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ScienceDirect
Procedia CIRP 29 (2015) 366 – 371
www.elsevier.com/locate/procedia

The 22nd CIRP conference on Life Cycle Engineering

Expanding the Scope of LCA to Include 'Societal Value': A Framework and Methodology for Assessing Positive Product Impacts

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Abstract

As resources become scarcer, efficiency improvements alone will not bridge the widening gap between supply and demand, resulting in the need for additional non-financial mechanisms to ensure the fairer allocation of resources. This paper asserts that, in the future, companies will need to demonstrate their products' positive contribution to society as well as minimising their negative environmental/social impacts. A review and analysis of existing tools and assessment methodologies identifies current capabilities and highlights the need for 'Societal Value' assessment that considers both quantitative and qualitative factors .This paper concludes by proposing a systematic framework for addressing the 'Societal Value' of products as part of an integrate sustainability assessment and allows the evaluation and comparison beyond products' shared functionality.

Peer-review under responsibility of the scientific committee of The 22nd CIRP conference on Life Cycle Engineering

Keywords: Sustainable development; Product Development; Eco-design methodology

1. Introduction

In the past fifty years, the global environmental impacts resulting from human activities have become increasingly apparent and the need to take immediate action to address these has been broadly accepted by the majority of the world leaders. Regular media coverage on issues such as climate change, loss in biodiversity and pollution are being increasingly reported (1). However, whilst the current environmental damage resulting from our activities and actions is clearly apparent, the longer term consequences, social and economic as well as environmental, are not always so obvious. For example, the slow recovery in the US and Europe from the recent financial crisis can be attributed in part to the restriction in global supply and increasing prices of key raw materials, food and energy costs. This in turn has led to a widening gap between rich and poor, an increase in poverty, and a decrease in social mobility (2). Whilst politicians have been largely ineffectual in dealing with the global challenge of disconnecting economic growth from environmental degradation, many of the more enlightened manufacturers have begun to address the sustainability of their own operations, which in turn has a direct impact on society. On our current consumption trajectory it is predicted that these problems will further intensify.

There have been a number of forecasts and assessments carried out by governments and corporate organisations that attempt to understand these 'near term' global changes (3–6). From a review of these recent reports, two key trends have been identified with regard to the availability and distribution of resources, which can be summarised as follows:

- Resources will continue to be depleted, with energy and water scarcity causing increasing cost and supply problem.

Peer-review under responsibility of the scientific committee of The 22nd CIRP conference on Life Cycle Engineering
doi:10.1016/j.procir.2015.02.076

- Growth in global populations combined with emerging markets and improved living standards in developing countries will increase global resource consumption.

It can be concluded therefore that the gap between global resources supply and demand is likely to widen further. It has been estimated that 1.5 planets worth of resources are required to support the world's current population, in terms of resource consumed and waste generated. It is predicted that this will increase to two planets by 2050 (7). If global populations continue to grow and consume at present rates, the reliance on finite resources to meet their needs and wants will eventually deplete all accessible resources (8). Resource efficiency has been traditionally driven by economic objectives (9); maximising financial profits through efficiencies in labour, materials and energy consumption (10), the same approaches have been transferred to embrace sustainable strategies where greater emphasis have been placed on not just the profit and loss but conservation of resources and efficient consumption of materials, water and energy (11). However, it has become increasingly evident that these efforts are not enough (12); radical changes are required in order to meet the targets. Furthermore, Stern (2007) asserted that in order to mitigate the effects of our current impacts, a reduction of 80% is required (13). It is therefore clear that to meet such challenging targets, a strategic, integrated, and radical approach will be required (14). One such approach could be the allocation of resources based on the value of a product to society, rather than the current financial mechanisms.

To some degree the Toy industry is ahead of others industries in this regard, (e.g. automotive, white goods, food) as some toys are marketed on their 'play value' rather than desirability alone (15). These 'play values' can include factors such as educational, communication, fitness and motor skills (16–18). The value of toys is evident when toys are being used as "tools" to explore the world and develop social, cognitive and motor skills. As with other sectors, the toy industry has grown dramatically since the industrial revolution and the growth in net wealth and disposable incomes. Nowadays, toys are mostly mass manufactured and come in many different forms, these variations create a number of categories of toys and encourage different innovative ways of play (19,20). However, the toy market is very crowded and increase competition and pressure to maintain and increase sales has led to over consumption and a throw away culture. Furthermore little consideration has been given to the end-of-life management of toys, where discarded products most likely end up in landfills or incinerators.

