

OBSTACLES IN THE TEXTILE UPCYCLING CHAIN

—A CASE STUDY OF THE COMMUNICATION
BETWEEN SMALL-SCALED UPCYCLING
ACTORS AND THEIR PROCESSES.

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SAMMANFATTNING

Återbruk av textilier är en väl omtalad metod för att ta vara på använda textilier för att minska på miljöpåverkan som kommer från textilindustrin. Många snabbt modeväxlande företag har försökt implementera återbruk i deras egna värdekedjor för att bli mer cirkulära. Även om tanken är god, så är det mer som behöver göras för att få en bättre effektivitet när det kommer till att återbruka textila modeprodukter.

Syftet med rapporten var att undersöka hinder i den textila återbrukskedjan hos småskaliga aktörer som ägnar sig åt designdriven återbruk. Rapporten utreder dels en specifik textil värdekedja som grundar sig på att omdesigna hemtextilier som kommer ifrån textilt konsumentavfall. Rapporten utreder samarbetet mellan leverantör, designer och tillverkare i denna specifika värdekedja. Detta genom att redogöra för deras nuvarande kommunikation och processteg. Studien avser att ligga till grund för skapandet av kommunikationsverktyg för aktörer som arbetar liknande.

Re:textile på Science Park Borås är en verksamhet som jobbar med att utveckla nya designmetoder, företagsmodeller samt produktionssystem i textilindustrin för ett bättre cirkulärt flödessystem. Samarbetet med Anna Lidström, Konstnärlig Ledare på Re:textile gjorde det möjligt för författarna att undersöka återbruksindustrin och identifiera bristerna i förproduktion och produktionsprocessen.

För insamling av information till denna rapport har datainsamling och intervjuer med svenska företag gjorts. Företagen som ställde upp på intervju var ifrån olika verksamheter i den textila återbruksindustrin. Företagen var Rave Review, XV Production, Björkåfrihet och SIPTex. Information från intervjuerna bidrog till underlag för en analys. De semi-konstruerade intervjuerna varierade med både telefonintervju samt platsbesök. Sammanställningarna från intervjuerna har med aktsamhet använts för få svar på rapportens frågeställningar.

Slutsatser redogörs som hinder för den textila återbrukskedjan hos designdrivna småskaliga aktörer. Ett hinder är bland annat att tillgodose större kvantiteter av textilt konsumentavfall som håller samma kvalitet. Ett annat hinder är att säkerställa kvalitén av produkten genom värdekedjan till kund. Ett tredje hinder är att kommunikationsverktygen inte är skrivna enligt några principer vilket bidrar till misstag i tillverkningsprocessen.

Nyckelord: Återbruk, Textilindustri, Hållbar produktion, Kommunikationsverktyg, Småskalig

ABSTRACT

Upcycling of textiles is a well-known method to remake worn textiles and decrease the environmental impact coming from the textile industry. Many fast fashion companies have tried to implement upcycling in their own textile value chains to become more circular. Although the effort is good in theory, there is more to be done to get better efficiency when it comes to upcycling textile fashion products.

The purpose of this report was to study the obstacles in the textile upcycling chain for small-scaled actors that are engaged in design driven upcycling. This report partly investigates a specific textile value chain that is based on redesigning home textiles that comes from textile consumer waste. The report investigates the collaboration between supplier, designer and manufacturer in this specific value chain. This was by outlining their current communication and process steps. The report intends to form a ground for creation of communication tools for actors working similarly.

Re:textile at Science Park Borås is a project that is working towards developing new design principles, business models and production systems in the textile industry for a better circular flow system. The cooperation with Anna Lidström, Artistic Director at Re:textile, made it possible to investigate the upcycling industry and identify the obstacles in the pre-production and production process.

For collecting information for this report, data research and interviews with Swedish companies have been done. The companies that attended the interviews were from different companies in the textile upcycling industry, that were provided with as much information as possible for the analysis. The companies that attended the interviews were from different companies in the textile upcycling industry. The companies were Rave Review, XV Production, Björkåfrihet and SIPTex. The information from the interviews contributed a ground for the analysis. The semi-structured interviews varied from telephone interviews and visits. The compilations from the interviews have been carefully used to answer the reports research questions.

