Thu 4.2 Assessing Relative Sustainability of Different Packaging Sizes

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Abstract

The classical method to compare the environmental impact or eco-burden of different packaging designs is to use life cycle assessment (LCA). LCA requires a functional unit to compare unequal concepts on an 'equal' footing, for instance by comparing three 0,5 litre bottles, with one 1,5 litre bottle. Creating this 'equal' footing usually ignores the very reason for having the differences in the first place. This paper uses the ecocosts/value ratio, or EVR, as a methodology for dealing with the environmental assessment of packaging design alternatives with unequal functionality, while incorporating their different value. The value is here the price of an existing product, or the Willingness to Pay of a new product design. The EVR model will be applied to several product portfolios, namely for bottled water and for table salt. These portfolios consist of groups of products, where the product, the brand and the retail outlet are identical, and only the contained volume, the packaging design and the value differ. Previous work by the authors demonstrated the use of the EVR method for design choices for a fixed volume of packed product. This paper elaborates who the EVR can be useful in assessing the sustainability of different pack-sizes. It will thus demonstrate how an EVR perspective connects better to business decision making than classical LCA.

Introduction

In marketing terms, packaging is a differentiator, distinguishing a branded product from the competition. To achieve this differentiation, packaging designers play with materials, printing and shapes, often exceeding the bare minimum requirement for protecting the product. The same product may be packed in different packages to accommodate different use scenarios, such as single serve portions and family packs. This perspective on packaging is at odds with the classical sustainability perspective that calls for packaging with a minimal environmental impact. In classical environmental product assessment, using Lifecycle assessment (LCA), these different pack designs would be compared by defining a functional unit (e.g. the delivery of X kilo of litre of product to the consumer). The differences in use-scenarios are thus eliminated.
Only when the different pack sizes would lead to different spoil or waste rates for the packed product, the use scenario might play a role. In comparisons between large packages and multiple small packages, the large package will come out of the LCA comparison better by having a better packaging over product ratio. However, there clearly is a market for alternative pack solutions, as these different use scenarios do exist. Smaller convenience packs often command higher prices per unit of packed product, because of their added convenience. LCA falls short in including these soft aspects of user-package interaction. At the

same time, on a macro level, a decoupling (or delinking) of economic growth and environmental burden is called for. Innovations are needed that allow the economy to grow without the historically associated increase in environmental burden. In other words, we need to create products with a much better value over eco-impact than we have done in the past.

In previous work we introduced the Eco-costs/value ratio (EVR) as a way to balance the two perspectives and enable pack designers to find an optimum, and work towards decoupling /11/. By expressing an innovation in terms of the environmental impact caused, in relation to the economic value created, designers obtain a ratio that can be optimized. The EVR model is already well established in the literature /4-9/.

Methodology

For a detailed explanation of the methodology behind the EVR model we refer to previous publications, in particular the open access publication introducing EVR to the field of packaging /11/, and the more general new book on the subject of eco-efficient value creation /9/.

An important part of EVR thinking is how potential new products score relative to existing solutions in the market in terms of their eco-costs/value ratio. Figure 1 gives an overview of the different options. Optimal are innovations that fall in quadrant 2, combining a reduction of eco-burden with an increase in value. As Wever & Vogtländer /11/ demonstrated, packaging innovation often fall in quadrant 1 or 3. Here, it is essential from a sustainability perspective, that innovations in these quadrant do improve the EVR score. Hence 1a and 3a are good, while 1b and 3b result in worsened EVR values.

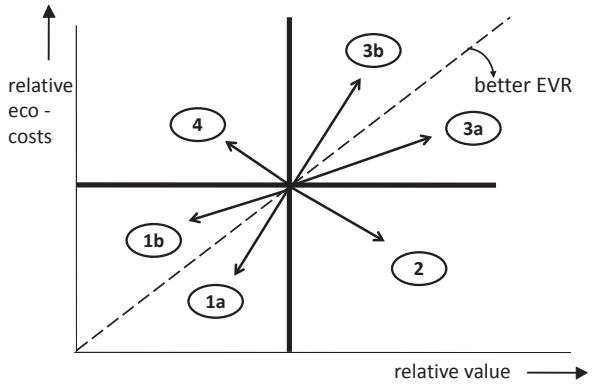

Figure 1. Potential directions of innovations in terms of EVR as compared to the reference product /11/

In previous work, introducing the eco-costs/value ratio in relation to packaging optimization, we placed certain limitations on the study, in order to allow maximum clarity. These limitations were that the studied couples of packaging solutions had to:

- Be exactly the same product,
- From the same brand,
- In the same amount/volume,
- Bought in the same retail outlet,
- At the same moment in time.