Current efforts in improving sustainability in the toy industry have been focused in material reduction and substitutions, reduction in packaging and improving working conditions within manufacturing facilities. These are all valuable activities and should be encouraged, however they may not be the solution to stop or reduce global resources depletion. It was reported that an average child in the UK receives 44 new toys a year (21) and owns 238 toys while only plays with 12 of them most of the time, that is 5% of the total. (22) These facts indicated that toy supply is actually exceeding demand and resources are being needlessly and inefficiently consumed.

2. Sustainable Concepts and Tools

The three dimensions of sustainability have received differing degrees of attention from research communities over the years (23). Sustainable development debate was dominated by environmental issues in the 1980s to mid-90s. Subsequently, economic concerns were connected and included into the debate in the mid-90s to late 90s and social issues only took up more focus by the late 90s (24). This is due to a shift of stakeholders concern (25).

It is widely agreed that the three dimensions have been prioritised unevenly (26). This was mainly because sustainable development was generated from a combination of the green movement of the 1960s and the "basic need" advocates of the 1970s, but also assessing social elements presents difficult measuring challenges (27). Indeed, social considerations have almost been treated as some kind of afterthought in sustainability. OECD (2012) points out that social sustainability is considered in terms of the social implication of environmental politics instead of an equally integral component of sustainability (6). Currently, there are a number of commercially available tools, methods and concepts aimed at supporting companies achieve sustainability improvements to specific aspects of their product, process or operations. These tools can be used stand-alone or together, however, only a handful actually considers the social factors and these are underdeveloped and do not provide a fully comprehensive assessment (25,28).

A key assertion of this paper is the need to evaluate the positive impacts of a product during its life cycle. Economic assessment is already well advanced in this regard. Tools such as life cycle costing (LCC) (29), and the Lean practices have enabled the economic assessment from an enterprise level to a product level (10). Conversely, sustainability assessments that evaluate the other two dimensions (social and environmental) offer little considerations on the positive impacts (sustainable gain) and recommendation for improvement tend to focus on reducing the negative impacts (sustainable loss). This may drive towards a net improvement, however enhancing the social and environmental gain will be more effective. Assessment for the inherent social value or gain will have increasing importance as financial capability will not be the only deciding factor for fair resource distribution in a material scarce world.

2.1. Assessment of Sustainability Tools

A list of sustainable concepts and tools were compiled from a number of sources including previous assessments (30). These tools were then assessed according to their application to the 3 pillars of sustainable development. The assessment also intended to highlight the need for social tools that appraise the positive benefits regarding the social pillar.

108 concepts and tools were listed from a compilation from three previous studies (30–32). The tools were grouped into seven main categories; analytical, checklists and guidelines, concepts, footprints, organising, rating/rankings, and software/expert systems, and summarised in table 1. From this total of 108 concepts and tools, 38 covered all three

Table 1Available sustainable tools and their categories

	ECO	SOC	ENVIR	Int	Semi-Int
Analytical	20	12	17	9	9
Checklists/ Guidelines	12	9	8	6	4
Concepts	13	9	14	8	6
Footprint	17	15	7	5	2
Organising	11	7	9	5	6
Rating and Ranking	9	5	6	5	1
Software/ Expert Systems	10	2	8	0	9
Total	92	59	69	38	37
Positive	23	11	14		
Negative	35	24	48		

sustainability pillars, whilst 37 considered just two. The remainder considered only one aspect.

Where possible the tools were also evaluated on their inclusion of positive and negative impacts, the results of which are also recorded in table 1. From the original 108, 61 economic tools, 46 social tools and 72 environmental tools were identified to measure the positive and negative impacts. Overall, there are more tools that measure the negative sustainable impacts than the positive impacts. It is clear that there is a lack of social tools in particular the ones that measure the positive impacts.

