Sustainability Life Cycle Assessment (SLCA) of RePack Packaging Bags

A report on sustainability of RePack polypropylene (PP) and polyvinyl chloride (PVC) bags
This report is based on a Sustainability Life Cycle Assessment (SLCA) of two designs of RePack’s packaging bags: 1) the polypropylene (PP) bag, and 2) the recycled PVC bag. The SLCA is a tool developed by The Natural Step that consists of a ten-step process aimed at identifying the degree of sustainability in key areas of a product’s life cycle. It helps in performing a quicker yet rigorous qualitative assessment, internal capacity building and communication around product sustainability.

Repack is a start-up company whose business model is based on the maximum utilization of packaging bags for online purchases through repeated use cycles. RePack’s packaging bags provide a sustainable alternative to one-time use conventional packaging. The main aim of this SLCA is to assess sustainability status of RePack’s packaging bags and propose a sustainability roadmap based on the assessment. The roadmap was proposed based on the sustainability assessment of PP bags because they are the third and the latest iteration of RePack’s packaging bags: recycled PVC bags being the second. In addition, the first iteration of the RePack bags were made of cardboard, however they are no longer in use due to their lack of durability.

SLCA suggested that RePack’s bags had achieved underlying progress while moving from recycled PVC to virgin PP as raw material. Despite the progress, factors such as raw materials and their sourcing, type of electricity and transportation fuel used, audits, purchasing guidelines, and a code of conduct are needed to be considered to increase their eco-effectiveness. A sustainability check for RePack’s PP bags was also done based on the criteria of the Sustainability Packaging Coalition (SPC), which suggested similar considerations as SLCA. A roadmap to sustainability was proposed based on the shortcomings highlighted by SLCA separating the business timeline into current status, intermediate status, and aimed status. While moving from current to intermediate status, use of renewable and recycled raw materials, use of renewable electricity, and renewable based fuel in transportation were the proposed additions. Similarly, audits of suppliers, purchasing guidelines, and code of conduct were the additions to be considered while moving from intermediate to aimed status.
List of Figures

Figure 1: Waste management hierarchy of the European Commission [3] .................................. 1
Figure 2: The use cycle of RePack packaging bags [1] .................................................................. 2
Figure 3: Sustainability principles and the process of identifying sustainability in product’s life cycle [4]. ................................................................................................................................. 3
Figure 4: System boundary of RePack PP bags .................................................................................. 5
Figure 5: RePack polypropylene bag [1] ............................................................................................. 6
Figure 6: System boundary of RePack PVC bags studied in the SLCA .................................................. 6
Figure 7: RePack’s recycled PVC bag .................................................................................................. 7
Figure 8: Result of SLCA of RePack PVC bags .................................................................................... 8
Figure 9: Result of SLCA of RePack PP bags ......................................................................................... 9

List of Tables

Table 1: Criteria of sustainable packaging set by SPC and their acceptance by PP bags .... 11

Abbreviations

FSSD   Framework for Strategic Sustainable Development
GHGs  Greenhouse Gases
PP     Polypropylene
PVC    Polyvinyl chloride
SLCA   Sustainability Life Cycle Assessment
SPC    Sustainable Packaging Coalition
TNS    The Natural Step
Contents

Introduction ........................................................................................................................................... 1
Background .......................................................................................................................................... 1
RePack ................................................................................................................................................ 1
Sustainability Life Cycle Assessment (SLCA) ..................................................................................... 3
SLCA of RePack’s Polypropylene and recycled PVC Bags .............................................................. 4
Methodology .................................................................................................................................... Error! Bookmark not defined.
Goal and Scope.................................................................................................................................. 4
RePack’s PP Bags- Life Cycle Phases ............................................................................................ 4
RePack’s Recycled PVC Bags- Life Cycle Phases ........................................................................... 6
Sustainability Assessment and Roadmap to Sustainability ................................................................. 7
Results ................................................................................................................................................ 8
Roadmap to Sustainability ............................................................................................................... 14
Conclusion ......................................................................................................................................... 1
References ......................................................................................................................................... 2
Introduction

Background

Human population has already passed the seven billion mark and it is on a steady rise. Alongside population, our per capita consumption of resources is shooting up, as well as pressure for economic growth. With these two factors acting in one direction, the finite resources available in nature are sure to become depleted in a near future. Besides resource depletion, there are many other environmental calamities such as global warming, wildlife extinction, and severe weather conditions on the way for mankind to face.

