Incorporating life cycle screening into Alternatives Analysis

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Project Members:
Jordan Chamberlain | Carolin Meier
Kristen Magnuson | Yu Yu

Project Advisor:
Dr. Arturo Keller

Project Client:
Department of Toxic Substances Control, California EPA

BREN SCHOOL OF ENVIRONMENTAL SCIENCE & MANAGEMENT
UNIVERSITY OF CALIFORNIA SANTA BARBARA

California Department of Toxic Substances Control

Background

Many consumer products contain chemicals that are known to be detrimental to human health and the environment. Typical regulatory responses include banning the use of Chemicals of Concern (CoC). Replacement chemicals, however, may later be determined to have negative impacts as well. To address these regrettable substitutions, the State of California created the Safer Consumer Products Regulations. These Regulations require manufacturers to find and evaluate potential alternatives to these Priority Products by conducting an Alternatives Analysis.

The Alternatives Analysis process consists of two stages. The First Stage focuses on screening alternatives and identifying factors that are relevant to consider in the Second Stage, which is a thorough investigation of alternatives. The Alternatives Analysis requires the incorporation of a life cycle perspective to account for impacts (e.g. public health, environmental, or waste and end-of-life) throughout the production, use, and disposal of a product.

The life cycle of a product is the "consecutive and interlinked stages of a product system", from raw material extraction to the end of life[1]. Life cycle assessment (LCA) is a systematic way to evaluate the impacts of a product or service system throughout the phases of its life cycle (Figure 1), with a particular focus on human health and environmental impacts. Current methods for assessing alternatives do not provide an approach with life cycle considerations in a time-limited environment. While methods exist for conducting LCA, a full LCA is time-consuming and data-intensive and is not required by the Safer Consumer Products Regulations. Furthermore, many businesses, particularly small businesses, lack the technical expertise to conduct such analyses.

Figure 1. Generic life cycle flow diagram indicating phases of a product's life cycle, from raw material extraction through manufacturing and use, into disposal.

We developed a framework for including life cycle thinking in a First Stage Alternatives Analysis and provided a user-friendly visualization of results. A case study of methylene chloride-based paint stripper alternatives was used to develop and test the framework.

The results of this project are expected to play a role in supporting the implementation of the Safer Consumer Products Regulations. Given the limited practical experience

[1] ISO 14044-1:2006: Environmental management — Life cycle assessment —Requirements and guidelines.

conducting an Alternatives Analysis, the framework and completed case study will help the Department of Toxic Substances Control (DTSC) guide industry through a First Stage Alternatives Analysis.

Objectives

1. To develop a life cycle screening framework and test the framework with a case study of methylene chloride in paint strippers and alternatives.
2. To design a document explaining the steps needed to implement the life cycle screening framework for a particular product, and a visual presentation to communicate results to public and corporate audiences.

Approach

Relevant literature was reviewed to provide a background on: (1) Alternatives Assessment; (2) Life Cycle Assessment; and (3) hotspot analysis—an approach to rapidly assimilate and process a large amount of data. The developed framework made use of valuable aspects of each of these separate methodologies.

To inform and test the framework, a case study was performed. Methylene chloride in paint stripper was chosen as an appropriate Priority Product because of the availability of both chemical substitutes (e.g. benzyl alcohol-based paint stripper)(Figure 2) and full process substitutes (e.g. sanding)(Figure 3). The combination of these alternatives ensured that the developed framework was applicable to both formulated and composite products.

Figure 2. Examples of chemical paint stripper.

Figure 3. Examples of sandpaper.

Data sources for the case study included government (e.g. US EPA) and non-government agencies (e.g. Material Safety Data Sheets). These sources provided both qualitative and quantitative data on human health, environmental, and waste/end-of-life impacts.

Results

Framework

Our framework outlines an approach for incorporating life cycle thinking into a First Stage Alternatives Analysis as set forth in the Safer Consumer Products Regulations. It works through the process of identifying and comparing human health and environmental impacts between a Priority Product and its alternatives.

The framework (Figure 4) consists of six primary steps: (1) determine the function of the Priority Product and the Chemical of Concern; (2) identify possible alternatives; (3) define the functional unit; (4) brainstorm questions to consider; (5) conduct focused research to address the questions that stem from step 4; and (6) evaluate impacts using standard evaluation criteria.

