SOCIAL LIFE CYCLE ASSESSMENT OF PRODUCTS MANUFACTURING FOR PRACTICING ENGINEERS

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Abstract

Sustainable product manufacturing processes have environmental, economic and social dimensions. Professional engineers and engineering students need to be aware of such dimensions as well as should be able to assess it. This paper presents a new Microsoft Excel-based Social Impact Audit Tool designed to introduce engineers and engineering students to the Social Life-Cycle Assessment (S-LCA) of products. The underlying procedures are consistent with those proposed in the UNEP-SETAC "Guidelines for Social Life-Cycle Assessment of Products", which are widely accepted as the starting point for any S-LCA study. The Tool, accompanying the methodology, is simple, fast and gives insight into the multi-dimensional social aspects of product's life, viewed from a top-down, nation-wide perspective. While the tool was originally designed for materials science and engineering students, it is equally valuable for professional engineers engaged in products manufacturing.

Keywords: social life cycle assessment, sustainable manufacturing, S-LCA, social audit, SDGs

1 INTRODUCTION

In the era of consumerism and cost-reduction, it is often easy to neglect the social impacts in a product life-cycle management. A Social Life Cycle Assessment (S-LCA) during the product design process helps to define the socio-economic performance associated with the product throughout its life cycle. This is relevant for practicing engineers and technical managers, who are engaged in decisions about product design, materials sourcing, manufacturing, usage and product end-life evaluations.

In this paper, we present a Social Impact Audit Tool that evaluates the socio-economic performance associated with a product throughout its life and "flags" social hotspots, based on a country, where the potential impact is coming from.

Complementary to the already available Eco Audit and Cost Audit tools in ANSYS Granta EduPack [1], this EXCEL-based Tool offers an introduction to S-LCA thinking, based on the United Nations Environmental Program - Society of Environmental Toxicology and Chemistry (UNEP-SETAC) "Guidelines for Social Life Cycle Assessment of Products" [2]. The Tool uses the data from Nations of the World Data-table, included in Sustainable Development Database of Granta EduPack. This Social Impact Audit Tool indicates issues such as human rights and equity, health and safety, working conditions and fair pay, freedom of speech and association, social support and welfare, good governance and control of corruption, wellbeing in the broadest sense, etc. in the product life cycle that includes materials sourcing, manufacturing route, transport mode, use pattern and disposal choice. It is intended for educational use, however, could also be used for decision-makers, as a guide for socially responsible engineering design process.

2 SUSTAINABLE MANUFACTURING

Sustainable manufacturing has three components: Plant, People and Profit, often represented as 3-Ps. These can be reinterpreted as three capitals: Natural Capital, Human and Social Capital and Manufacture Capital, respectively, as shown in Fig 1.

The three capitals are interdependent. While the natural capital provides the materials and energy that supports manufacturing and generates financial capital, providing the resources that support education, health care and social support that are the building blocks of human and social capital, which in turn provides the motivation methods to conserve natural capital.

