use, reuse, maintenance, recycling and final disposal. S-LCA makes use of generic and site-specific data, can be quantitative, semi-quantitative or qualitative. Its approach to community planning and development can lead to fewer environmental impacts from materials used, construction practices, and waste management, as well as the energy and water used by people living and working in the community. In 1969, researchers initiated an internal study for The Coca-Cola Company that laid the foundation for the current methods of life cycle inventory analysis in the United States. When solid waste became a worldwide issue in 1988, LCA again emerged as a tool for analyzing environmental problems. In the research community concerned, there is heated debate on the future of the S-LCA methodology.

KEY WORDS: *Life Cycle, Assessment, Environmental Effects*

Life cycle thinking applies to the daily decisions we make at our homes and workplaces, decisions about creating services and how we develop our communities. Citizens, businesses, and governments are finding ways to promote life cycle thinking and balance the impacts of their choices. For example, thinking about how our industries and homes use water and what we release into our water systems are key life cycle considerations. With life cycle information, we can design industrial processes and use raw materials in ways that preserve water quality and access to clean water around the world. A life cycle approach to community planning and development can lead to fewer environmental impacts from materials used, construction practices, and waste management, as well as the energy and water used by people living and working in the community.

Experts from industry, government, and other organizations agree that making life cycle approaches a part of the way we design products, develop services, make policies, and decide what to consume (or what not to consume) will help to halt and possibly reverse some of the damaging trends in our communities and environments; it certainly won't solve all our environmental problems, but it can help us find sustainable ways to tackle some of them (UNEP, 2004).

BRIEF HISTORY OF LCA

Life Cycle Assessment (LCA) had its beginnings in the 1960's. Concerns over the limitations of raw materials and energy resources sparked interest in finding ways to cumulatively account for energy use and to project future resource supplies and use. In one of the first publications of its kind, Harold Smith reported his calculation of cumulative energy requirements for the production of chemical intermediates and products at the World Energy Conference in 1963.

In 1969, researchers initiated an internal study for The Coca-Cola Company that laid the foundation for the current methods of life cycle inventory analysis in the United States. In a comparison of different beverage containers to determine which container had the lowest releases to the environment and least affected the supply of natural resources, this study quantified the raw materials and fuels used and the environmental loadings from the manufacturing processes for each container. Other companies in both the United States and Europe performed similar comparative life cycle inventory analyses in the early 1970's. At that time, many of the available sources were derived from publicly-available sources such as government documents or technical papers, as specific industrial data were not available.

Global modeling studies published in `The Limits to Growth' (Meadows et al 1972) and `A Blueprint for Survival' (Goldsmith et al 1972) resulted in predictions of the effects of the world's changing populations on the demand for finite raw materials and energy resources. The predictions for rapid depletion of fossil fuels and climatological changes resulting from excess waste heat stimulated more detailed calculations of energy use and output in industrial processes. During this period, about a dozen studies were performed to estimate costs and environmental implications of alternative sources of energy.

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From 1975 to the early 1980's, as interest in these comprehensive studies waned because of the fading influence of the oil crisis, environmental concerns shifted to issues of hazardous and household waste management. However, throughout this time, life cycle inventory analysis continued to be conducted and the methodology improved through a slow stream of about two studies per year, most of which focused on energy requirements.

When solid waste became a worldwide issue in 1988, LCA again emerged as a tool for analyzing environmental problems. As interest in all areas affecting resources and the environment grew, the methodology for LCA is again improved. A broad base of consultants and researchers across the globe has been further refining and expanding the methodology.

In 1991, concerns over the inappropriate use of LCAs to make broad marketing claims made by product manufacturers resulted in a statement issued by eleven State Attorneys General in the USA denouncing the use of LCA results to promote products until uniform methods for conducting such assessments are developed and a consensus reached on how this type of environmental comparison can be advertised non-deceptively. This action, along with pressure from other environmental organizations to standardize LCA methodology, led to the development of the LCA standards in the International Standards Organization (ISO) 14000 series (1997 through 2002) (SAIC, 2006).

The United Nations Environment Program (UNEP) and the Society for Environmental Toxicology and Chemistry (SETAC) launched in 2002 an International Life Cycle Partnership, known as the Life Cycle Initiative (LCI), to enable users around the world to put life cycle thinking into effective practice. The Initiative responds the call by Governments around the world for a Life Cycle economy in the Malmo Declaration (2000). It contributes to the 10-Year Framework of Programs to promote sustainable consumption and production patterns, as requested at the World Summit on Sustainable Development (WSSD) in Johannesburg (2002). It aims to promote life cycle thinking globally and facilitate the exchange of knowledge of over 2,000 experts worldwide and four regional networks from different continents (UNEP/ SETAC Life Cycle Initiative, 2005).