Hence, only the price and the packaging differed. These limitations were purely for the clarity of the paper. The EVR method is capable of dealing with such differences, as the can be represented in the value and/or the eco-costs of the of each design solution.

In order to illustrate the flexibility of the EVR method, we will apply it in this paper to assess two product portfolios, consisting of multiple packaging solutions for the same packed product. The two examples used are bottled water and table salt.

Incorporation of sustainability on a product portfolio level is a part of the sustainability literature that is ill-addressed. Only preliminary explorations have been done so far (e.g. /10/). Structural incorporation of

sustainability in goal finding and target setting phase of sustainable is currently being actively investigated /1,2,3/, but mainly on a per project basis. Portfolio level thinking will be a next level challenge. As this paper will demonstrate, the EVR model will be one possible approach to managing sustainability on a portfolio level.

For this study, two products were selected that had relatively simple to calculate eco-burdens themselves (again a self-chosen limitation for clarity, not a limitation of the methodology per se) and were available in multiple (>2) pack sizes in the same retail outlet.

The choice was made for a group of SPA bottled water products (two of these bottles were also in the original study /11/, thus enabling comparison of the different ways of applying EVR to packaging alternatives), and table salt. For the bottled water a portfolio of 5 different bottles was used (Figure 2) for the table salt a portfolio of 3 pack sizes was used (Figure 3). Table 1 summarizes the different alternatives.

Table 1. Included packaging solutions with quantity, materials and value.

Product	Quantity	Materials	Remarks	Price in € (value)
SPA water	2 litre	39.8g PET bottle, 1.94g PP cap	'Family' *bottle*	1.05
SPA water	1 litre	23.6g PET bottle, 2.00g PP cap	Normal cap	0.55
SPA water	0,75 litre	21.6g PET bottle, 4.10g PP cap	Sports cap	0.66
SPA water	0,5 litre	13.7g PET bottle, 1.29g PP cap	Normal cap	0.36
SPA water	0,5 litre	13.7g PET bottle, 3.12g PP cap	Sports cap	0.59
Jozo table salt	1 kg	8,9g paper	Paper bag	0.33
Jozo table salt	600 gram	29g PP + 2g sleeve	PP dispenser	0.55
Jozo table salt	125 gram	11.5g PP + 0.78g sleeve	PP dispenser	0.35



Figure 2. The SPA bottle portfolio



Figure 3. The table salt portfolio

As in the previous study, the value used was the established market price in the supermarket where the products were purchased. In real business applications the richness in market data would allow a more robust figure, taking into account the differences in sales prices at different retail outlets. However, for this

assessment only the relative price differences are relevant, hence, the prices in a single store are sufficient here

Results

Table 2 and 3 give the calculations of the eco-burden of the different packaging solutions. In combination with the value of each, as presented in Table 1, this results in the mapping of the EVR as presented in Figures 4 and 5. Like in the previous study, where appropriate two scenarios have been included in the calculations, one assuming no recycling, the other assuming 50% recycling.

Here, the data points are calculated to equivalent values for 1 kg and 1 litre equivalent, to clearly visualize the EVR scores of the products. A mapping that leaves the data as they are (e.g. the respective eco-costs and value of a 125 g package vs. a 600 g and 1kg pack), would be equally possible, and would demonstrate the identical EVR scores.

Table 2. Eco-burden calculation for the Salt packages.