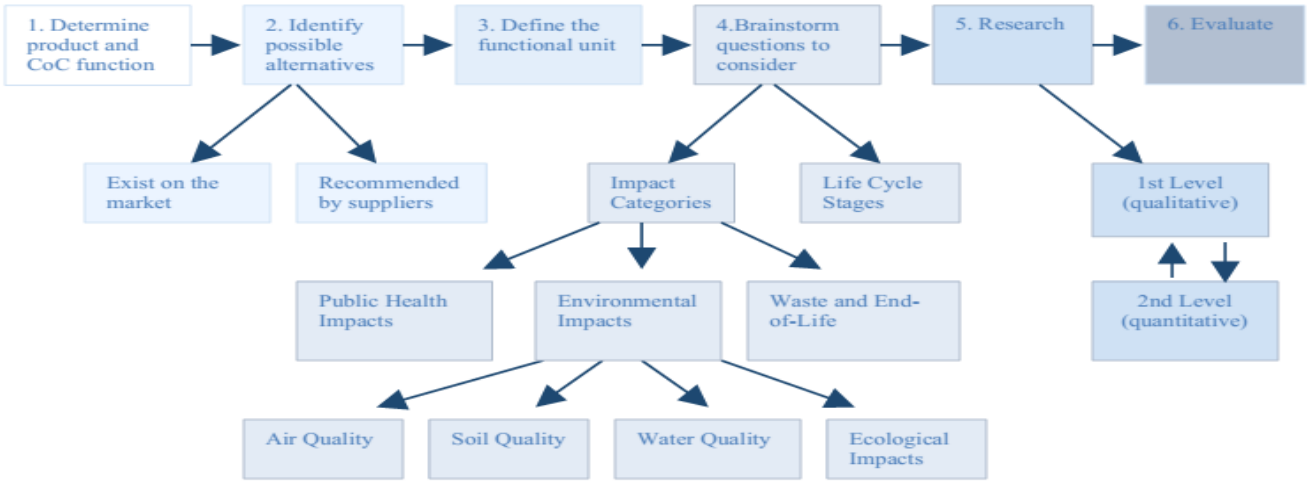

Figure 4. Life cycle screening framework.

A guidance document was created detailing each of these steps and providing examples. A full framework description and guidance can be found at http://www2.bren.ucsb.edu/~alternatives/

Visualization

The data gathered by following the framework requires a user-friendly visualization to achieve two of the goals of a First Stage Alternatives Analysis: (1) to screen alternatives; and (2) to identify factors that are relevant for consideration in a Second Stage Alternatives Analysis.

A series of heat maps was used to present the results of the case study on paint strippers and to illustrate how this visualization tool can be useful to decision-makers. Colors for the heat maps were assigned based on evaluation criteria identified in the Toxic Use Reduction Institute's (TURI) L-M-H guidance document.

1. Screening Alternatives

To identify alternatives that could be screened out from further consideration, evaluations of human health and environmental impacts were presented as product-specific heat maps (Figure 5). This presentation of the evaluation allows for the identification of alternatives that have an overall similar or worse level of impact than the Priority Product.