Conclusions are presented as obstacles for the textile upcycling chain at design driven small-scaled actors. One obstacle is to cater bigger quantities of textile consumer waste that keeps the same quality. Another obstacle is the way of ensuring the quality of the product through the value chain to consumers. The third obstacle is that the communication tools are not written according to any principles which contribute to mistakes in the manufacturing process.

Keywords: Upcycling, Textile industry, Sustainable production, Communication tools, Small-scaled

ABSTRACT IN POPULAR VERSION

Today, the textile industry is the leading environmental villain in the world, both when it comes to manufacturing and consuming garments. At some point, the garments reach their “end-of-life” that leads to discarding the product or sell it as second-hand. 95% of the total amount that is put to waste are still in good quality and therefore can be used again. Still, there are millions of tons of textiles that are discarded each year around the world. One waste management method that are well mentioned is the upcycling of textiles. Upcycling means to remanufacture or redesign the used garment in order to extend its usage phase and give the garment a “second life”.

Re:textile at Science Park Borås is working with several research groups and is well mentioned in Sweden and abroad. Re:textile aim to develop and encourage new design principles, business models and production systems that enable circular flows in the textile industry. This report investigates obstacles in one specific textile upcycling chain which include Rave Review, XV Production and Björkåfrihet. The companies are all included in Re:textiles projects as active actors of upcycling.

From the interviews, weaknesses were identified to investigate further in the report. The main obstacles in the textile upcycling chain were to collect bigger quantities of materials and the low efficiency in the cutting process. Other obstacles are that the specifications are not written to any principles that results in a confusion in where the responsibility lies. The conclusions indicate, better communication tools are needed for a more efficient upcycling chain and would also lead to better control and quality for the upcycled textile product.

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We would like to thank the staff at the Swedish School of Textiles in Borås, especially our supervisor Joel Peterson, Senior Lecturer in knitting technology and supply chain management, who has helped us through the process. We would also like to thank our collaborator Anna Lidström, Artistic Director at Re:textile for the inspiration, involvement and huge knowledge in this area.

At last, we would like to thank those who lined up for the interviews and shared their work, expertise and experiences. XV Production in Borås, Rave Review in Farsta, Björkåfrihet in Gothenburg and SIPTex project at IVL (Swedish Environmental Institute) in Stockholm. The opportunity to visit XV Production and Björkåfrihet gave us Textile Engineers a view of reality and better knowledge of production and sorting of textiles.

The research and the writing of the report have been divided equally.

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CONCEPTS

Upcycling- A waste management method, adding value to an object to be reused.

Remanufacturing- Uses discarded products as a raw material instead of virgin materials.

The Rs- A waste management method called the 6R:s- Reduce, Recycle, Recover, Redesign, Reuse and Remanufacture.

Traditional textile industry- Is the industry using virgin materials and accessories to manufacture new garments.

Pre-consumer waste- The waste material before reaching the consumer. Also called post industrial waste.

Post-consumer waste- The waste material after reaching the consumer, “end-of-life” products.

Semi-structured interview- An interview method that have prepared questions asked in the same order for the candidates.

Value chain- Is the chain from designing a product to be finished and out on the market.

Open loop system- A system where the waste in material and energy are not reused in the manufacturing loop.

Closed loop system- A system where the waste material and energy are reused in the manufacturing loop.

Flow chart- A visual representation of the operations made to produce the garment.

Communication tools- Documents with the details for making the required product.

Tech Pack- A communication tool that show all the details for manufacturing a specific product.

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1 INTRODUCTION

This chapter provides an overview of the topic in research and a description of what the report will investigate. Based on the state of the art, research questions and purpose for this report are presented. The research questions are the main focus of this report.

