Societal Benefit Assessment: An Integrated Tool to Support Sustainable Toy Design and Manufacture

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Abstract. A framework and methodology for assessing the societal benefits of a product was developed based on the assertion that, in order to access future diminishing resources, manufacturers will need to demonstrate both the social and environmental benefits of their products. This paper follows on from this published research and presents an integrated tool to support the implementation of this framework and methodology within the toy industry during the design and development phase. A simulated case study is used to exemplify the application of this tool and to support the concluding discussions.

Keywords. SLCA; Sustainable Design, Product Development; Toy Manufacturing; Societal Benefit Introduction

1. Introduction

Previous research published by the authors presented a rational and framework for a step-wise approach to evaluating the societal benefits associated with a company's products, which in turn could be evaluated against the environmental performance to allow a company to develop a sustainability strategy for its product portfolio [1]. This was based on an assertion that as materials become scarcer, companies will have to compete for these resources based on environmental performance and the value of the company's outputs to society (societal benefits) [2]. This framework provides a systematic approach to undertaking this 'Societal Value Assessment' at various levels within the organisation; Strategic, Tactical and Operational, whilst supporting the design process to enable these additional considerations to be included. Further research identified the need for both a tool to support the implementation of the framework within companies and a specific assessment methodology tailored to the company's industry sector. For this study the Toy industry was selected to demonstrate the application of this research. This paper provides an overview of the decision support tool and provides a detailed description of the assessment methodology for the Toy Industry. The paper begins with a brief introduction to the framework, followed by an outline plan of the tool and a detailed description of the assessment methodology using simulated data to demonstrate its application within an industrial context.

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2. Overview of Framework and Tool

The framework as shown in figure 1 provides an overview of a systematic approach to incorporating societal benefits into manufactured products. The sustainable toy design framework consists of three stages: assessment & target setting (strategic positioning), trajectory correcting & prioritisation (tactical plans) and design. The aim of the strategic framework is to facilitate the translation and communication of the strategic goals into design and manufacturing of toys.

2.1. Design Support Tool

A cost benefit matrix (CBM), as proposed in previous paper, is a strategic tool that was developed for the first stage of the framework [1]. It supports all three steps of the strategic positioning. The CBM plots the environmental impacts against societal benefits. It can be divided into four grids by setting baseline performances for both environmental impacts and societal benefits. This would effectively set up a matrix. This matrix can be used for sustainability performance positioning, forecasting and performance targeting. The environmental impacts are assessed through the use of the life cycle assessment (LCA); whereas the assessment for societal benefits required development of a novel methodology. There is a need to develop a specific societal benefit assessment as existing methods do not have a consensus definition of positive societal benefits and there are no established methods to assess the user values from the function of the products, hence the societal benefits of the product. The following section describes the mechanisms of such assessment methodology. The methodology was developed for the toy industry because toys, as products, are not considered to meet an essential human need, such as food, warmth or shelter [3]. Toys therefore exemplify the need for societal benefits assessment in order to demonstrate the hidden developmental benefits that result from the actions of the children playing with the toy.

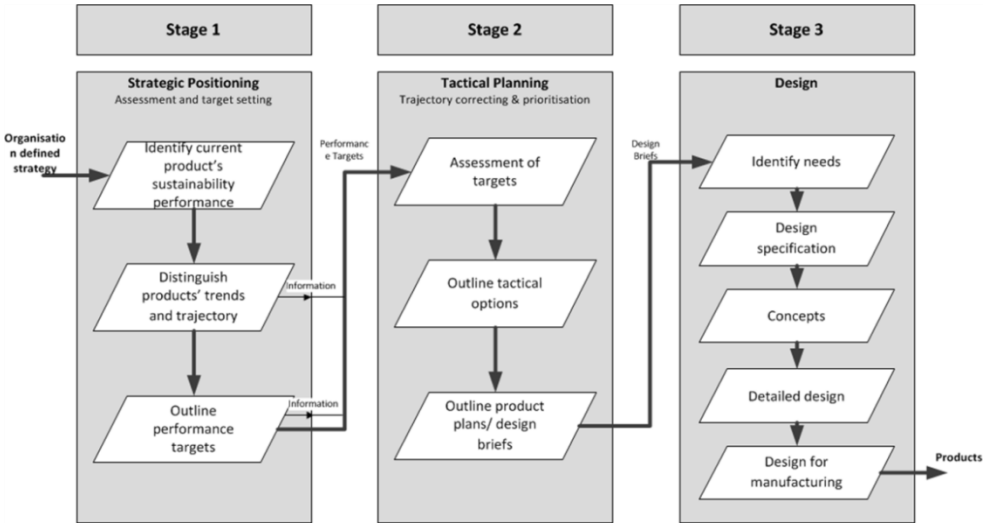

Figure 1. Framework Diagram.

