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Supply/value chain analysis of carbon and energy footprint of garment manufacturing in Sri Lanka

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A B S T R A C T

Paper presents the carbon and energy footprint of a bra, manufactured in Sri Lanka based on life cycle analysis under PAS 2050 standards. Carbon footprint of the product is 1.37 $kgCO_2e$ and energy footprint is 7.05 MJ. Highest contribution (61%) of carbon emission comes from raw material production. Therefore, sustainable procurement policies are critical. Second and third largest (12% and 10%) is in the user phase and manufacturing of the final product in Sri Lanka. Most of the emissions occur outside UK. Biggest energy consumption is at the user phase (28%). Manufacturing plant in Sri Lanka was an eco-friendly one. Targeting hotspots helped to improve carbon and energy efficiencies of manufacturing process. When these values were compared with footprint values if the product was manufactured in a standard garment factory in Sri Lanka, the carbon and energy footprints in the standard factory were 23% and 15% higher, respectively. Incremental improvements are possible through consumer behavioral changes; sustainable procurement policies; energy/carbon efficient technologies; grid electricity mix and management practices can influence final footprint values. Radical changes can be achieved using alternative low carbon raw materials, renewable grid electricity mixes, and by dramatic reduction of consumption. Doubling the number of wears before disposing (avoiding a new buy) can reduce the carbon emission by 44% and energy by 35.7% per garment. At the design stage it is important to take: washing behavior; types of raw material; recyclability; durability and biodegradability of raw material into account. Economically, the largest share of manufacturing costs is due to raw material, while the value remaining in the country is low — a feature typical to buyer driven supply chains.

Keywords: Sustainable-development; Carbon-footprint; Sustainable-production; Value chain-analysis; Garment-industry; Asia

1. Introduction

Carbon and energy footprint (CF & EF) is getting popular among export led garment manufacturers in Asia, and Sri Lanka who cater to western buyers. For manufacturers, footprint accounting is the first step in the carbon/energy reduction process. Once accounted, the tangible value depends on the ability to implement a more carbon/energy friendly pathway for the future. This requires careful analysis of a unit manufacturing processes along the entire supply/value chain (e.g., modeling, designing, forecasting, management, etc.). Overall sustainability requires a shift from unit to system-level focus through the incorporation of concepts such as close-loop modeling. This study seeks to draw attention to the current enthusiasm for footprinting and address how the concept can be used beyond just carbon

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reduction per product. It has several unique features. First, it seeks to identify critical issues in the industry by analyzing the supply/value chain, and determining carbon and energy footprints. Unlike most value chain studies which focus on the manufacturing process, this analysis extends over the entire product life cycle. Second, it pin-points opportunities for improving CF & EF in specific hotspots within the production process going beyond the conventional analysis of monetary costs. Third, the work was carried out jointly by academics and industry experts, ensuring that practical measures would be identified and effectively implemented. Finally, key policy implications are drawn for the garment sector, which can benefit the entire Sri Lankan economy and has relevance for resource use globally.

Section 2 summarizes literature on CF and EF relating to the garment industry. The importance of the garment industry in Sri Lanka is explained in Section 3. Section 4 explains the methodology, data and calculations, Section 5 presents the results and analysis, and Section 6 describes the conclusions.

Growing natural resource shortages and anthropogenic GHG emissions are prompting business interest in life cycle analysis of production, focusing on supply/value chain analysis and carbon and energy foot-printing (BSR, 2009). Such analyses measure human pressure on the environment-based on the amount of resource extraction and pollution produced during the life cycle of a product or service. They provide firms with two important advantages. First, these tools enhance the ability to identify and analyze potential hotspots for resource savings or pollution reduction in the production process (Upham and Bleda, 2009; Munasinghe et al., 2009). Second, they help businesses offer more carbon friendly products and services to improve their market share or visibility amongst increasingly environmentally-conscious consumers.