1.1 BACKGROUND

The fashion industry is a key economic sector. The industry is worth around 2.5 trillion dollars and employs over 75 million people worldwide (UNECE 2018). Ever since the quantitative restrictions on global textiles and clothing trade expired, the textile industry has been able to meet the markets demand regarding fast fashion. This because of the profound reconfiguration of the supply chains. Today, successful companies work with supply chains with short delivery cycles including fabric production, material sourcing and finishing processes (WTO 2013). The industrial development for a manufacturer with more efficient technology has moved to a smaller environmental impact. However, studies show that production and consumption have increased to the level where the benefits of industrial development are reduced (Niinimäki & Hassi 2011). From 2002 to 2015 the sales of clothing have risen from 1 to 1.8 trillion dollars and are projected, according to Greenpeace, to rise with 0.3 trillion dollars by 2025 (Greenpeace 2016). In a study from Mistra Future Fashion, they motivate different strategies for making fashion more sustainable. For fast fashion, they claim that the recycling process of the manufacturing needs to be more effective. Also, to not prioritize high quality material for fast fashion products. Instead, use low value/ low quality material such as nonwoven. For slow fashion, the manufacturing process could be longer, but the design of the product must ensure a long active lifespan such as classic designs (Mistra Future Fashion 2019).

Waste – A part of the consumption habits is the unsustainable desires among customers such as short-term use and frequent clothing replacement (Niinimäki & Hassi 2011). When the clothes are discarded, they produce what is called post-consumer waste. 95% of the clothes that are thrown away could be used again, depending on the worn out state of the textile waste (Lu & Hamouda 2014). The total amount varies between countries. In the USA every year, 9.3 million tons are discarded and in Germany around 1.9 million tons (Fletcher 2014). Post-consumer waste means that the finished garments and textile materials have reached their “end-of-use” and therefore completed their cycle for use. The waste is often discarded in the trash or the dump, incinerated or pouring down the drain. For the textile industry, the textile can also be sent to second-hand. Upcycling companies are actors trying to take care of the post-consumer garments and textile materials and remake it into new fashionable garments. Unfortunately, many upcycling companies have it difficult to source for the materials that they require (Taha 2016).

Pre-consumer waste, also called post-industrial waste consists of waste material generated by the manufacturing processes. Pre-consumer waste is all the materials

that are put to waste before reaching the customer. Post-consumer waste materials are often used in the manufacturing process but are not included for recycling (Taha 2016). The quality of pre-consumer waste is higher than the post-consumer waste and are equal or even better than new fashion clothing (Fletcher 2014; Dissanayake, DGK, Sinha 2016).

Today, the numbers are indicating this massive waste as a problem. The European Commission has produced a waste framework directive (seen in Figure 1). The model indicates a priority order for waste legislation and policy for the EU Member State. This concerns all types of waste (European Commission 2019). Considering the environmental aspects of the apparel industry, companies are trying to take part in more innovative methods for their products and therefore be more circular. The global recycling from textile to textile is estimated as nonexistent. For Sweden, the majority of worn out clothes are incinerated. Only 5 % of the total textile waste is collected. For increased reuse and recycle, the collection and sorting need to be regulated (IVL 2020). If the garment is recycled, it is often with mechanical recycling where the fiber losing its value and is transformed into padding or isolation (Mistra Future Fashion 2019)

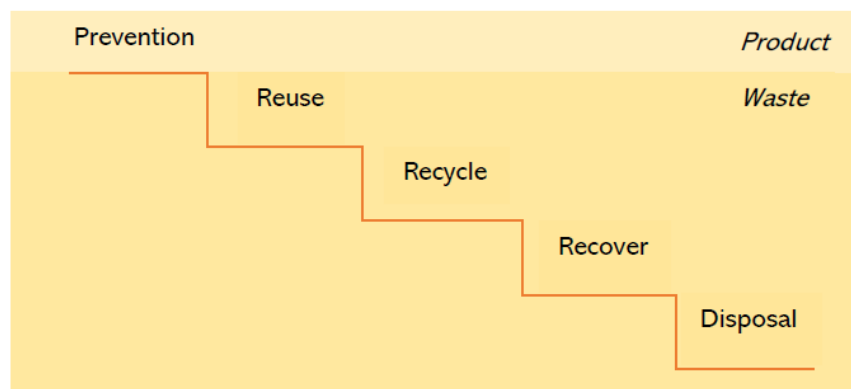


Figure 1. Waste management hierarchy (European Commission 2019) (Aguilar 2020)

The 6 R:s – In the apparel industry, there is one method for waste management called the 6R:s- Reduce, Recycle, Recover, Redesign, Reuse and Remanufacture (Jawahir, Dillon 2016). The method includes consideration of how any of the Rs can be applied in the product design phase of product development. The Rs will be one way to manage the produced waste when it has been discarded, and by this extend the products lifecycle. Critique has been pointed towards these management strategies. Even though the strategies help treat the waste issue, they fail to prevent the product from being produced in the first place (Fletcher 2014).