3. Societal benefits assessment methodology

For the purpose of the assessment method, it is necessary to define the terms “play values” and “play benefits”. Firstly “play” is defined as the quality of mind during enjoyable, captivating, intrinsically motivated and process focused activities. Hence “play value” is the affordance of play. This definition of play value means that it focuses mainly on the action or activity of play and the affordance of an enjoyable, captivating, and intrinsically motivated play from the toys. On the other hand “play benefits” focus on the effects that are created after play. Therefore play benefits are the skills and growth that are developed through playing. Thence play value is not the play benefits, they are closely related. The higher the play value that a toy brings the more effective it is benefiting child’s development.

The structure of the Societal Benefits Assessment (SBA) methodology, as illustrated in figure 2, is based on the similar approach to that used by the ISO14040 standard for LCA [4]. In place of inventory impacts, the SBA substitutes play types, and for mid points the SBA equivalent is play benefits. The individual steps undertaken during an assessment are similar to that of an LCA with the initial scoping and definition of the societal group, aggregation and allocation of the play types , and classification and characterization into play benefits, with an optional final stage of weighting and grouping into a single score.

For the purposes of demonstrating the SBA methodology two toys with a similar function and societal group (children 12 to 24 months) have been chosen for assessment and comparison. It should be noted that the age range within the societal group chosen represents a key stage of child sensory-motor and preoperational development, according to the Piaget’s stages of development [5].

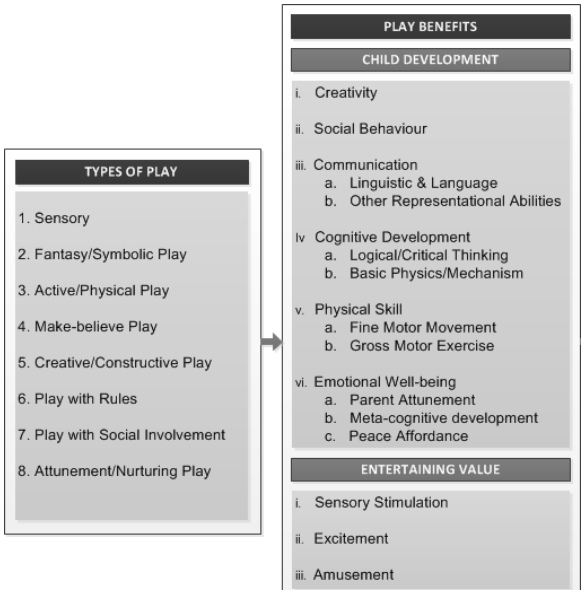

Figure 2. SBA Diagram

3.1. Inventory stage

In traditional LCA, inventories are selected before being quantify as there is an extensive list of environmental inventories. Conversely, SBA for toys have a limited amount of play types, which is the equivalent of inventories in this case. The data collection phase consists of the scoring of all the play types of the toys. The play types are adopted from previous work on the play pyramid, in which a list of play types were summarised from previous researches [6]. The play types defined and used in this case study are: sensory play, construction play, challenge, fantasy, social play, solitary play, free play, play with rules, mental play and physical play.

Sensory play refers to how the toys and play feels, looks, smells, tastes and sounds. Fantasy play is referred to the ability of the toy to puts player into a world or state of mind that is outside of the ordinary. Construction play refers to toys and play that allows users to create. Challenge play refers to play that tests one's abilities against others or oneself.

The rest of the play types can be referred to play characteristics, they refers to the atmosphere or the setup for which the toys are play in. for example social play and solitary play refers to whether the toys enable children to play together or alone. One toy can be played both socially and solitarily, and may bring different benefits from different play. This is the same case for free play vs play with rules, and mental vs physical play. All of the play types are scored from 0 to 10, where 0 means the toy being assessed does not afford that type of play and 10 means it fully affords that type of play. The scores are modified objectively to relate to the societal scope, this process is similar to relating inventory data to the functional unit in LCA.

