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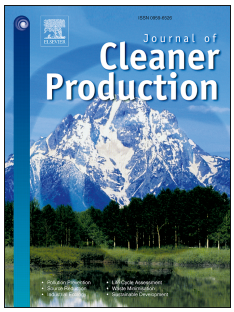

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What Should Be Recycled: An Integrated Model for Product Recycling Desirability

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Abstract

This research was focused on developing a new scientific approach for prioritising recycling of end-of-life products in a circular economy. To date, product complexity based on the mixture of materials has been used as a predictor of what gets recycled. While the separation of materials that make up a product has been modelled as a measure of product complexity, this does not taken into account the benefits and considerations in recycling products. In this paper, a new agenda and approach to prioritise the recycling of products was developed based on a recycling desirability index. The material mixing complexity measure was inverted into a simplicity index and then extended by modelling the security index for the mix of materials and the technological readiness level of recycling technologies. The extended model is proposed as an integrated measure of the desirability of recycling of end-of-life products. From this analysis, an apparent recycling desirability boundary, enabling products to be prioritised for recycling, was developed. This model and analysis can be used as an information source in developing policies and product recycling priorities.

Keywords: Circular Economy, Recycling Desirability, Complexity, Material Security, Criticality, Technology Readiness Level

1.0 Introduction

A product made up of more than one material will usually be required to undergo material separation prior to recycling. Many manufactured products fall into this category. For instance, a mobile phone and television board can be made from a dozen of materials ranging from plastic to base metals and precious metals (Hagelüken, 2006). These products are more complex compared with beverage plastic bottles that are built typically using 96% plastic and 4% paper or plastic label (Yam, 2009). The higher the number of material types used in a product, the more complex material separation becomes (Dahmus and Gutowski, 2007).

End-of-life products retain substantial worth if they can be separated into isolated forms that used in the production of new products (Despeisse et al., 2015). Therefore, the act of separating material is key to recycling. A product may have been built from either one or a number of components. Similarly, one or many types of materials can make up a particular component. A product can also have similar types of materials distributed within different parts or components. Products built from a single type of material do not require material separation and directly proceed to the recycling process if the technology exists. Such a material is an easy candidate for recycling.

Research related to material separation can be traced back to Sherwood (1959) and Dahmus and Gutowski (2007). Both addressed the difficulty of material separation.