RePack

A solution to these grave and ever-increasing problems is the goal of sustainability. RePack packaging is a step in that direction. This report is based on a sustainability life cycle assessment (SLCA) of RePack’s two flagship products: polypropylene (PP) and polyvinyl chloride (PVC) bags. Based on its four sustainability principles, which provide a principled and science-based approach, the SLCA aims to figure out the unsustainable areas within the life cycle of a product, service or a company. It assists in developing a road map or important steps to be taken in the course of reaching a target where activities are the most sustainable possible.

RePack is a sustainable alternative to conventional packaging such as cardboard, paper and plastic for online retailers and shoppers because of its numerous use phase cycles [1]. Reuse of a material is seen as the first and best option in waste management hierarchy of the European Commission as shown in Figure 1. It closes the loop in a product’s life cycle which brings numerous benefits such as the need to extract virgin materials from the Earth’s crust is avoided, amount of waste is decreased, pollution is prevented and money and energy are saved [2]. In RePack’s business model, the packaging bag enters its End-of-Life phase only after its use is exhausted. Thus, the sustainable aspect of RePack can be seen from its business model. That is, RePack allows customers to conveniently return their used packaging by post and it will be reused for the next delivery, up to 20 times for the current product design [1].

Figure 1: Waste management hierarchy of the European Commission [3]

When one makes an online purchase choosing RePack packaging, he/she pays a refundable deposit. RePack packaging is designed such that, after one removes the purchased item, it can be easily folded and returned via post without the need of postage stamps [1]. The entire process of how RePack packaging works is well described in the Figure 2.
2. Open your parcel and flatten RePack.
3. Simply mail the RePack. No postage stamp required.
4. Receive your deposit online.
5. The RePack will be re-used.

Figure 2: The use cycle of RePack packaging bags [1].

The reuse model of RePack was inspired by beverage cans and bottles collection system that is in practice in Finland with approximately 98% return rate [1]. Please refer to RePack website in [1] for further details.
Sustainability Life Cycle Assessment (SLCA)

The sustainability life cycle assessment is a tool developed by The Natural Step that consists of a ten-step process aimed at identifying the degree of sustainability in key areas of a product’s life cycle. It helps in performing a quicker yet rigorous qualitative assessment, internal capacity building and communication around product sustainability [4]. The ten steps of SLCA combine the requirements of the ISO standard for Life Cycle Assessment with strategic planning methodology of the Framework for Strategic Sustainable Development (FSSD) [2]. These ten steps of SLCA are listed below:

1. Setting goal and scope
2. Creating a shared definition of the sustainable product system
3. Define the system boundaries and life cycle scenario for the sustainability assessment
4. Conduct an inventory analysis of the life cycle
5. Sustainability assessment – Use the sustainability principles to assess sustainability strengths and weaknesses
6. Analysis & synthesis of results – Identifying key impact areas
7. Brainstorm possible solutions
8. Prioritize solutions
9. Create an innovation roadmap
10. Measure and report progress (ongoing)

The sustainability principles mentioned in Step 5 of SLCA are the system conditions of a sustainable society set by The Natural Step which form the ‘trunk and branches’ of their approach to strategic sustainable innovation and development. Figure 3 shows the system conditions and the process of identifying sustainability in different phases of product’s life cycle.

![Figure 3: Sustainability principles and the process of identifying sustainability in product’s life cycle [4].](image-url)
The questions related to each sustainability principles are divided into two categories: impact and progress questions. With the first, the impacts of present practices in the life cycle of a product are assessed. With progress questions, the practices that should be included in the product’s life cycle are assessed. Please refer to the link in [4] for further details on SLCA process.

Methodology

SLCA of RePack’s Polypropylene and recycled PVC Bags

This report is based on the SLCA of two RePack bag designs. RePack is a new direction in the packaging business and the company owners were interested in testing the sustainability of their product using the holistic approach of The Natural Step (TNS) and the SLCA. Therefore, the main aim of this SLCA of RePack bags was to identify their sustainability using TNS’s framework [2]. This was an excellent opportunity for Natural Interest, newly the Finnish office of TNS to gain valuable experience and test the implications of SLCA on a product.

