ADVANCING PLASTIC MODELLING METHODS IN LIFE CYCLE ASSESSMENT

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1 Additives, Additives Everywhere:

Additives make up anywhere from .01-70% of the net weight of plastics currently in the market today (OCED, 2014). These chemicals are the secret sauce which help make plastics so multi-fictional, durable, and useful, in everyday life. As different mixes of additives help certain plastics meet key performance metrics, historically additive data has been seen as intellectual property, and is not widely reported to the consumer or even across supply chains. This knowledge gap has not only resulted in the omission, scaling, or use of proxies to replace critical data on additives in LCAs, but also, in a lack of robust datasets for use in these studies (Logan et al., 2024a,b).

This study is investigating how we can use better proxies and advanced LCA approaches to help inform prospective, circular economy, and safe and sustainable by design studies going forward.

Fig 1- High and low contribution of additives to plastics by polymer commonly found in cosmetic packaging: *In our ongoing sampling of waste cosmetic packaging returned to stores in Denmark for recycling we observe that HDPE, LDPE, PET, and PP were the most commonly used in cosmetic packaging (Moscatelli et al., In Manuscript). This table is derived from Logan et al (2024b) and shows the common composition of packaging per polymer type.*

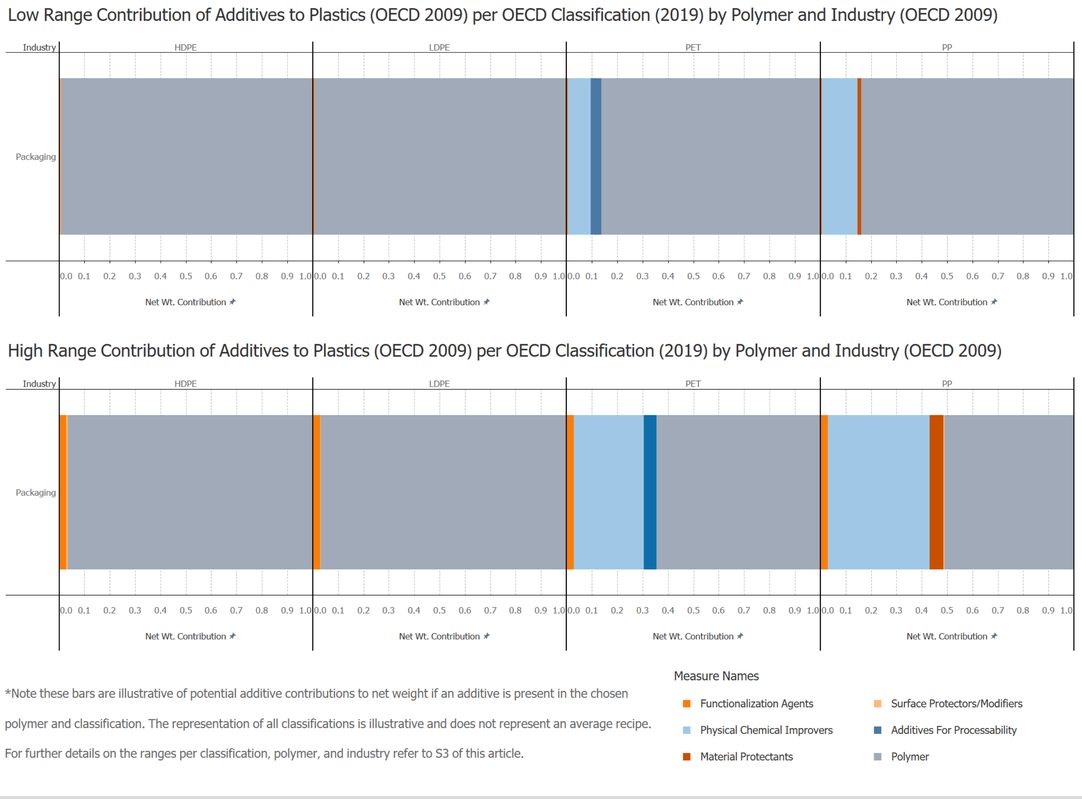


Figure modified from Logan et al (2024b)

2 FINDING BETTER PROXIES

The Plastic Additive LCA Data Finder (PLAD_LCA_DF) was developed following the methodology for cross referencing the LCA data availability records provided openly by major LCA Databases (ecoinvent, LCA 4 Experts, and CarbonMinds) with the PLASTCHEM (2023) and UNEP (2023) databases on plastic additives as proposed in Logan et al (2024b). The PLAD_LCA_DF also includes a tool for creating personal database for your research on plastic products. We used this tool to find which additives have known links to the cosmetic packaging industry. and generate a list of additives to use as better proxies for our case study on circular packaging.