1000 grams in bag				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
8,9	grams	paper	Paper, woodfree coated (Idemat2010)	0,28	1,26	0,00	0,01
			Total			0,00	0,01
600 grams salt in plastic container (PP), 0% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
30,97	grams	PP	Idemat2010 PP	1,03	1,97	0,03	0,06
			Idemat2010 Injection moulding	0,26	1,33	0,01	0,04
			Total			0,04	0,10
125 grams salt in plastic container (PP), 0% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
12,3	grams	PP	Idemat2010 PP	1,03	1,97	0,01	0,02
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,02
			Total			0,02	0,04
600 grams salt in plastic container (PP), 50% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
15,485	grams	PP	Idemat2010 PP	1,03	1,97	0,02	0,03
15,485	grams	PP	Idemat2010 PP, recycled	0,24	1,24	0,00	0,02
			Idemat2010 Injection moulding	0,26	1,33	0,01	0,04
			Total			0,03	0,09
125 grams salt in plastic container (PP), 50% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
6,15	grams	PP	Idemat2010 PP	1,03	1,97	0,01	0,01
6,15	grams	PP	Idemat2010 PP, recycled	0,24	1,24	0,00	0,01
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,02
			Total			0,01	0,04

Table 3. Eco-burden calculation for the Salt packages (continues on next pages)

50 cl water bottle, standard, 0% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
13,7	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,01	0,04
			Idemat2010 Blow moulding bottles	0,21	1,09	0,00	0,01
1,29	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,00
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,00
			Total			0,02	0,06
50 cl water bottle, sportscap, 0% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
13,7	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,01	0,04
			Idemat2010 Blow moulding bottles	0,21	1,09	0,00	0,01
3,12	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,01
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,00
			Total			0,02	0,06
75 cl water bottle, sportscap, 0% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
21,6	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,02	0,06
			Idemat2010 Blow moulding bottles	0,21	1,09	0,00	0,02
4,1	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,01
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,01
			Total			0,03	0,10
1 litre water bottle, standard, 0% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
23,6	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,03	0,07
			Idemat2010 Blow moulding bottles	0,21	1,09	0,01	0,03
2	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,00
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,00
			Total			0,03	0,10
2 litre water bottle, standard, 0% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
39,8	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,04	0,12
			Idemat2010 Blow moulding bottles	0,21	1,09	0,01	0,04
1,94	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,00
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,00
			Total			0,05	0,16

Table 3 *continued* (with 50% recycling).

50 cl water bottle, standard, 50% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
6,85	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,01	0,02
6,85	grams	PET	Idemat2010 PET, recycled	0,21	1,08	0,00	0,01
			Idemat2010 Blow moulding bottles	0,21	1,09	0,00	0,01
0,65	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,00
0,65	grams	PP	Idemat2010 PP, recycled (estimate)	0,24	1,24	0,00	0,00
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,00
			Total			0,01	0,05
50 cl water bottle, sportscap, 50% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
6,85	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,01	0,02
6,85	grams	PET	Idemat2010 PET, recycled	0,21	1,08	0,00	0,01
			Idemat2010 Blow moulding bottles	0,21	1,09	0,00	0,01
1,56	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,00
1,56	grams	PP	Idemat2010 PP, recycled	0,24	1,24	0,00	0,00
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,00
			Total			0,01	0,05
75 cl water bottle, sportscap, 50% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
10,80	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,01	0,03
10,80	grams	PET	Idemat2010 PET, recycled	0,21	1,08	0,00	0,01
			Idemat2010 Blow moulding bottles	0,21	1,09	0,00	0,02
2,05	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,00
2,05	grams	PP	Idemat2010 PP, recycled	0,24	1,24	0,00	0,00
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,01
			Total			0,02	0,08
1 litre water bottle, standard, 50% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
11,80	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,01	0,03
11,80	grams	PET	Idemat2010 PET, recycled	0,21	1,08	0,00	0,01
			Idemat2010 Blow moulding bottles	0,21	1,09	0,01	0,03
1,00	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,00
1,00	grams	PP	Idemat2010 PP, recycled (estimate)	0,24	1,24	0,00	0,00
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,00
			Total			0,02	0,08
2 litre water bottle, standard, 50% recycled				eco-costs	CO2 equi	eco-costs	CO2 equi
weight		materials and processing		(euro/kg)	(kgCO2/kg)	(euro/bottle)	(kgCO2/bottle)
19,90	grams	PET	Idemat2010 PET bottle grade	1,07	2,89	0,02	0,06
19,90	grams	PET	Idemat2010 PET, recycled	0,21	1,08	0,00	0,02
			Idemat2010 Blow moulding bottles	0,21	1,09	0,01	0,04
0,97	grams	PP	Idemat2010 PP	1,03	1,97	0,00	0,00
0,97	grams	PP	Idemat2010 PP, recycled (estimate)	0,24	1,24	0,00	0,00
			Idemat2010 Injection moulding	0,26	1,33	0,00	0,00
			Total			0,04	0,13