The SLCA was performed according to the steps mentioned above (with the exception of step 10) but only important steps are described within this chapter. Upon agreement with RePack representatives, the shared definition of sustainable product system was agreed to be the one where activities within life cycle phases of the bags are the most sustainable as revealed by the sustainability assessment (step 5). In other words, RePack’s sustainability goal is to achieve full practical sustainability in its products’ life cycle.

This report and study concludes with a suggested roadmap to reach the ultimate goal of becoming sustainable throughout the whole life cycle.

Goal and Scope

The main aim of this SLCA was to test the sustainability of RePack bags using The Natural Step framework and prepare a roadmap for further innovations to reduce the associated negative impacts on the environment and socio-economic wellbeing of people, and increase the utility of packaging systems to fulfill customer needs.

The first design of RePack’s bags was made of cardboard. However, upon testing, its durability found to be was lacking. Next, RePack designed a bag made of recycled polyvinyl chloride (PVC), but it also failed to meet the expected durability standards. In addition, the PVC bag was fairly heavy considering its use as packaging material.

For the third version, virgin polypropylene (PP) was used as raw material. Currently, PVC and PP bags are considered the flagship products of RePack. For example, Globe Hope, a Finnish company that designs and manufactures ecological products from recycled and discarded material, is one of RePack’s partner companies that uses recycled PVC bags as packaging material for its online purchases. Another partner, Varusteleka, is using RePack’s PP bags for its online purchases.

RePack bags are currently used only in Finland. Thus, the phases’ impacts are analyzed based on assumed practices and activities occurring within Finland, such as working conditions, salaries of workers, and end-of-life options. A few exceptions include assumptions made on the raw materials phase where PP woven fabric was assumed to be produced in Sabic’s factory in Saudi Arabia. As an aside, these assumptions could be at least partially removed through increased transparency into the supply chain of products and raw materials.

RePack’s PP Bags- Life Cycle Phases

System Boundary

As set by the 10-step process of an SLCA, the third step is to define the system boundaries of the product being analyzed. This helps organizations visualize their own material and energy flows, as well as factors over which they have no influence. The system boundary studied in the life cycle of RePack’s PP bags is shown in Figure 4. The entire lifecycle is divided into five different phases: Raw material, Production, Packaging, distribution and retail, Use, and End-of-life phases.
Figure 4: System boundary of RePack PP bags.

Raw material
The raw material used in RePack PP bags is mostly virgin polypropylene. Other parts of bag include a Velcro strap, a sticker and prints. For the sake of speed and agility during the first round, only polypropylene is included in the analysis.

Production
The production of bags was done in a factory in, Finland. According to manufacturer, the fabric used in making these bags was woven PP. The main suppliers of woven PP fabric are Borealis in Turkey and Sabic, a petrochemical manufacturer in Saudi Arabia. Oil is the primary raw material in PP fabric production but due to lack of information on the exact site of extraction and refinement of oil, it was assumed that the oil was produced in the Kingdom of Saudi Arabia and questions related to raw material phase would be answered based on answers found on Sabic’s website and from RePack’s executive decision makers (especially the progress questions).
Packaging, Distribution and Retail
The packaging that delivers RePack’s PP bags to the warehouse is also made of polypropylene, which is recycled by RePack after the bags are taken out for use. According to a representative from the manufacturer the deliveries are normally made through the logistics company, Itella.

Upon RePack receiving orders from partners (or retailers), the bags are dispatched by RePack via Itella.

Use phase
During the use phase, items are sent to online shoppers in RePack’s bag for their online purchases via Itella. After the bag is emptied, customers can simply fold and strap it using the Velcro strap of the bag and drop it to the post box. From there, it is delivered to Itella’s sorting center and then to RePack warehouse. This cycle of use from RePack’s warehouse to retailers, retailers to customers, and customers to RePack’s warehouse via postal company is expected to last for an average of 20 cycles.

End-of-Life
The end-of-life option for these bags is recycling. Thus, when they get worn out after repeated use, they undergo mechanical recycling in a plastic recycling center.

RePack’s Recycled PVC Bags- Life Cycle Phases
Globe Hope, a Finnish company that designs and manufactures ecological products from recycled and discarded material, for its online purchases, uses RePack’s recycled PVC bags. Globe Hope also manufactured the recycled PVC bags.