Fig 2 - Count of additives for HDPE from similar industries with LCA data: *This graph illustrates the count of additives available for each given additive functions from industries with similar restrictions to the cosmetic packaging industry. While this highlights that there are alternatives to generic proxies, it also highlights the need for more representative data for the different functions of additives in plastics.*

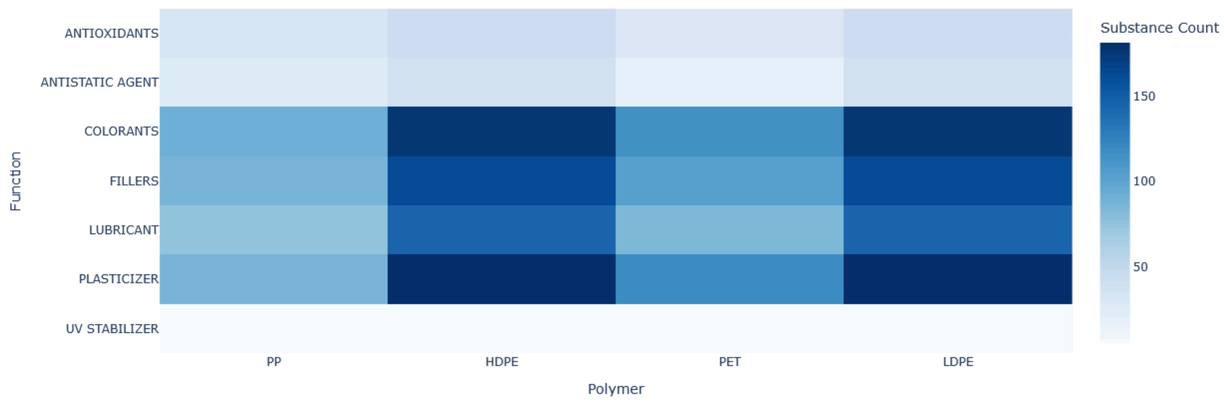


Fig 3 - PLASTCHEM watch list status of additives for cosmetic packaging with LCA data: *This figure offers an overview on the watch list status of additives with available data by a given function. Most likely additives on the watch lists are more represented as they have known concerns or risks and have therefore been studied in greater detail then new or under reported additives.*