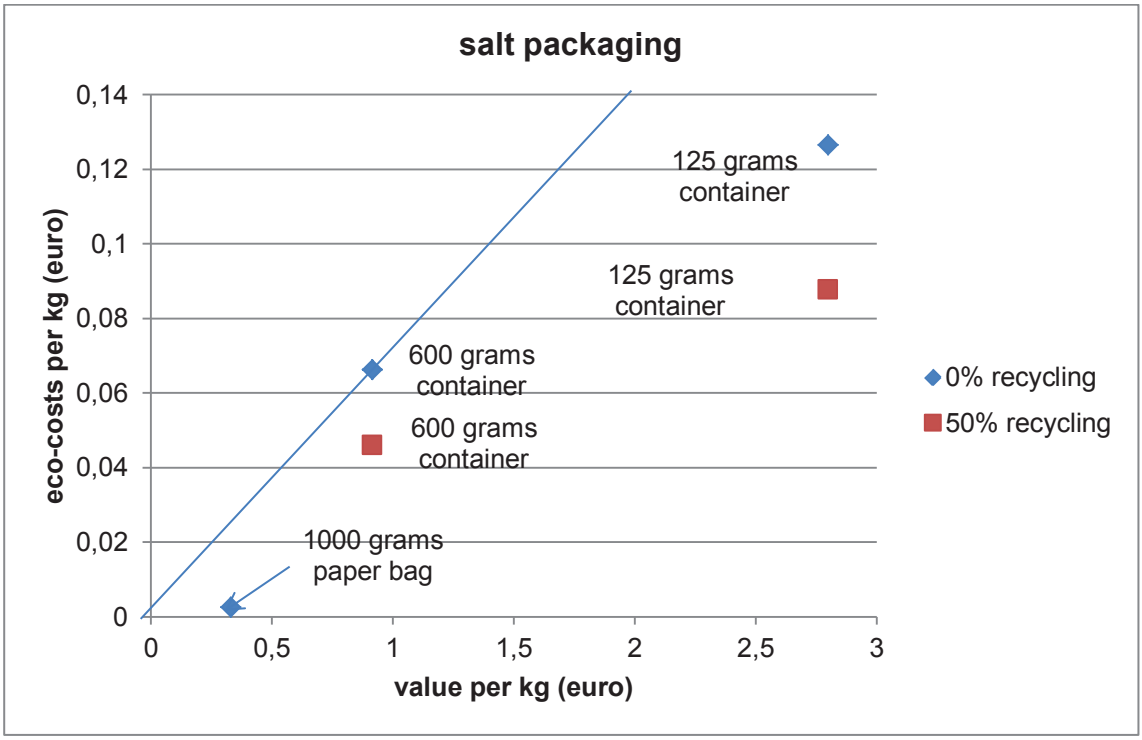

Figure 4. The resulting EVR mapping of the salt packs, with the 50% recycling situation where relevant.