LIFE CYCLE ASSESSMENT

Life Cycle Assessment (LCA) is a science-based, comparative analysis and assessment of the environmental impacts of product systems. It is distinguished from other environmental assessment methods by two constitutive and unique features: the analysis from 'cradle-to-grave' and the 'functional unit'. 'Cradle-to-grave' means that all the important steps in the life cycle of a product are included in the analysis, namely the extraction of raw materials from the environment (soil, water, air), the production of materials and the final products, their use and waste removal or recycling. Any transportation that occurs across these steps is also accounted for. The 'products' are defined as 'goods and services' in all relevant standards. The final products in services are intangible but need the same processes, energy sources, etc. as tangible products or goods; the definition of the life cycle has to be modified accordingly case-by-case.

The concept of 'life cycle' used in LCA is always the physical life cycle, rather than the 'marketing life cycle' which starts with planning, R&D and design, introducing a product into the market, producing, selling, leasing, etc. until the product is taken out of the market. This definition can also be used for goods and services where a functional unit can be defined (Klopffer, 2014).

LIFE CYCLE COASTING

It is a tool to determine the most cost-effective option among different competing alternatives to purchase, own, operate, maintain and, finally, dispose of an object or process, when each is equally appropriate to be implemented on technical grounds. For example, for a highway pavement, in addition to the initial construction cost, LCCA takes into account all the user costs, (e.g., reduced capacity at work zones), and agency costs related to future activities, including future periodic maintenance and rehabilitation. All the costs are usually discounted and totaled to a present-day value known as net present value (NPV). This example can be generalized on any type of material, product, or system.

In order to perform a LCCA, scoping is critical, i.e. what aspects are to be included and what not? If the scope becomes too large the tool may become impractical to use and of limited ability to help in decision-making and consideration of alternatives. If the scope is too small then the results may be skewed by the choice of factors considered such that the output becomes unreliable or partisan. Usually the LCCA term implies that environmental costs are not included, whereas the similar Whole-Life Costing, or just Life Cycle Analysis (LCA), generally has a broader scope, including environmental costs (Life-cycle Cost Analysis: wikipedia).

SOCIAL LIFE CYCLE ASSESSMENT IN SOCIAL SCIENCE

A social life cycle assessment (S-LCA) is a method that can be used to assess the social and sociological aspects of products, their actual and potential positive as well as negative impacts along the life cycle. This looks at the extraction and processing of raw materials, manufacturing, distribution, use, reuse, maintenance, recycling and final disposal. S-LCA makes use of generic and site-specific data which can be quantitative, semi-quantitative or qualitative, and complements the environmental Life Cycle Assessment (LCA) and Life Cycle Costing (LCC). It can either be applied on its own or in combination with other techniques. S-LCA does not provide information on the question of whether a product should be produced or not – although information obtained from an S-LCA may offer "food for thought" and can be helpful for taking a decision. The UNEP Guidelines for Social Life Cycle Assessment of Products proposes a methodology to develop life cycle inventories. A life cycle inventory is elaborated for indicators (e.g. number of jobs created) linked to impact categories (e.g. local employment) which are related to five main stakeholder groups (e.g., worker, consumer, local community, society, and value chain actor (S-LCA: lifecycleinitiative.org).

SETTING SYSTEM BOUNDARIES

How system boundaries are set is dependent on the researchers' perspective with respect to a product development (single product). It suggests that the relevant elements should be the parts of the life cycle that the company can influence directly (i.e., 'hotspots' that the company is able to address). In this case the company should not be held accountable for what is beyond its influence. The application of S-LCA implies that only the company and its closest suppliers and distributors are assessed (Dreyer et al., 2006; Methot, 2005), thus setting the system boundaries well short of the entire life cycle. Such an approach has similarities with Corporate Social Responsibility (CSR) where the concern is with the conduct of a specific company and its social impact rather than the social impacts of a product across it whole life cycle (Paragahawewa, U., et al, 2009).

SOCIAL INDICATOR

According to UNEP (2009), in Environmental Life Cycle Assessment (E-LCA), there are two types of impact categories; midpoint and endpoint indicators. This difference refers to the location of the indicators in the causal chain from process to impact. In general, endpoint indicators are considered the most appropriate as an E-LCA impact on the AoP (Area of Protection). However, it may be difficult to relate the activities in the product process chain to some endpoint indicators. For example, consider the impact category of climate, the endpoint indicator might be 'the amount of climate change as a function of the life cycle of product X'. This could be difficult if not impossible to measure or calculate. So instead, a midpoint indicator, somewhere along the causal chain between the life cycle processes of product X and climate change, such as, 'greenhouse gases released into the atmosphere during the production and life of product X' might be used as a proxy measure. An impact pathway links the two types of indicators by describing the cause-effect relationship between midpoint and endpoint.