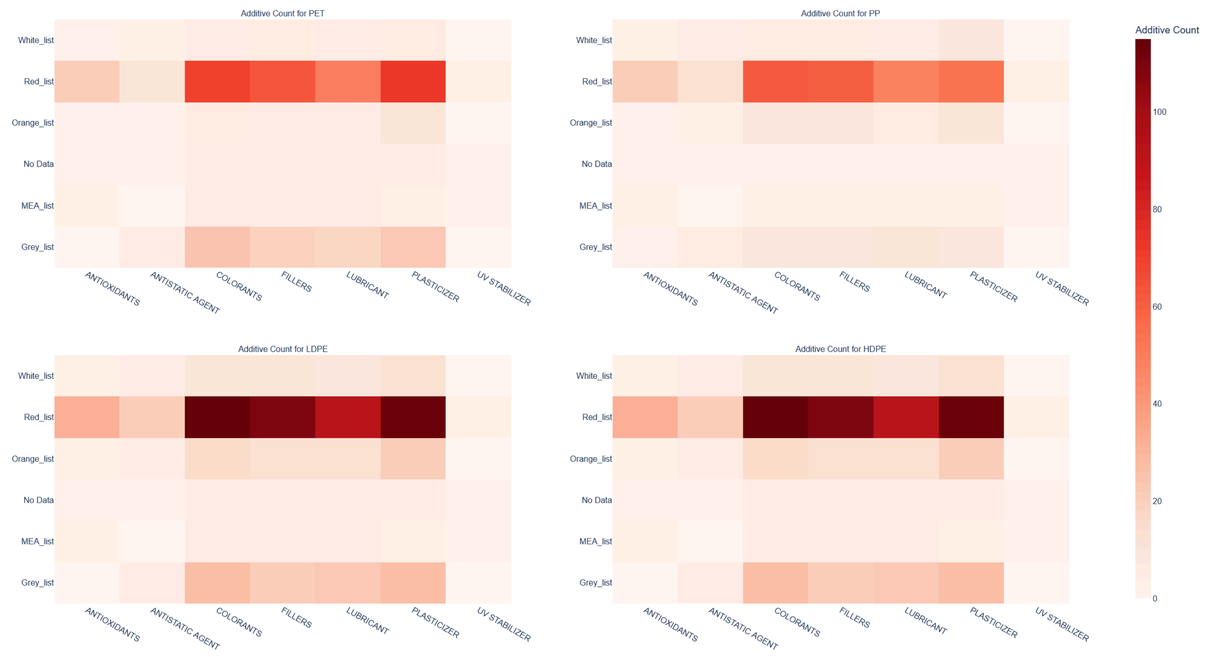
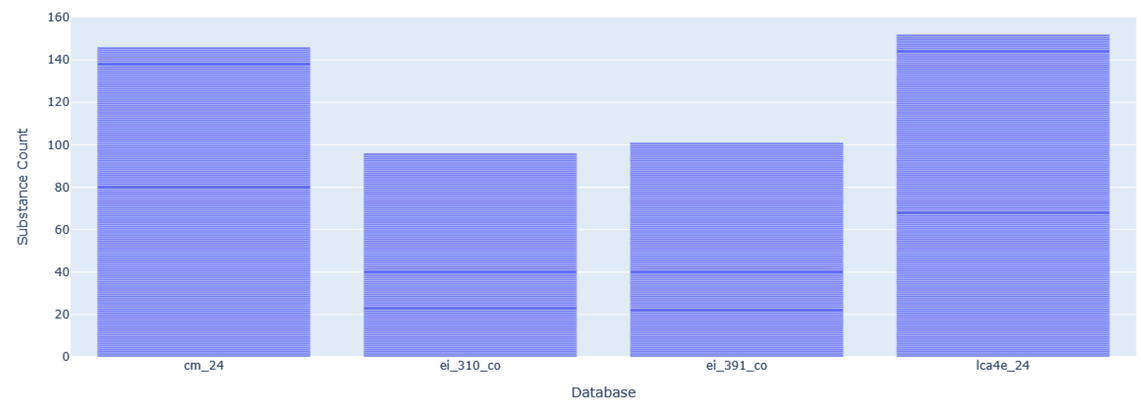


Fig 4- LCA data availability by database for additives likely to be used in Cosmetic Packaging: *This figure shows that LCA 4 Experts (lca4e_24) offers the most data on additives with known links to this use case, followed by CarbonMinds (cm_24), ecoinvent v3.9.1 cutoff (ei_391_co)and ecoinvent v3.10.1 cutoff (ei_310_co). While ecoinvent had less data available for the given case it was used for initial testing due to database restrictions.*



3 SIMULATING DEGRADATION

Key Takeaways:

1. Additives are **essential** to modeling circular plastics
2. There is **better data** than generic proxies **available**
3. **Need for more data** on **safer alternatives**
4. **Need for more representative** data per **function**

Our next steps focus on using data gathered from lab experiments with collaborators from iterative extrusions of the collected cosmetic packaging material to understand how additive and polymer degradation plays a role in assessing the impacts of polymers and additives over multiple loops. Follow along with the research and test our scenario builder for LCAs of circular plastics.

Works Cited:
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OECD Organisation for Economic Co-operation and Development. (2014). Emission scenario document on plastic additives (OECD Series on Emission Scenario Documents No. 3). Organisation for Economic Co-operation and Development.

trace
a transition towards circular economy

Learn About Brightway

We think Brightway is an unbeatable tool in helping make LCAs more accessible and reliable. If you haven't heard about Brightway before you can scan this code to learn all about their mission and revolutionary approach to LCA!

Learn About Activity Browser

In our opinion, Activity Browser is one of the best ways to get started modeling in Brightway. Users can be up and running LCAs quickly with the help of clear and concise videos which walk you through the basics. While we aren't associate with AB we love their open-source software and encourage practitioners to give it a try.

Get to know PLAD_LCA_DF & Tools

Knowing what chemicals are used in plastics is tough enough, but finding the data you need to model them can be even tougher. PLAD was developed based off of Logan et al. (2024) and aims to match leading information on the use of chemicals in plastics and map it to available LCA data. You can access all the tools developed so far, and even contribute to the code here.