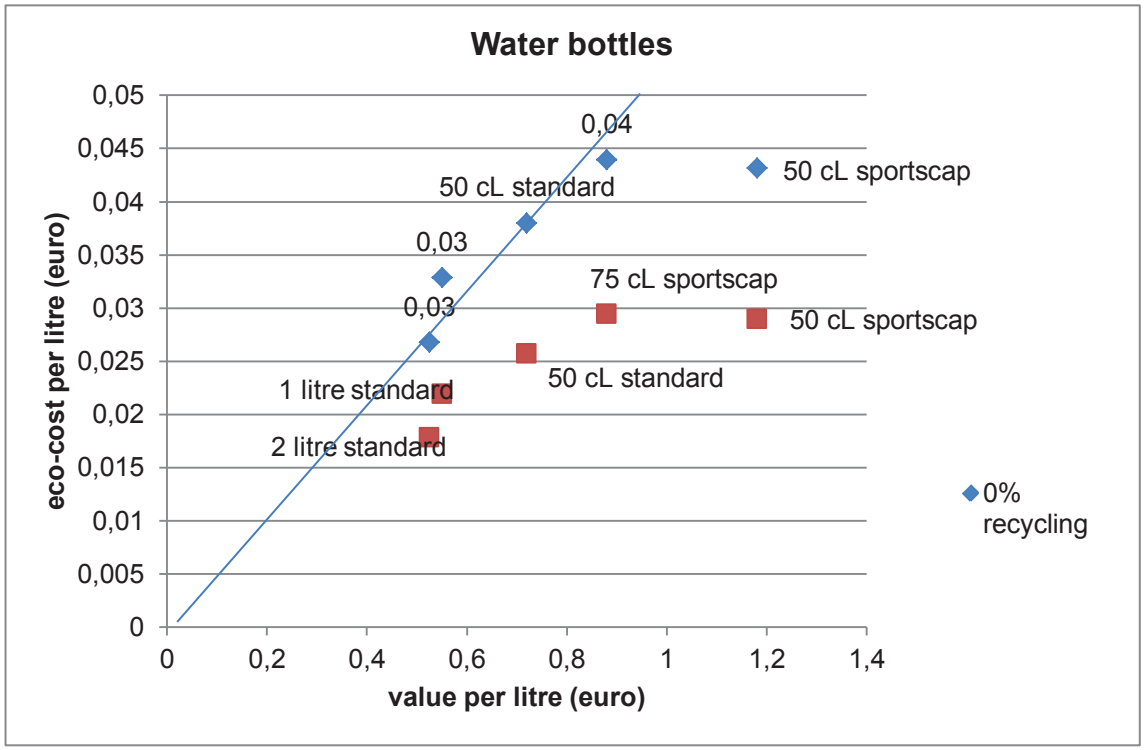

Figure 5. The resulting EVR mapping of the water bottles, with the 50% recycling situation where relevant.

Conclusions

The calculations for the salt show that the eco-cost of the paper bag are so low, that they easily compensate for the lower value, resulting in an EVR of 0.0076 (note that for the EVR calculations we have consistently used the 0% recycling numbers). The EVR of the 600g bottle is roughly tenfold that of the paper bag, namely 0.073. The small bottle, subsequently, performs a bit better than the larger bottle, with an EVR of 0.046. Hence, from an EVR perspective the preferred order of these packaging solutions would be the paper bag first, followed by the small 125g bottle, and the 600g bottle last.

When compared with classical LCA (for which the eco-costs by them self are a good indicator), the paper bag would also score best, but the eco-cost per kilo of delivered salt are better for the 600g bottle than for the small 125g bottle.

The EVR scores of the water bottles are: 0.053 for the 0.5l with normal cap, 0.037 for the 0.5l with sports cap, 0.050 for the 0.75l with sports cap, 0.060 for the 1l and 0.051 for the 2l bottle. This gives an order of preference based on EVR of: 0.5l sports cap, 0.75l sports cap, 2l, 0.5 normal cap and finally the 1l. The preference based on eco-costs per litre of water (and thus regular LCA) would be: the 2l, the 1l, the 0.5l with normal cap, the 0.5l with sports cap and finally the 0.75l with sports cap. Hence, here the pictures for classical assessment and EVR assessment run much wider apart.

Discussion

The portfolio analysis as presented in this paper only included existing products. Such a mapping, as presented in Figures 4 and 5, can be used in multiple ways, such as (see also the typology of product mix decisions as presented in /10/):

- to explore gaps in the regions with better EVR scores, in order to generate ideas for potential new product offerings,
- to map one or more potential ideas for future products, i.e. as a decision support tool at evaluation moments during the product development process,
- to help formulate the innovation goals for upcoming redesigns (i.e. should future (re)design projects for a particular product be focussed more on reducing eco-burden or on adding value?),
- to assist in decision making in relation to the continuation or termination of existing products in the market.

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