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Environmental evaluation of localising production as a strategy for sustainable development: a case study of two consumer goods in Jamaica

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Abstract

The objective of this study was to compare the life-cycle environmental impacts of changed production structures for two consumer goods (high-density polyethylene (HDPE) shopping bags and beds) in Jamaica. A scenario technique was used to construct three alternative production structures for each product; each scenario reflecting an increase in local production in Jamaica which depended on an increased supply of input materials which may be sourced: (1) externally from overseas suppliers, (2) from post-consumer recycling, and (3) locally on the island of Jamaica. These three constructed scenarios were then compared to the existing supply chain or reference scenarios of the products. The results showed that for both case products the recycling scenario was most preferable for localising production, resulting in the lowest environmental impact. This was because the production of raw materials accounted for the largest effect on total environmental impact. As such, the most immediate environmental improvements were realised by lowering the production of virgin materials.

Keywords: Scenario analysis; Local production; LCA; Sustainable development

1. Introduction

Current systems of centralised mass production arose from industrialisation and draw cost advantages from economies of scale and access to cheap labour through the use of cheap globalised logistics systems. Such systems typically produce in much greater volume than required for a local market so products are used and disposed far from the factory. In order to maximise production speeds, input materials must be as predictable as possible, therefore such systems have a strong preference for high-grade virgin material inputs. Where price margins are small, growth can come only by expanding sales volumes, which favours the development of products with rapid obsolescence. These forces tend to drive an increased demand for highly processed and often energy intensive virgin materials and inhibits material re-use due to the difficulty of collection and re-processing to the quality of the original material inputs. Mirata et al. [1] describe features of the dynamics of large-scale production units that undermine sustainability such as: increased throughput of non-renewable material and energy resources to the economy; increased waste generation; increased movement of raw materials and products over large distances; and the distancing of production from consumers which hides environmental and social costs and reduces the chances that local actors can have ownership and control over their immediate economic environments. Existing production structures drive growing demand for materials and increased waste. In the UK, on average, each person buys 1 tonne of products each year. At the end of the year their stock of products has increased by 0.1 tonne, but to create the products they bought, 10 tonnes of materials were required. As an example of material profligacy, Womack and Jones [2] describe the 'value stream' of a drinks can, showing how it takes 319 days to make a product with a useful life of a few hours at most, during which time it passes through 14

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storage facilities, and has value added for less than 1% of the total time. They consider how this might be improved with 100% recycling into mini-smelters and mini-rolling mills close to the point of consumption.

A system of distributed localised production may, therefore, offer an economically viable and environmentally more benign alternative to centralised production. The principal environmental attractions of localised production are that it would facilitate re-use of materials, and less energy would be required for transportation and storage. A major inhibitor of material re-use in centralised mass production is the high cost and complexity of collecting, sorting, separating and cleaning used materials prior to sending them to the appropriate re-use facility. If small production facilities were located closer to the point of consumption and disposal, it might be easier to take back used materials before damage or contamination in the collection process. For example, a system to recycle office paper within the office would benefit from an internal discipline in avoiding folding, tearing or besmirching used paper, whereas a centralised system must cope with a range of non-paper inputs into the recycling process. Similarly, the processes of repair and renewal would be more economically attractive if used materials and products were locally available so the cost and time of arranging repair at a remote location could be avoided. The possibility of increased material re-use with reduced waste and reduced demand for new materials are the key attractions of localisation. Potentially a secondary impact is that a system based on flexible technologies with reduced use of dedicated tooling, might be less dependent on high volume sales, and therefore could work on products with less obsolescence and increased life span through renewal.

A system of localised production might allow significant reductions in demand for primary material and transport with corresponding reductions in demand for energy. Russell [3] provides a comprehensive comparison of the environmental effects of current production structures with the environmental potential of localisation. This paper aims to predict and categorise the environmental consequences of a localised system of production, specifically addressing the question: would the environmental impacts change if more of consumption were supplied by local production rather than imports?

In order to explore and catalogue these changes the entire supply chain need to be analysed. Different environmental tools can be used to measure the environmental impacts of a product or process, such as, life cycle assessment (LCA), material intensity per service unit (MIPS) and material flow accounting (MFA). Since LCA measures all environmental inputs and outputs and environmental impacts of a product or service from 'cradle to grave' it was the tool chosen for these studies. Previous studies on scale change and localisation have used similar methodology but have largely compared existing, rather than future or alternative systems. For example, Andersson and Ohlsson [4] used LCA to compare different scales of white bread production and analyse their potential environmental effects. However, they highlighted a limitation of their work by noting that 'a study that aims to determine what production scale has the potential to cause the least environmental impact should not simply compare specific existing systems.' Sundkvist et al. [5] explored the strengths and limitations of localising bread production on a Swedish island community, Gotland. Like Andersson and Ohlsson [4] they evaluated the consequences of existing large- and small-scale systems. They used an approach similar to LCA (but not an LCA) for the environmental analysis. However, the study focused only on primary energy use and the emissions of CO_2, SO_2, and NO_X, in the transportation and production of flour and bread.

The main objective of these studies was to compare the environmental impacts of three plausible future alternative production structures with the existing supply chain structures of two consumer goods. A secondary goal was to identify the principal environmental impacts or 'hot spots' for the activities in the supply chain to get an overall understanding of the impacts of the products' supply chains.

2. Area and systems studied

The area of study was Jamaica, the third largest island in the Caribbean Sea. Jamaica has a land area of 10,991 km^2 and a population of around 2.65 million people, 57% of whom are under the age of 30 years. Being an island, it is geographically well defined and moreover, because there is no road access to other countries it was more straightforward to trace energy and raw material flows.

The plastics and packaging and the furniture industries in the manufacturing sector were chosen for these studies. It was important to choose industries in which goods are manufactured locally as well as imported in order to compare the environmental changes if local production were to increase. One consumer good from each industry was chosen as the case product: single use high-density polyethylene (HDPE) plastic shopping bags from the plastics and packaging industry, and beds from the furniture industry. These products were also selected based on the following criteria: more than one country involved in the supply chain; products used a high percentage of imported raw materials; products are common and widely consumed in Jamaica; and local demand is met by small-scale local production in tandem with imports from overseas manufacturers.

Plastic shopping bags have become engrained into the shopping culture of consumers and Jamaicans consume an estimated 500[1] million bags annually. Even though there are no precise production and consumption figures, based on discussions with the largest plastic bag manufacturers in Jamaica, it is estimated that approximately 70% of domestic consumption in Jamaica is supplied by local small-scale manufacturers, the remaining 30% imported to meet the demand. Jamaica is not an oil-producing country; consequently there is no polymer resin producer. As such all the polymers used in the manufacture of plastic shopping bags are imported. There is currently

[1] Figure calculated by authors by extrapolating from raw materials, production and sales data from the largest plastic bag manufacturer in Jamaica for the year 2005, and corroborated by import/export data for Jamaica (2005) from UN Comtrade database (www.comtrade.un.org).