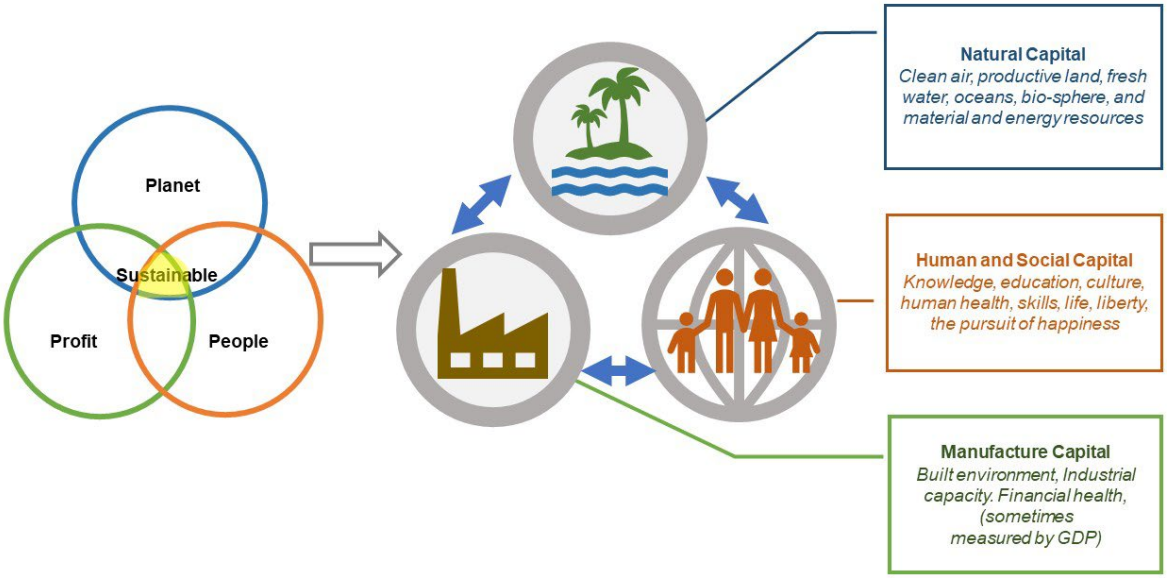

Figure 1. The fundamental components of sustainable manufacturing: The 3-Ps.

In the era of consumerism and cost-reduction, often economic considerations over-shadows the environmental and social priorities. For example, standard methods for Environmental Life-Cycle Assessment (E-LCA) [3] and Economic Life-cycle Costing (LCC) [4] of products have existed and been practiced for the last 30 years. Comparatively, Social Life-Cycle Assessment (S-LCA) is newer, with the formulation of an "Assessment Protocol" for S-LCA first appearing in 2009 with the publication of the UNEP-SETAC Report. The ultimate goal of a S-LCA is to improve social conditions and socio-economic performance associated with a product throughout its life. The Assessment or *Social Impact Audit* truly identifies "Social Hotspots" which are the points of contact between stakeholders and aspects of product life that harm human welfare or allow improved well-being of the individuals and communities touched by it. While a social impact audit is normally neither taught at universities nor considered by engineers while determining materials sources or end life of a product, it is imperative that only through such assessments, we can conduct a sustainable manufacturing process.

3 SOCIAL LIFECYCLE ASSESSMENT OF A PRODUCT

3.1 Steps in S-LCA

UNEP-SETAC Guidelines describe the steps in S-LCA and these are similar to the environmental assessments of products manufacturing. However, unlike the latter, S-LCA draws on imprecise data, much of it qualitative rather than quantitative. S-LCA does not also deliver numerical outputs like E-LCA. The first step in S-LCA is establishing the goal and scope, which is generally concentrated on finding the issues related to social well-being or "hotspots" during a product manufacturing process, starting from materials sourcing and ending with the disposal of materials. The second step is identifying the functional unit, stakeholders and the impact categories. There are primarily five stakeholder groups (workers, consumers, local communities, society and other value-chain actors) associated with the supply chain and manufacturing processes, and the impact of these are well-categorized. For example, while analyzing the workers stakeholders, one must assess the fair pay, social benefits, etc. in its impact categories. Based on such possible 31 impact categories, UNEP/SETAC guidelines suggested that these impact categories are broadly related to:

1. Human rights and equity
2. Health and safety
3. Working conditions and fair pay
4. Freedom of speech and association
5. Social support and welfare
6. Good governance and control of corruption

7. Wellbeing in the broadest sense

Therefore, the third step in S-LCA is to prepare a "social inventory" of the product manufacturing process. This step analyzes the above impacts categories in every stage of the product manufacturing. It starts with sourcing of the materials for the product and, using Nations of the World data tables, assesses the possible social impacts in the above impact categories, and prepares a social inventory.

In the fourth step, we assess the results flag a "hot spot" if there is an issue related to any stage in the product life cycle. For example, if the manufacturing of a product has taken place in a country where workers are not paid fairly, it flags a hot spot.

In the final step, management decisions are made using the above assessment, thus allowing for making changes in the supply chain or manufacturing or disposal process.