A list of importance weighting will be calculated with the use of analytical hierarchy process (AHP) [7]. AHP generates the weightings objectively through pairwise comparisons of each play types. The score on the play types will be multiplied by the importance weighting for further classification and characterisation into play benefits. The table below shows the scores and adjustment of two soft toys where product A is a standard teddy bear and product B is one with electronic songs system.

Table 1 Play type score and priority weight

	Product A	Adj. Product A	Product B	Adj. Product B	Priority Weight
Sensory	6	6.00	8	8.00	100%
Construction	1	0.10	2	0.21	10%
Challenge	1	0.10	1	0.10	10%
Fantasy	5	1.53	7	2.14	31%
Social Play	3	0.22	5	0.36	7%
Solitary Play	8	1.87	8	1.87	23%
Free Play	10	3.74	7	2.62	37%
Play with Rules	1	0.10	2	0.21	10%
Mental	2	0.95	4	1.90	48%
Physical	7	6.25	7	6.25	89%

3.2. Assessment stage

Figure 3 below shows how the play types are classified into play benefits. The play types are given scores of 0 to 5 where 0 means that particular play type do not contribute to that benefits and 5 means it strongly contributes to that play benefits. The list of play benefits are summarised from a number of literatures that focuses on the relationship between playing and child development [8]. Play benefits can be grouped into two categories: child development and entertainment value. Child development entails physical development, cognitive development, emotional well-being, etc. entertainment value entails sensory stimulation, excitement and amusement.

	Child Development											Entertainment Value		
	Creativity	Social Behaviour	Communication		Cognitive Development		Physical Skill		Emotional Well-being			Sensory Stimulation	Excitement	Amusement
			Linguistic & Language	Other Representational Abilities	Logical/Critical Thinking	Basic Physics/Mechanism	Fine Motor Movement	Gross Motor Exercise	Parent Attunement	Meta-cognitive development	Peace Affordance			
Sensory	0	0	0	1	3	5	3	3	1	0	4	5	4	3
Construction	5	1	0	1	3	5	4	2	2	1	4	0	2	3
Challenge	3	2	4	3	5	1	0	0	1	4	1	0	3	2
Fantasy	5	2	2	3	3	0	0	0	2	4	5	0	3	3
Social Play	3	5	5	3	2	0	0	0	1	3	1	0	3	4
Solitary Play	3	1	0	0	3	0	0	0	0	3	5	0	1	1
Free Play	5	0	0	0	1	0	0	0	0	5	2	0	4	4
Play with Rules	1	3	0	2	2	0	0	0	0	1	0	0	2	1
Mental	4	0	0	0	5	3	0	0	1	5	2	0	0	0
Physical	0	0	0	1	0	1	5	5	0	0	0	4	0	0

Figure 3. Play benefits classification

Societal benefits scores are calculated by multiplying the inventory scores to the classification scores. The scores of each play benefits are divided by the theoretical maximum scores to calculate the potential fulfilled of each play benefits. The results of both product A and B are very close, but product B is generally better in most categories. Product A has an overall societal benefit of 53% and Product B 63%. It is also worth noticing that product B has much better results in sensory stimulation and both fine and gross motor development. This may be caused by the integration of electronic music units in the soft toy. However, previous LCA carried out on musical teddy bear concluded that the environmental impact of the battery operated toy is far higher than without [9]. Therefore, it is expected that product A's societal benefits can be improved by integration of non-battery operated rattle or music box type mechanism. That would increase product A's societal benefits without compromising its environmental advantage over product B.

4. Conclusions and further work

This paper presented a systematic framework that integrate consideration of societal benefits and aid the strategic planning and design of products. The tool that is developed for the implementation of the framework is reviewed. This paper described the structure and mechanism of the societal benefit assessment, which is fundamental to the design support tool. The methodology is demonstrated through the case study comparison of two soft toys. It was demonstrated that the result can be used for design improvement recommendations. Further work is required to improve the methodology and tool through an iterative process. Case study with actual toy is planned.

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