

DECOMPOSITION ANALYSIS FOR MULTIPLE ENVIRONMENTAL IMPACTS:
CASE OF WASTE GENERATION AND CO₂ EMISSION IN SOFT DRINK MARKET

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ABSTRACT

This research aimed at evaluating performances of production/consumption systems on multiple environmental impacts by comparing factors with single input and with multiple inputs by method of decomposition analysis. The detailed system setting was soft drink market in Japan from 1996 to 2012 with five types of containers (Aluminum can, Steel can, Glass bottle, PET bottle, and Paper carton) as inputs of the production/consumption system and two environmental impacts of waste generation and CO₂ emission as outputs.

The waste generation and CO₂ emission were decomposed to different factors accounting for the change of the two environmental impacts. The factors included population, consumption of soft drink per person, market share, and container weight per volume of drink sold. The factors together with environmental impacts were shown as trends from 1996 to 2012, for provision of information on the change of the two environmental impacts and the factors accounting for them, based on what the soft drink market was evaluated and future

environmental impact mitigation was introduced. The comparison was made between two kinds of factors based on their difference in number of container types as inputs. The first kind of factors only took one type of container into account, called individual factor. The individual factors were generated by decomposition analysis directly. The second kind of factors took all the five type of containers into account, called integrated factor. The integrated factor was synthesized from the individual factors. The comparison was to investigate whether a complete set of individual factors for all the five types of containers provided the same implication as one integrated factor for mitigation decision on environmental impacts. Furthermore, whether the comparison results differed between waste generation and CO₂ emission was in concern, which led to the overall environmental impacts trade-off analysis and market equivalent CO₂ emission coefficient calculation.

From the comparison results, it was shown that the individual factors could provide more detailed trend information for each type of container. However, the individual factor failed to include the interconnectivity among the five types of containers, which made the market overall environmental impacts hard to be evaluated. On the other hand, the integrated factor did not contain information on individual type of containers but captured the overall environmental impacts change even if the trends showed more complex trade-off behavior between waste generation and CO₂ emission. It was also able to show the equivalent CO₂ emission coefficient for the market of the five types of containers, with the help of the

integrated factors.

As conclusion, by comparison between the two kinds of factors in multiple environmental impacts analysis in a soft drink market containing five types of containers, it was shown that a set of individual factors did not provide the same information an integrated factor could provide. A complete set of individual factors and an integrated factor are not equivalent in providing accountability for the overall variation in environmental impacts, even if the total number of inputs in the set of individual factors and the integrated factor are equal to each other, because a collection of the individual factors was still lack of the interconnectivity among them. In some case, the two kinds of factors implied opposite recommendations on mitigation in environmental impact. As a result, the applicable scope need cautious check before recommendation made for future decision. And in order to consider trade-off situation between different environmental impacts, analysts should refer to an integrated type of factor with multiple inputs.

Keywords: decomposition, factors, environmental impact, CO₂ emission, waste, trade-off