For example, the two most widely used social sustainable tools, namely Corporate Social Responsibility (CSR) and Social Life Cycle Assessment (SLCA), both demonstrate the potential for measuring the positive impacts. However, both tools seem to offer little or no assessment in regards to the actual functional societal benefits of a product during a product uses phase, something that is mentioned in the SLCA guidelines (33). In practice, CSR is more effective as a tool to set strategic goals for an organization and it will be difficult to determine the societal benefits of a product from CSR reports. On the other hand, SLCA is a product specific assessment that evaluates the entire life cycle, however most of the social impacts measured are within the production and distribution supply chain, and the consumer subcategories are enterprise system related, such as health and safety, consumer privacy and feedback mechanism.

3. Strategic Framework

The following section proposes a framework for supporting toy companies in achieving these aims at strategic, tactical and operational stages within the organisation.

In order for a company to develop the objectives and actions required to implement a holistic sustainability strategy, their current position, trajectory and velocity must first be established. In smaller companies it may be possible to achieve this by simply focusing on the individual products and/or services, however in larger organisations, the range and diversity of products often requires a degree of 'business segmentation' by grouping product, services or functions into common categories (e.g. divisions, departments, categories, markets, brands). Meanwhile in multi-national conglomerates, further segmentation may be required into its autonomous business groups or geographic regions. It is envisaged that an organization would enter the framework at it relevant level of complexity as shown in Figure 1, the organization would then follow the sequential stages running horizontally.

At the higher levels of complexity, it is the groupings that are considered and not individual products. This means that the information used will be more qualitative and general rather than quantitative and specific. However, mechanisms exist to improve the accuracy of this information, such as AHP and Fuzzy Logic, which would be integrated into the tool to support these stages. By starting at the higher levels, the business is able to quickly identify those parts of the business that need to be prioritized. These groups will then be addressed at the next level of lower complexity and the process is repeated until the lowest complexity level is reached, the product level. It should also be mentioned that the outputs from the lower levels can then be used to inform the higher levels in an iterative process that ensures continuous improvement, and increasing accuracy. The stages of the framework at the product level are now discussed in more detail but the same principles apply to the previous higher levels.

This first stage of the framework will support the assessment of the business at each level, from division to product, sector to service and translate this understanding into a series of definitive actions and objectives.

3.1. Framework at Product Level

The framework for the stages in the lowest complexity level (product level) is presented in the form of an IDEF0 diagram, see Figure 2. The processes directly link to the three stages of control, where a product plan is outlined in the strategic stage, a design brief is formed at the tactical stage and a design is produced in the operational stage. The advantages of using IDEF0 diagrams is that it clearly highlights the requirements and corresponding mechanisms for each process box as well as the input and output. Requirements are represented by arrows going into the boxes from the top (e.g. Legal Requirements at the Design Toy stage). Mechanisms are represented by arrows going into the boxes from the bottom (e.g. the corresponding officers in charge of finishing the task of that stage). It is also worth noticing a product design specification (PDS) is set within this stage and will be used in production and quality control as a benchmark. The framework is also set up for design feedback coming out from the operational stage as a feedback input loop for the strategic stage. The entire framework aims to produce a design that will have maximized the product's societal value. Sustainable tools can be applied at different stages of the framework. Organisational tools such as CSR can be used for the strategy formulation as the input for the first stage. Conceptual and rating tools can be used at the tactical stage for design brief setting and analytical tools and checklists can be used during operational stage in design to ensure the product is meeting the strategic targets. The results from these analyses can subsequently be fed back for continuous improvement at the strategic stage.