System boundary
Figure 6 shows the system boundary involved in the SLCA of PVC bags. As with the PP bags, PVC bags also have five life cycle phases: raw material, production, packaging, distribution, and retail, use, and end-of-life.
Raw materials and Production
Information regarding raw material and production phase was requested from Globe Hope but the information was not acquired, as RePack’s main contact was not available during the duration of the SLCA and the bags are no longer in production. Therefore, certain assumptions on those phases were made based on expert knowledge of how plastic recycling and processing works.

During the raw material phase, PVC waste was assumed to be collected at the source and sorted at the waste centers. The fabric used in making bags is nonwoven PVC fabric, assumed to be produced by extrusion of recycled PVC resins, and then sewn to make bags. The bag also contains prints and a Velcro strap, but they were not included in the analysis. Packaging of these bags was assumed to be made of PP, similar to the case of the recycled PVC bags explained above. Figure 7 shows RePack’s recycled PVC bag.

Figure 7: RePack’s recycled PVC bag.

Packaging, Distribution and Retail, and Use
The distribution, packaging and retail phase, as well as the use phase are assumed to be similar to that of PP bags (described in above). However, but the number of cycles of use is less than PP bags as PVC bags were found to wear out faster than PP bags.

End-of-Life
The end-of-life option for PVC was assumed to be landfill, as recycling of PVC is not practiced in Finland due to lower volume of waste generated, and incineration of PVC is not allowed [5; 6]. The bags may end up in landfill from either RePack’s warehouse or from customers.

Sustainability Assessment and Roadmap to Sustainability
The current sustainability status of RePack bags was assessed by answering a questionnaire which consists of carefully directed questions in the SLCA for each of the life cycle phases [4]. These questions were answered in a software platform, Ouro, developed by Nativa Lab, affiliated with TNS in Italy [7]. The questions first assess the impact of the product based on four sustainability principles (shown in Figure 3). Alongside impacts, the questions also try to identify if there are any targets of the related company in making sustainable changes within the life cycle of the product, again based on sustainability principles. Thus, the questions are divided into impact and progress categories. The impact questions were answered based on information available from companies that were involved during respective life cycle phases of bags while progress questions were based mostly on RePack’s targets with an exception of use phase’s progress questions (related to transportation and energy use) which are all based on postal company’s targets (again, Itella). After the questions were answered, the software gave a result in the form of colors for each sustainability principle in each life cycle phases: green for the most sustainable and red for the least sustainable. The process and color-coding are effective for 1) product sustainability assessment, 2) communications to business leaders, and 3) education around TNS’s principled approach to sustainability.

The next step in the SLCA was the identification of key impact areas and brainstorming of possible solutions for respective unsustainable areas. Solutions were prioritized based on various factors such as cost, available technology, and practicability. Finally, an innovation roadmap was created and presented to the company for approval. In this SLCA, the innovation roadmap was designed for RePack’s PP bags, as the recycled PVC bags are not in production anymore.
Results

In this section of the report, the results of the SLCA are presented and a roadmap to sustainability is proposed for RePack packaging bags. As mentioned earlier, roadmap was designed based on the impact of PP bags and RePack’s vision of sustainability in their packaging bags. A general study was also made on prerequisites of sustainable packaging to understand the sustainability status of the bags.

SLCA of PVC bags

Figure 8 shows the result of SLCA of PVC bags. As seen from the figure, further sustainable development is possible on the raw material, production, and end-of-life phases, especially on the activities related to sustainability principles 1, 2, and 3.

![Figure 8: Result of SLCA of RePack PVC bags.](image)

The unsustainability of PVC bags shown by SLCA can be traced back to factors listed below:

- PVC being a plastic is made from oil, which is scare in nature. In addition, PVC does not degrade naturally and is highly persistent in nature.
- Use of fossil based fuel and energy in extraction, production, and transportation of raw materials and in the use phase.
- Use of persistent material (plastic) in packaging.
- Landfilling as the only end-of-life option available in Finland for PVC waste.

As can be seen from the result, Sustainability Principle 4 has been well followed by all life cycle phases of the bags, while the use phase is the most sustainable phase. RePack’s business model focuses in making the use phase of their packaging bags uniformly sustainable. The result being that, this SLCA verifies their attempt to head in the right direction.

SLCA of PP bags

Figure 9 shows the result of SLCA of PP bags. Comparing this with the result of SLCA of PVC bags, PP bags have achieved greater sustainability. End-of-life and production phases have moved up in terms of sustainability in all of the sustainability principles.
Figure 9: Result of SLCA of RePack PP bags.

