Environmental Analysis of Food Packaging & Labelling for Sustainability

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OVERVIEW

Motivated by the ever-growing concerns over the **sustainability** of our action, even our most simple daily habits results in carbon emissions, energy consumption and crude oil usage, we have provided a methodology for food company to make an informed-decision about their food packaging's environmental impact using a single aggregated performance scoring. Using this performance scoring as a label, the food consumer would be informed about their purchasing decision towards impacting the optimal health of Earth.

As a way of quantifying the detrimental effects on the environment, a life-cycle assessment (**LCA**) was conducted on the packaging of the UK's favourite lunch: a **Tesco Meal Deal**, consisting of a pre-packaged sandwich, Walker's crisps and a bottle of Coca-Cola.

The most informative indicators of sustainability over all life-cycle processes of a product are:

1. **Mass of CO_2e Gas Emitted – related to global warming**
2. **kJ of Energy used – related to the efficiency**
3. **Mass of Crude Oil Consumption – related to the depletion of limited resource**

METHODOLOGY: LCA

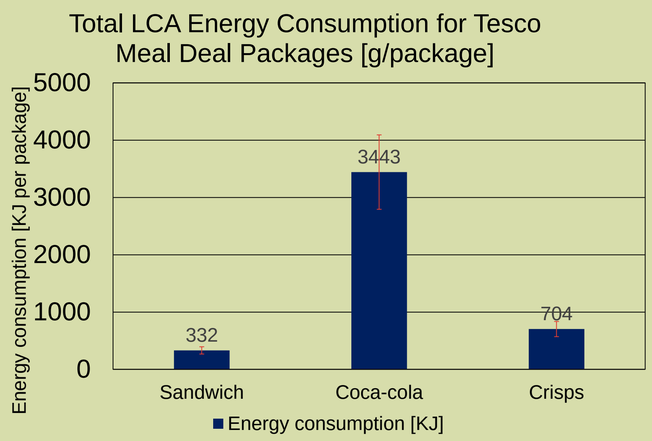
A life-cycle assessment (LCA) is a systematic tool to assess the potential environmental impacts throughout a product's life cycle. By assessing these stages and indicators, a LCA helps to identify the most significant **environmental impacts** of plastic products and make an informed-decision to mitigate them as much as possible, such as improving recycling processes, optimizing transportation logistics, or developing more sustainable materials [1]. For this project, the LCA was split into four stages, where our three indicators were individually assessed:

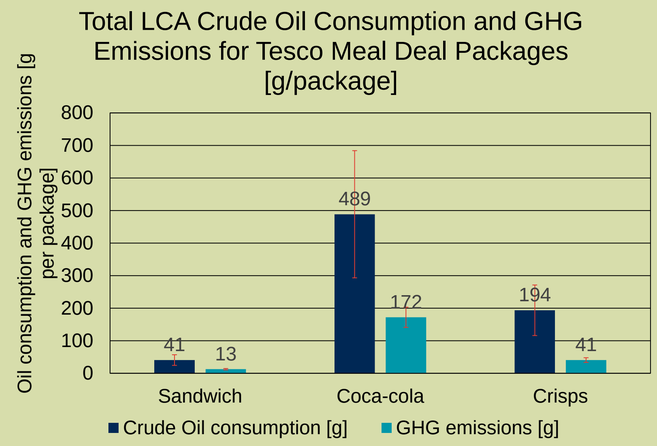
1. **Raw Material Extraction**
2. **Production**
3. **Transportation**
4. **Waste Management**

For the study, the materials of interest were mainly **cardboard** and **plastics,** specifically:
High-Density Polyethylene (HDPE), Low-Density Polyethylene (LDPE), Polyethylene Terephthalate (PET) and Polypropene (PP).

Detailed below is an example of the process that we investigated for our plastics.

ENERGY CONSUMPTION AND CARBON EMISSIONS





After finding the emissions/consumptions from each stage of the LCA, we were able to find the total environmental impact of each of the meal deal constituents. From here it is evident that **production is the costliest process** during the lifetime of the packaging, with a **Coca-Cola bottle being the most pollutive and requiring the most energy**. By producing a single full meal deal, **225.8g of Carbon Dioxide** are emitted into the atmosphere, **5514.5kJ of Energy** is used and **723g of Crude Oil** is consumed.