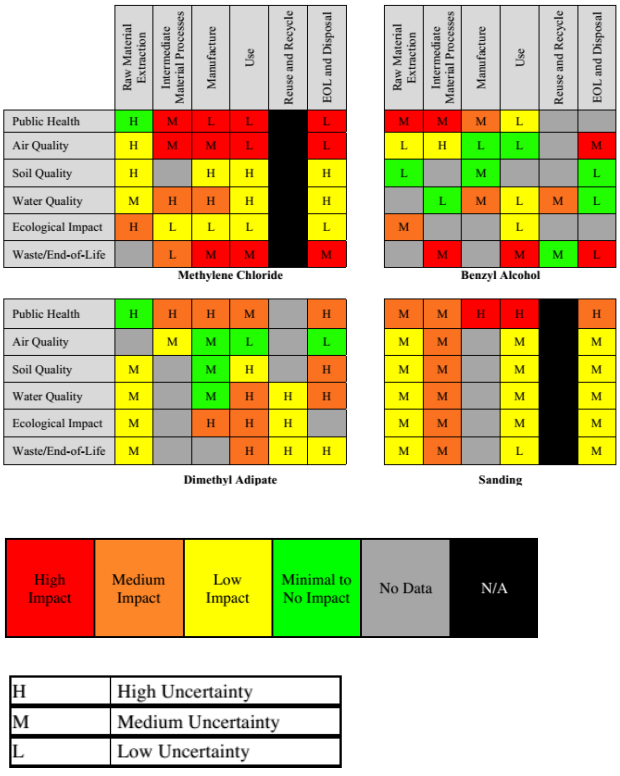

Figure 5. Example heat maps by impact. Evaluation of impacts associated with four paint-stripping products and separated by impact category. The heat map columns indicate life cycle phases; rows indicate impact category; colors indicate the severity of an impact; and L-M-H indicate the level of uncertainty associated with the evaluation. Life cycle segments colored grey indicate a lack of data upon which to evaluate, and life cycle phases colored black do not apply to that product.

2. Identifying Relevant Factors

To help identify factors relevant for consideration, the evaluation was presented as a series of impact-specific heat maps (Figure 6). This format allows for an easier comparison of alternatives for specific impacts to determine whether a more in-depth investigation of a particular impact is warranted.

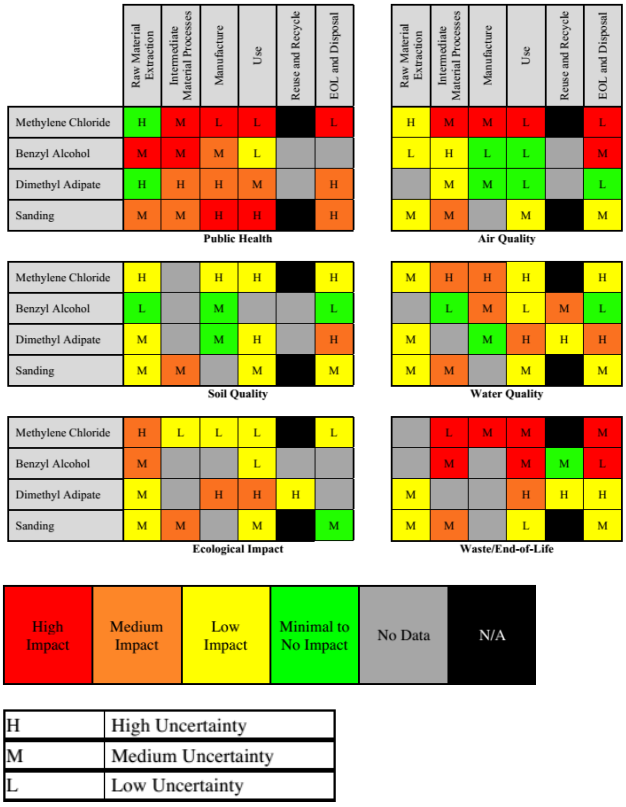

Figure 6. Example heat maps by impact. Evaluation of impacts associated with four paint-stripping products and separated by impact category. The heat map columns indicate life cycle phases; rows indicate impact category; colors indicate the severity of an impact; and L-M-H indicate the level of uncertainty associated with the evaluation. Life cycle segments colored grey indicate a lack of data upon which to evaluate, and life cycle phases colored black do not apply to that product.

Conclusion

A new framework was developed and tested using a case study of methylene chloride-based paint strippers and three alternatives. It incorporated critical aspects from Alternatives Assessment, LCA methods, and hotspot analysis, and is applicable to both formulated and composite products.

The framework introduces life cycle concepts to a non-expert audience as a way to achieve the objectives of a First Stage Alternatives Analysis to: (1) identify alternatives; (2) screen alternatives; and (3) identify relevant factors to consider in a Second Stage Alternatives Analysis. This framework successfully addresses these three objectives.

This framework was tailored to the Safer Consumer Products Regulations. It focuses on introducing the concepts of life cycle thinking and suggests an approach to incorporate these considerations in a time-limited environment. This framework is malleable, and additional impacts, such as economic or social impacts, could be incorporated into this methodology.

Next Steps

Next steps include: (1) further developing quantitative methods for life cycle screening using the paint stripper case study; and (2) developing a framework for the Second Stage Alternatives Analysis.

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