In 'The Guidelines', UNEP (2009,) defines qualitative indicators as: "…nominative: they provide information on a particular issue using words. For instance, text describing the measures taken by an enterprise to manage stress." Quantitative indicators are described as: "…a description of the issue assessed using numbers: for example, number of accidents by unit process." Semi-quantitative indicators are described as: "…indicators that have results expressed into a yes/no form or a scale (scoring system): for example, presence of a stress management program (yes/no). Qualitative and quantitative indicator results may be translated into semi-quantitative form".

CONCLUSION FROM CASE STUDIES

Laptop study: The laptop study showed that it is possible to conduct a simplified S-LCA using the Guidelines on a generic complex product. The study identified workers and the local community as the stakeholders at risk of negative social impacts, with social benefits/social security, working hours and freedom of association being important issues for workers. The local community was mostly affected by access to immaterial resources, safe and healthy living conditions, community engagement, delocalization and migration, cultural heritage and respect for the rights of indigenous peoples. The countries showing up as potentially important were China, Russia, Saudi-Arabia, Thailand and Brazil. These are generally less frequently mentioned in relation to ICT products, which may illustrate the added value of the life cycle perspective.

Vehicle fuels study: The conclusion was that among the different fuels assessed, there seems to be a mix of fossil and renewable displaying high or very high risks for negative impacts. This suggests a need for developing policy so that strict procurement requirements on social performance are set for the purchasing of all types of vehicle fuels, not just bio-fuels.

E-waste study: The study of e-waste recycling showed that it has mostly negative social impacts for workers and the community, but at the same time helps them in decreasing poverty by providing employment and by playing a vital role in economic development. The results point at a need for raising awareness among the workers, community and government officials on the negative social impacts identified (Petersen, E.K. 2013).

RECENT TRENDS IN LIFE CYCLE ANALYSIS

Whereas the structure of LCA as a science-based method for environmental assessments is unchallenged, new developments occurred in recent years (or older ones were rediscovered, as in the case of sustainability assessment) requiring more flexibility and/or detailed requirements than ISO 14040+44 can offer. The changes suggested—and partly are enacted in separate ISO norms or other guidelines—can be classified as belonging to one of the following trends:

- Make it simpler and more flexible
- Reduce the life cycle impact assessment to one impact category
- Expand the environmental LCA to a life-cycle based sustainability assessment.

This concept has been represented as the following non-numerical 'equation':

LCSA = LCA + LCC + SLCA

LCSA: Life Cycle Sustainability Assessment

LCA: (environmental) Life Cycle Assessment

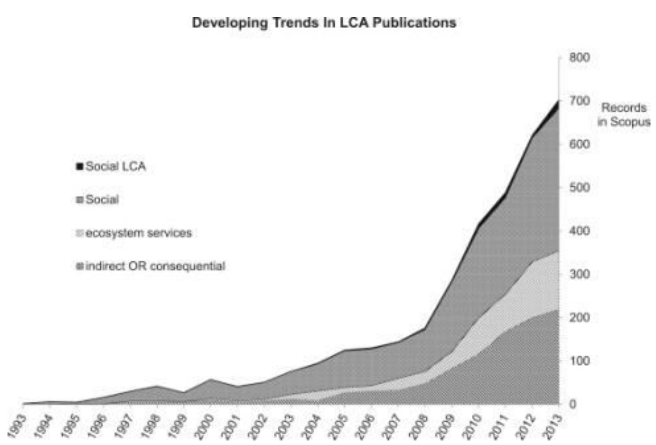
LCC: (environmental) Life Cycle Costing

SLCA: Social Life Cycle Assessment

In order to apply this 'equation' properly, it is essential that the system boundaries of the three life cycle assessments are compatible, ideally equal (Klopffer, W,2014).

RAPID GROWTH IN LCA

LCA has become a tool used to help drive and shape policy. Because of its history of efficacy, much of the emerging attempts to quantify such effects are appearing in LCA development and the published literature. Social aspects have expanded almost as rapidly as have indirect or consequential, and the beginnings of a formalization of Social LCA can be seen just starting to emerge (Marcelle C. M, et al, 2015).



CRITICISM OF S-LCA

In the research community concerned, there is heated debate on the future of the S-LCA methodology. One argument is that the tool does not improve social conditions (Jørgensen 2013). Another view is that there are no benefits from attributing social impacts to products, as they are more related to company conduct (Dreyer et al. 2006).

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