Conjoint analysis as a tool for risk communication

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Introduction

Over the last 20 years, the Swedish steel industry has been successful in their efforts to promote environmental protection by reducing emissions, use of energy and raw materials.

A new challenge for the steel industry is to find out to what extent it can further contribute to the evolution towards a sustainable and resource efficient society.

Thus, a research project called “Towards the closed steel eco-cycle” has been initialized, with six subprojects, one of them focusing on attitudes towards environmental issues.

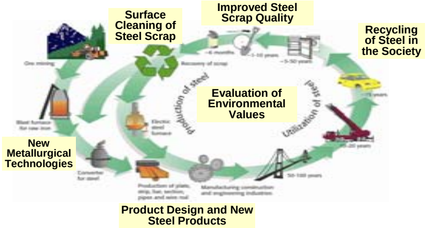

Figure 1: The steel eco-cycle.

The environmental objectives for the steel eco-cycle focus on:

- Use of energy
- Emissions of carbon dioxide
- Use of raw materials
- Eco-efficient construction

To assess the environmental objectives our sub-project concentrates on which of these environmental issues different stakeholder groups prefer to prioritize. The aim is to present a decision tool that can evaluate and rank environmental preferences among stakeholder groups.

Torpedo transporting iron from the blast-furnace to the steelworks. SSAB Tunnplåt AB, Luleå, Sweden. Photograph: Stig-Göran Nilsson (2002)

Slag removal from blast-furnace. SSAB Oxelösund AB, Oxelösund, Sweden. Photograph: Stig-Göran Nilsson (2002)

Method

Conjoint analysis is a method that evaluates the preferences of a person or a group of persons. The method has been used in marketing and transportation. During the last decade it has also been adopted to environmental issues [1].

Surveys are designed through the construction of products or situations with hypothetical attributes that are varied between different levels. All attributes and levels are combined to create situations that the respondents are asked to evaluate, in this case rank and rate.

Experimental design (fractional factorial design) is used to bring the number of alternatives down to a manageable size in order to avoid fatigue effects. In this survey the following attributes and levels were used:

Table 1. Alternatives in the study: environmental effects from production of one metric ton of steel.

Alternatives	Energy from non-renewable energy sources (kWh)	Carbon dioxide (kg)	Non-renewable resources (kg)	Increased cost of production (%)	Dioxins (µg)
I	5 800	2 600	3 200	10	0,1
II	10 400	2 600	1 700	0	0,1
III	5 800	3 400	1 700	10	0,1
IV	10 400	3 400	3 200	0	0,1
V	5 800	2 600	3 200	0	5
VI	8 100	3 000	2 400	5	2,5
VII	10 400	2 600	1 700	10	5
VIII	5 800	3 400	1 700	0	5
IX	10 400	3 400	3 200	10	5

The rankings made by the respondents are then analyzed so that the importance of each attribute is estimated. The results were analyzed directly after the respondents completed their questionnaires and the respondents were shown the results immediately. This allowed for the respondents to comment on their results as well as for the researcher to initialize a discussion on the identified preferences.

Results and Discussion

The respondents came from three groups; students at the University of Kalmar (30 respondents), representatives from the steel eco-cycle program (41 respondents) and members of the public (17 respondents).

Emission of dioxins was found to be the most important attribute to reduce according to the respondents, followed by use of energy, use of resources and cost of production. Emissions of carbon dioxide was the least important attribute by all respondents.

Although the difference among the groups were not as clear as expected, there is a small difference between the three groups of respondents, where younger people (students) tend to focus on one single attribute; dioxins, while older respondents (steel eco-cycle) seem to have a wider perspective in there preference of attribute.

The results were analyzed by multiple linear regression (MLR) and partial least squares regression (PLSR). MLR is based on averages from the participating groups while PLSR is a bilinear modeling method that allows for a higher resolution than MLR and other traditional methods of analysis used for conjoint analysis.

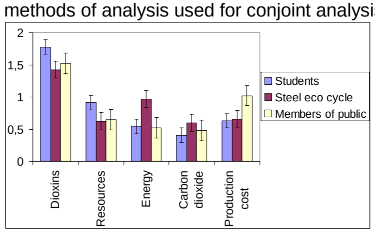

Figure 2 Regression coefficients (MLR) for groups, equaling one half of the factorial effects

Coils (Steel band). SSAB Tunnplåt AB, Borlänge, Sweden Photograph: Stig-Göran Nilsson (2002)

With PLSR the results of each individual can be displayed and this is an essential characteristic in communicating the results directly back to the respondents.

Figure 3: PLS2 regression loadings, linking individual preferences to the design variables

Conclusions

A conjoint analysis was made to evaluate the objectives for the steel eco-cycle. The respondents prefers the industry to reduce use of non-renewable energy, production costs and use of non-renewable resources.

Emissions of carbon dioxides was considered to be of less importance. A fifth environmental issue was included in the study, emissions of dioxins, and the results indicate that the respondents find this issue important. However, the factor levels used for dioxins had a relatively wider range of variation than the other attributes and this could have influenced the outcome.

Through this study we have shown that conjoint analysis is a useful method for evaluating effects of an entire process or system, in this case steel production. The method is likely to work as well with preferences for other types of risks and environmental issues.

We aim to develop this method so that it can be used as a decision tool for strategic environmental and risk decisions and assist in environmental risk communication.

References

1. Alriksson Stina, Öberg Tomas, (2006). Conjoint Analysis for Environmental Valuation – A Review of Methods and Applications. Submitted.

Acknowledgement

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