From a national economic perspective, global supply/value chain analysis could help developing countries enhance their production capacities and capture a bigger share of value added. Unfortunately, value is mainly captured in the design and conceptual stage where technology is important, as well as in retailing, whereas most developing countries are generally engaged in lower value, labor-intensive manufacturing. Structural transformation of sectors and national economies is needed to avoid being trapped in this state. Given that sustainable development is an important trend, we argue that CF and EF, has benefits beyond reduction of product based footprinting. It could identify actors, underlying systems, cost anomalies and technological and innovative upgrading by which efficiencies can be enhanced along the supply chain and add more than mere monetary value in developing countries. An array of environmental and social indicators would improve over all sustainability.

Our study focuses on garment manufacturing supply chain, analyzing carbon emissions and energy use, and cost anomalies.

2. Literature review on CF and EF related to the garment industry

2.1. Advantages of supply/value chain analysis and carbon and energy foot-printing

Identifying and analyzing carbon and energy hotspots along the supply/value chain, improves energy efficiency, reduces emissions and provides overall improvements, particularly when focused on the "cradle to grave" lifecycle (as opposed to a "cradle to gate" analysis, where the boundary ends at the manufacturing plant). Firms in diverse industries already employ such tools to reduce production costs. Examples include Tesco, Walkers Crisps of Pepsi Co and Tate & Lyle UK (Gardner, 2010; The Economist, 2011; FAO, 2011; PepsiCo, 2013). Any cost reductions among Asian manufacturers are un reported.

In the garment industry, the main energy and carbon hot spots reported are generally raw material production and end-usage (Economist 2011; Bevilacqua et al., 2011; Allwood et al., 2006; The Carbon Trust, 2008; Upham and Bleda, 2009 and CO2focus, 2008)—see Table 1 for summary of studies.

Reducing the CF and EF for a product or service requires a combination of strategies. Some studies have shown that changing consumer behavior (e.g. washing methods) influences the final values. If garments require extensive maintenance, usage becomes the most energy intensive phase where washing at higher temperatures, tumble-drying and ironing are significant contributors (Cox, 2011; The Carbon Trust, 2008; Carbon Trust, 2011; Systain Consulting, 2009). Consumer behavior also depends on climatic and cultural elements of countries; Zhang et al. (2015) found that Chinese washing habits are more environmentally friendlier than American. Moreover, longevity and recyclability of garments promote closed-loop lifecycles that reduce virgin raw material inputs and lead to sustainability improvements. Raw material production requires special attention. Artificial fabrics (like viscose, polyester, nylon, and spandex) are more carbon intensive than agricultural fabrics because of petrochemical inputs in the production process. Van der Velden et al. (2014) argue that the environmental burden is not only a function of the base materials but also of the thickness of the yarn, dyeing, knitting, weaving etc.

Natural fabrics like cotton are neither entirely carbon friendly nor sustainable, since cotton farming can damage the environment through biodiversity loss, heavy irrigation and use of toxic fertilizers and pesticides (Van der Velden et al., 2014). Organic farming can be less carbon intensive, in combination with highly efficient harvesting technology (Allwood et al., 2006; The Carbon Trust, 2008). Bevilacqua et al., 2011 (Table 1) report that 49% of disposed products were burned and less than 2% reused. Such information shows the potential for greater re-use or re-cycling of raw materials.

Businesses could use foot-printing analysis to improve market share or visibility. Since the product of this study ends up in UK, the attitudes of European consumers (end consumers and retailers) were given special attention. Evidence on end-consumer attitudes towards CF and EF is mixed. A majority of European shoppers do not seriously consider CF information of a product. Nevertheless, 90% believe a label indicating a product's CF should be mandatory in the future (The Gallup Organisation, 2009). In Britain, only 20% of shoppers recognize CF labels, while 82% recognize the "for fair-trade" label and 54% identify labels of organic products (Bolwig and Gibbon, 2009). More importantly, 44% of British consumers are willing to pay more for low CF products (Pandey et al., 2011). In 2011, sales of such products exceeded £2 billion, surpassing the sales of both organic (£1.5 billion) and Fair-trade (£800 m) products (FAO, 2011). Despite these findings, there is uncertainty as to whether the increase in sales reflects the influence of carbon labeling on consumer choice or increased availability of such products