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## Life cycle and supply chain management for sustainable bins

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### Abstract

Packaging is essential in logistics processes. All products consumed in a supply chain from fresh berries to large containership-parts are packed during their transportation and storing processes. Often plastics are used as a basic component for the bins. These synthetic materials are produced from crude oil. After their use plastic packaging is often burned to receive thermal energy. To measure and analyse the environmental impact a life cycle assessment can be carried out. In this paper the assessment is done for a Kanban bin made out of sunflower granulate. A typical supply chain situation is simulation. Different system boundaries are used. The production and the use/ maintenance phase are analysed with the help of a framework. The highest impact on the environment is during the use phase. The transportation and the recycling phase can be neglected in terms of the environmental impact. Using a sunflower-granulate the emissions during the production phase can be reduced. The impact is less strong considering a life cycle process.

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### 1. Introduction to life cycle management

Life cycle management is a holistic management concept. In the industry as well in the service sector life cycle management is used as a tool to achieve sustainable products and value chains. The aim is to reduce the environmental impact and maximize the economic and social value. Whereas in the late 90's life cycle management was considered as a "linkage between life cycle environmental criteria and an organization's strategies and plans to achieve business benefits" [1] it is today " a systematic integration of life cycle thinking in modern business practice

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with the aim to provide the societies with more sustainable goods and services and to manage the total lifecycle's of an organizations product portfolio towards more sustainable production and consumption" [2]. As a holistic approach life cycle management is structured in:

- Policy/strategy like the triple bottom line
- Systems/processes like eco-labelling
- Concepts/programs like green procurement
- Tools/techniques like risk assessment
- Data/information/models like standards [3]

In order to quantify the impact of products and supply chains a life cycle assessment can be carried out. It is an evaluation of the inputs and outputs during a complete life cycle from raw material extraction, production, use, recycling and a final disposal. This is known as the 'cradle to grave' process. The aim of a life cycle assessment is to identify possibilities for the reduction of the environmental impact at different phases of a products' lifetime. With these information decision-makers can set goals and formulate strategies [4].

## 2. Sustainable Kanban-bins

### 2.1. Kanban-cycle

Kanban is a specific production control method. It works according to the pull-principle. The 'Kanban' is a card, an empty box or in a digitalized world just a signal to inform a supplying process about material requirements. This results in low inventory and small cycle times. Especially C-parts like screws are stored and transported in specific boxes.

### 2.2. Fiber compounds for bin production

Polypropylene is a thermoplastic polymer and commonly used for the production of packaging and plastic bins. After the use phase the polymers are mostly energetically utilized and in smaller proportion recycled. In Germany 61% of the plastic waste is incinerated, 38% is recycled [5]. The recycling process is possible for collected waste with a single-variety. Crude oil is the basis for the polymer production. To reduce the environmental impact of the polypropylene production bio-based fibers are used as a compound in plastics production. The bio-based plastics can consist of 100% bio gradable components or they can have co-polymers from non-renewable resources. Alvarez-Chavez et al. point out that "it is important to understand the flow of these materials and their adverse impacts in all parts of their life cycles in order to select a material that is more sustainable" [6].

A recent approach to integrate bio-based fibers in plastics is done by sunflower fibers. By processing sunflower kernels to various products the waste hulls are used as an additive for plastics compounding. Up to 50% by weight of the sunflower hulls can be used together with polypropylene. The company *Golden Compound* [7] introduced in cooperation with the company *Würth* [8] a sustainable Kanban-bin, containing 35% of sunflowers hulls and 65% polypropylene. Although a complete life cycle assessment has not been carried out yet, the energy reduction in the production process should decrease by 25-30%. Whereas the production of straight polypropylene is quite energy-intensive. This results in a high emission of greenhouse gases. On the other hand the growing of sunflowers have a negative emission value due to the consumption of carbon dioxide during the growth phase of the sunflowers.

In terms of a life cycle assessment not only the production phase but also the use and recycling/ disposal phase have to be taken in consideration. Is there still a positive impact on the environment if a complete life cycle assessment is done?

Therefor a typical scenario is constructed and a life cycle assessment is carried out. The different scenario are first analyzed by evaluating the single processes. After that a model based on the software-tool GaBi (Ganzheitliche Bilanzierung) is used. The scenario modelling is done for a conventional bin made of polypropylene and as well for the sustainable bin. The results are discussed and the main processes for reducing the environmental impact are identified.

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