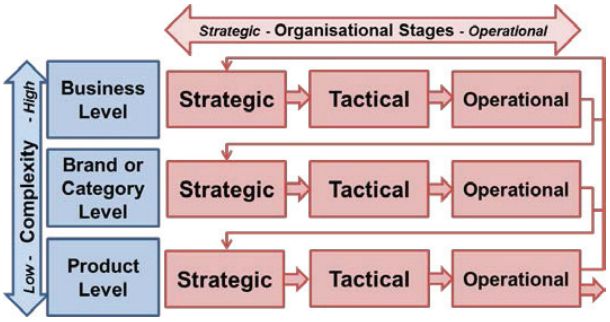

Fig. 1 Level of complexity and organisational stages

3.2. Strategic Stage at Product Level

A sub-model is formed for the strategic stage, see Figure 3, it consists of four processes which describe the sequential procedures in order to outline a product plan for the tactical stage downstream. The four stages follow an established strategic management procedures; analysis, goal-setting, strategy formulation, strategy implementation and evaluation and control. These procedures are represented as Identify Current Product Performance, Set Performance Target, Identify Adjustment, and Plan Adjustment respectively. Evaluation and control comes in the form of performance feedbacks which is formulated downstream from a number of stakeholders including middle managers, product designers, engineers and customers. There are two "blind" mechanisms carrying out the process of Identify Current Product Performances as the participation of Designers and Managers are not always necessary. It may also be noted that the performance target is set according to future sustainable drivers as well as internal reporting. A comprehensive product plan will be produced when all four processes are accomplished.

3.3. Cost-Benefit Matrix

A two axes / four grid matrixes assessment tool proposed would consider the societal benefits against the environmental costs as illustrated in Figure 4. The boundary of this tool is set around the toy industry. The scope for measuring environmental impacts is based on existing environmental LCA with particular attention paid to abiotic resource consumption to justify the use of resources. The scope for societal assessment is based primarily on the use phase of the toy where educational, communication, fitness and motor skills are the key factors. The product with the least environmental cost and most social benefit is sitting in the most desirable position. The 4-grid assessment is set up similar to the Boston matrix, and it is intended for the tools to be complementing the Boston matrix for strategic recommendations. The Boston Matrix or growth-share matrix was first developed by the Boston Consulting Group (BCG) (34) to help companies decide on their internal investment and marketing strategies (which products and parts of the business should get the investment). This tool will be the main instrument for the strategic stage as it can visually represent the current performance and identify the targeting position and path to identify the targets.

