

Product Longevity: a state of art review through the three pillars of sustainability

The significance of product lifetimes to sustainable development is increasingly recognised. A range of factors explain this emerging debate, most notably the evidence that short-lived products imply an unsustainable throughput of materials in industrial economies. Latterly this has led to an understanding that, as these materials embody carbon, this fast throughput contributes to climate change (Allwood and Cullen, 2012).

Once discarded, such products end up as waste, and concern at the amount of waste generated has led to a growing public policy interest in product lifetimes. Thus the European Union Framework Directive on Waste (2008/98/EC) requires member states to produce waste prevention programmes and the Foreword in Britain's programme states: 'Products should be designed to use fewer resources from the start and with longer lifetimes, repair and reuse in mind. Services for householders and businesses should make preventing waste and using reuse and repair services easier' (HM Government, 2013, p.3). The emergent debate also reflects frustration among consumers that products too often prove unduly or unexpectedly short-lived, or develop faults that cannot be fixed due to the cost of repair.

Historical perspectives of planned obsolescence, technical studies on product life-span measurement and case studies aimed at identifying optimum life spans represent valuable contributions to recent literature in this field. However, the broader picture - specifically, connections to the sustainability agenda - remains less clear. The paper thus locates knowledge about product longevity within the prevailing discourse on sustainable development. The chosen methodology frames an analysis of the current state of knowledge concerning product longevity around the three pillars of sustainable development - environmental, economic and social.

The method used was a comprehensive and systematic review of publications from the 1950s to the present time using a keyword search of appropriate electronic publications databases. This type of literature review aims to identify general patterns to findings from multiple examples of research in the same area (Robson, 2011). Methodological rigour is applied (Vom Brocke et al., 2009) and material selected with care (Maxwell, 2006). Methods for selecting and evaluating publications are stated explicitly (Velamuri et al., 2011). These principles of good practice were followed in this study as described below.

Robson (2011) recommends using keywords that describe central aspects of the research and linking these to a subject search. Thus a list of relevant key words was developed based on the three pillars of sustainability and these were linked to 'product longevity', 'durability', 'product lifetime', 'product life-span' and 'planned obsolescence'. For the environmental section, the main keyword subject search terms were 'resource scarcity', 'depletion', 'emissions', 'embodied energy' and 'waste'. For the economic perspective the main keywords were 'economic growth', 'economic de-growth', 'prosperity' and 'circular

economy'. Finally, for the social perspective the main keywords were 'quality of life', 'equity', 'social cohesion', 'community' and 'participation'.

Publications considered within the scope of the review were journal articles, reports, conference proceedings, theses and books. In total around 275 relevant publications were identified and are referenced. Book reviews, editorials, abstracts and teaching cases were excluded. The review was carried out through the Nottingham Trent University library search system in order to access to the most relevant databases of academic publications (e.g. EbscoHost, Springer Link, ScienceDirect, Wiley InterScience, IEEEExplore and ProQuest). In addition, internet-based search engines (e.g. Google and Google Scholar) were used to identify non-academic publications such as governmental reports, consultancy reports and working papers. The sources identified were checked against literature cited in Cooper (2010), a major study for Defra by ERM (2011) and recent reports for the European Commission (Ardente et al., 2012; Ricardo-AEA, 2014).

The relationship between product longevity and environmental sustainability was addressed first. The literature suggests a consensus that, in general, longer product lifetimes provide net environmental benefits, but an important and unresolved issue is whether product lifetimes should be maximised in the case of energy-using products. Literature was then considered from an economics perspective. Little research has been undertaken in macroeconomics on the effect of policy objectives such as economic growth on product lifetimes or the economic implications of increased product longevity. The knowledge base is stronger in microeconomics, with significant publications on market conditions, innovative business models, consumers' attitudes to product lifetimes and disposal behaviour. Lastly, social sustainability aspects were addressed by considering the literature on product longevity in relation to quality of life, equity, social cohesion and community participation. The prospect of increased product longevity resulting in higher prices raises equity concerns that have not yet been adequately addressed. By contrast, the literature on collaborative consumption describing the emergence of various grassroots initiatives that help to extend product life spans reveals potential social benefits.

The quantity and quality of publications was then assessed, for each of the three pillars of sustainable development, in relation to potential areas of enquiry previously identified (e.g. in Cooper, 2010) and a matrix was developed to visually represent the state of knowledge. Finally, the paper presents an overview of disciplinary knowledge which revealed the further research needed, across a range of disciplines, to improve knowledge in order to guide policy and practice toward optimum product lifetimes.

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