Meal Deal Item Packaging	Carbon Emissions (g)	Energy Consumption (kJ)	Crude Oil Consumption (g)
Sandwich	12.8	331.9	40.7
Walker's Crisps	40.8	704.1	193.7
Coca-Cola	172.2	3442.5	488.6
Total	225.8	5514.5	723

SCORING

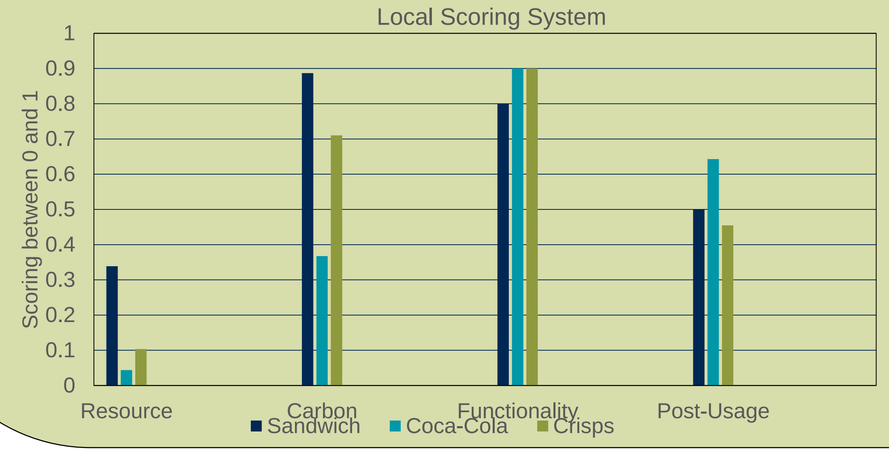
Functional Unit: A function unit is a quantified measure of the function of a product that serves as the reference basis for all calculations regarding impact assessment. In our case, the functional unit is a specific food packaging for three Meal Deal food items. This functional unit allows for the comparison of different packaging of the same food product on a standardized basis.

Local Scoring Methodology

As a way of creating a quantifiable measurement of sustainability in comparison to the same function unit, we have used a **local scoring system,** which was dictated by four scoring categories:

1. **Resource Footprint Scoring –** computed using equation 1 where x is the absolute resource footprint and p is a fitting parameter.
2. **Carbon Footprint Scoring –** computed using equation 1 where x is the absolute carbon footprint and p is a fitting parameter.
3. **Functionality**
4. **Post-Usage Scoring**

Functionality Scoring and Post-Usage Scoring are individually based on a series of criterion related to shelf-life and post-usage fate respectively and this is translated to a series of questions [2] with a binary Answer. The scoring is defined as ratio between the number of "Yes" Answer and the number of questions (equation 2).



$$f(x) = \frac{p}{p+x}$$

Equation 1 [2]

$$Score = \frac{No.\ Yes}{No.Yes + No.No}$$

Equation 2 [2]

CONCLUSION

In conclusion, we have assessed the environmental impact of a meal deal purchased from a Tesco store based in Central London by performing an estimated LCA on a sandwich, a packet of Walker's Crisps and a plastic bottle of 500ml Coca-Cola.

We then went on to develop a way of scoring, using a system with 4 scores for the packaging of a particular functional unit. Therefore, by comparing the local scoring of different packaging for the same functional unit, we could use a method called **voting rule** [2] which inputs the local ranking within the 4 different local scores of different supermarkets packaging for the same functional unit (i.e. comparing two different supermarkets sandwich package) and output a single global score. This single global score of packaging is called an aggregated performance score of packaging relative to the other possible packaging it is being compared to. This has huge potential in the food packaging industry as it would allow a packaging company to make informed-decisions about the optimal solution to minimise the environmental impact of specific food packaging.

FURTHER WORK

Suggestions for further improvements to this case study is to increase the number of recycling processes and waste-management routes according to present UK BPF statistics. Including these details, it is calculated to have an improvement for GHG and Energy values by **15%** and **6%** respectively, overall deviating from the official Coca-Cola sustainability report by **18%**.

Reference:
[1] T. Theis, J. Tomkin, Sustainability: A Comprehensive Foundation. 12th Media Services, 2018.
[2] J. Frojan et al., Scoring methodology for comparing the environmental performance of food packaging, Packaging Technology and Science, 2023.

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