3.2 S-LCA Implementation

1. Identify the Nations used for material sourcing, manufacture.

2. Use the Look-Up Table in Excel for Nations Social impact category ranking to **select the**

3. Set a Hotspot Threshold – percentile of quality of practice below which wellbeing of stakeholders is affected.

4. Report the outcomes with the selected nations.

5. Impacts Assessment & Call for Actions.

Figure 2. The implementation of the S-LCA steps using EXCEL-based Social Impact Audit Tool

The Granta Excel tool described in this paper uses data from UNEP-SETAC Guidelines and the Impact Indicators assembled by Governments and Non-Governmental Organizations. Then it collects and scales data from 1 (worst practice) to 100 (best practice) to set a Hotspot threshold - the quality-of-practice below which concern might be felt for the wellbeing of one or more stakeholder group to flag Social Hotspots. An outcomes report is then prepared to make final assessments and call for action. This process a described in Fig 2. The below case study also explains the process.

4 CASE STUDY: S-LCA OF A PRODUCT

In this case study, S-LCA of a cotton t-shirt is conducted. There are five steps in the t-shirt product life cycle. The material is cotton, which is grown in Australia. The t-shirt is manufactured in Bangladesh and transported to Europe in Panamanian-flagged ships, sold and used over three years in Switzerland and sent to Kenya at the end of first life. Using the Granta Excel tool and NGO data, as described above, a hotspot analysis with the threshold set at 10% is performed. Australian society is flagged because of its high ecological footprint. The use of low wages and child labor and other working conditions such as

Table 1. Hot-Spot Summary Table of Cotton T-Shirt

	NATION	Workers	Consumers	Local Community	Society	Supply chain (others)
Material	Australia				X	
Manufacture	Bangladesh	X X X X	X	X		
Transport	Panama	X				
Use	Switzerland					
End of life	Kenya	X X		X X		

long working hours and public health provision that fall in the bottom 10% of those of all nations, so there is a hotspot. Additionally, Panama and Kenya are flagged for child labor, high unemployment and political instability. Table 1 shows the assessment which is further visualized on Figure 3. Finally, the outcomes report will be helpful in determining whether the manufacturing process needs to be revisited – a management decision will therefore be made.

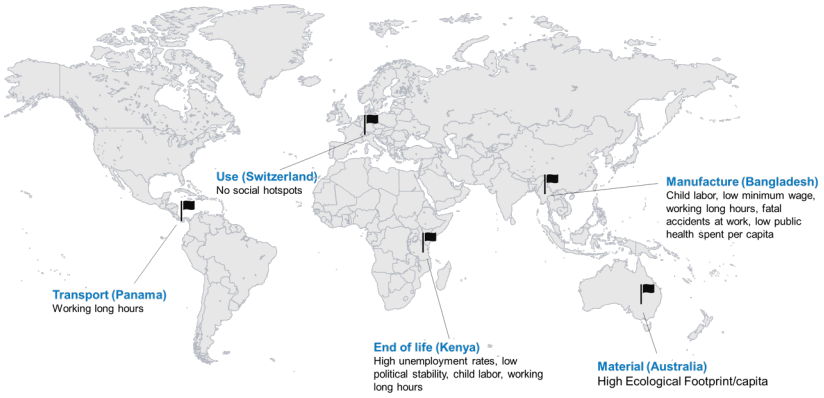

Figure 3. Hotspot summary map of t-shirt manufacture

5 CONCLUSION

S-LCA provides a thorough insight into the social and human impacts during a product manufacturing process. An Excel-based tool that derives information from a large body of regularly updated socially relevant data compiled by respected International Agencies and NGOs is used to assess social impacts and flags social hotspots for further decision making and social improvement. The approach developed in the UNEP/SETAC Guidelines and the Social Impact Audit Tool also align well with the 2030 Agenda for Sustainable Development [5] that defines 17 Sustainable Development Goals (SDGs) which include ending poverty and other deprivations, improving health and education, stimulating economic growth among others.

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