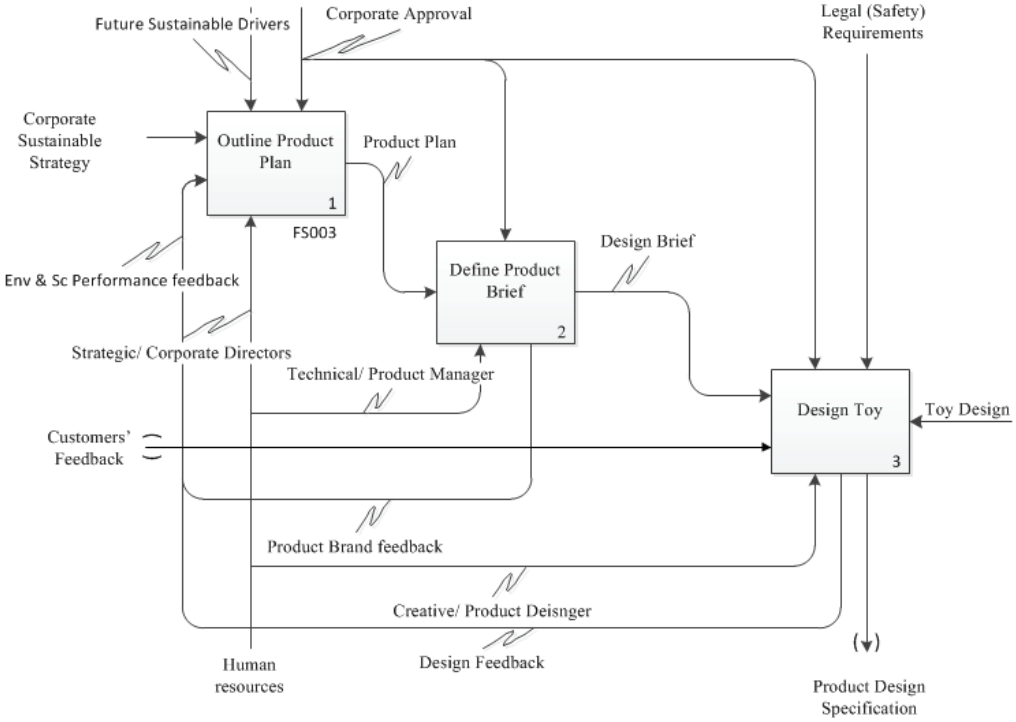

Fig. 2 Product level framework

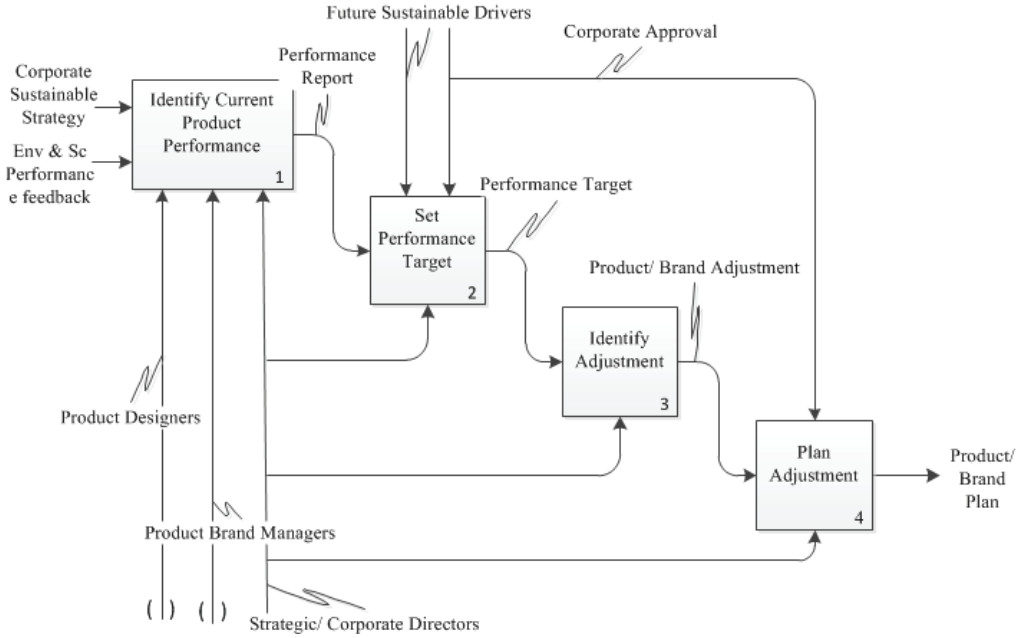

Fig. 3 Strategic stage framework: Outline product plan

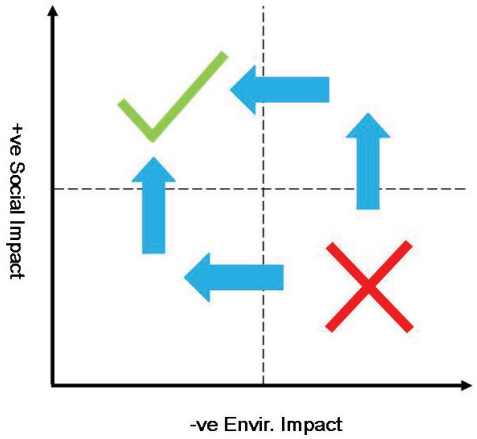

Fig. 4 Cost benefit matrix

4. Conclusion

Current sustainability tools are inadequate for supporting the radical changes required to meet the future manufacturing and societal needs. As non-financial mechanisms become increasingly important for the allocation of resources, so the ability to demonstrate a product's wider range of benefits, environmental and social, will become increasingly necessary. The toy industry has been identified as being particularly vulnerable to the impacts arising from resource depletion, but with significant societal benefits currently unaccounted for. The framework proposed in this paper provides a systematic approach to the holistic evaluation of a company's product(s) at a strategic, tactical and operational whilst providing an iterative approach to the levels of business complexity. To implement this framework, a number of existing tools can be used, however a new tool is required to enable the evaluation of societal benefits during the products' use phase. To enable the evaluation within the toy industry, four factors have been identified; educational, communication, fitness and motor skills.

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