Despite the underlying progress achieved by PP bags, there are a few factors that can move them upward in the sustainability index that are listed below:

**Raw Material and Sourcing**

PP is a material primarily made out of oil. In this case, it is based on fossil oil. With an extensive amount of energy spent on extraction, transportation, refining, and processing of oil, problems such as pollution, global warming, and other emissions arise. Furthermore, PP is a plastic and persistent in nature which decreases its eco-effectiveness as per Sustainability Principle 2.

The raw material used is virgin PP. Use of virgin materials in products promotes extraction of resources from nature and thus, adds stress to nature’s ecosystems, which is a negative effect as per Sustainability Principle 3. Thus, one of the factors that decreased PP bags’ sustainability was the use of fossil based virgin raw material.

**Energy Source**

The electricity used in most phases of these bags was assumed (due to lack of exact information) to be derived from fossil based sources because only about 28% of energy consumed in Finland in 2011 was based on renewables [8]. Due to use of fossil based electricity, the sustainability of PP bags during the production especially phase decreased in the SLCA.

Fossil based electricity also emits Greenhouse Gases (GHGs) into the atmosphere at a rate much higher than would naturally occur in nature.

Fossil based electricity is a driving force in climate change, which undeniably disturbs natural systems.

**Fossil Fuel in Transportation**

Transportation during all life cycle phases of PP bags was assumed to done by fossil based fuels based on widespread use of fossil fuels in logistics and other transportation. Similar to the use of fossil fuel derived electricity, use of fossil fuel in transportation also decreases the bags' sustainability ranking in Sustainability Principles 1 and 2.
Audits, Purchasing Guidelines, and Code of Conduct

Currently, RePack doesn’t have clear purchasing guidelines for suppliers or a Code of Conduct for its business. Also, there is a lack of regular auditing of raw material, packaging, and the distribution supplier. These factors are largely a matter of business scale, as RePack is in its start-up phase. RePack is a very small company at the moment and it is not feasible or an absolute necessity to have such guidelines and audits for its business activities. Such factors have affected negatively in all sustainability principles of certain life cycle phases.

Sustainable Packaging Coalition standards

This part of report is an additional section included to check the sustainability of RePack packaging with the standard set by Sustainable Packaging Coalition (SPC) that has about 200 members including big corporations like The Coca-Cola Company, FedEx, and UPS [9]. Table 1 shows the criteria of sustainable packaging as set by SPC. In the same table, the criteria met or unmet by PP bags are also shown, using “Yes”, referring to criteria met and “No” referring to the criteria unmet.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Criteria met/unmet?</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is beneficial, safe &amp; healthy for individuals and communities throughout its life cycle;</td>
<td>Yes</td>
<td>PP is non-toxic</td>
</tr>
<tr>
<td>Meets market criteria for both performance and cost;</td>
<td>Yes</td>
<td>PP is cheap and durable</td>
</tr>
<tr>
<td>Is sourced, manufactured, transported, and recycled using renewable energy;</td>
<td>No</td>
<td>Uses fossil based energy</td>
</tr>
<tr>
<td>Optimizes the use of renewable or recycled source materials;</td>
<td>No</td>
<td>Fossil oil based material</td>
</tr>
<tr>
<td>Is manufactured using clean production technologies and best practices;</td>
<td>Yes</td>
<td>PP weaving is fairly clean technology</td>
</tr>
<tr>
<td>Is made from materials healthy throughout the life cycle;</td>
<td>No</td>
<td>PP is persistent</td>
</tr>
<tr>
<td>Is physically designed to optimize materials and energy;</td>
<td>Yes</td>
<td>Multiple sizes, light-weight, scalable</td>
</tr>
<tr>
<td>Is effectively recovered and utilized in biological</td>
<td>Yes</td>
<td>Mechanically recycled</td>
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and/or industrial closed loop cycles.

<table>
<thead>
<tr>
<th>Criteria of sustainable packaging set by SPC</th>
<th>Acceptance by PP bags</th>
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Table 1: Criteria of sustainable packaging set by SPC and their acceptance by PP bags.

As seen from Table 1, RePack PP bags meet five out of eight criteria set by SPC as a sustainable packaging. The criteria unmet are also the ones concluded by SLCA to be unsustainable. This criteria check was useful in providing more assurance on the unsustainable aspects of PP bags’ life cycle.