Remanufacture – In 2019, 80% of the garments environmental impact stemmed from the production phase (Mistra Future Fashion 2019). Remanufacturing uses discarded products as a raw material instead of virgin materials. According to Krystofik et al (2015), remanufacturing is therefore recognized as one of the best methods for sustainable production and managing waste (Krystofik et al. 2015). The general understanding of the definition of remanufacturing is described as a process of reinstating a discarded product back to its useful life (Lund 1996). In the

clothing industry, remanufacturing fashion products is seen as a new business opportunity, but today this business operates on a very niche market (Dissanayake & Sinha 2015). Remanufacture of fashion products requires an industrial process carried out in a factory environment and should serve the same function or end-use as the original.

Upcycling – In another way of remanufacturing of fashion products, second-hand clothes can be used as raw material and be upgraded. The Swedish company Rave Review work progressive in this field. They work, unlike other actors, with combining remade clothes with high end fashion (Rave Review 2019). Their final looks can be seen in Figure 2. For them and others, remaking clothes means some form of fashion upgrade. The upgrade contributes to a new design and gives the product a longer lifespan. As for the example above, Rave Review is a perfect example of what the definition of the activity of upcycling says. Fletcher (2014) describes upcycling in her book: “Upcycling, where the processed and practices of reclamation and reuse enhance a piece’s perceived value, quality and design capital, drawing upon a mix of factors including uniqueness of bespoke production, scarcity and preciousness of material, emotional engagement with past experiences and memories and craft skills of making” (Fletcher 2014).



Figure 2. Pictures from Rave Reviews look book 2020. Permission from Rave Review (Rave Review 2019)

1.2 RESEARCH GAP

Based on observations from Creative Director at Re:textile, Anna Lidström there is an absence of research regarding the communication between upcycling actors. This problem and the absence of solutions and research make it complicated for the upcycling business to be implemented in the industry. In the whole, this problem complicates the whole branch chances for sustainable solutions.

In the master thesis “Closing the value chain loop in the apparel industry” written by Petersson and Fahlén (2014) the Rs are discussed and analyzed. This, in order to answer the research questions in how a Swedish apparel company can develop their value chain towards a circular economy and what barriers exist for implementing a circular value chain. In their account of the upcycling process (in their paper identified as redesign) the theories about redesign processes are lacking. In their results, it states that redesign is the concept less explored in the scientific community and not as common in the business society.

In the study “Feasibility of Fashion Remanufacturing” authored by Pal et al. (2018) three projects were conducted. The potential for industrial models for remanufacturing (including redesign) was investigated. One of the projects that accounted for redesign activities on post-consumer waste was called “Scaled fashion remanufacturing”. Different design techniques were analyzed based on efficiency and input material. The study delivered value stream mapping for different redesigned products, a categorization system, financial models and critical success factors for the case to become feasible.

There are several other studies that present interviews with companies that are devoted to upcycling activities (Niinimäki & Hassi 2011; Sinha et al. 2016). However, not many studies write about the collaboration between actors such as the supplier, designer and manufacturer in the upcycling chain.

1.3 RESEARCH PURPOSE

Previously research on upcycling indicates a positive method for waste management. That is why the obstacles of the textile upcycling chain should be investigated. The purpose of this report is to research the communications and the production processes for one specific upcycling chain, based in Sweden. Also, to research how the chain can be improved and more effective. This is done by mapping out the restraints of the information flow in upcycling between the actors. The report aims to work as research for further specifications that could be implemented in the upcycling chain.

1.4 RESEARCH RELEVANCE

Companies in the textile industry have committed to UNs global goal of sustainability, Agenda 2030. Whereas one of the goals is to solve the climate crisis. Moving from linear to more circular business by for example using renewable sources is common. Waste management is included as a relevant part of circular business models and some states and companies are working towards improving the system for the ideas to accomplish. To be able to contribute research for upcycling businesses is motivating. There are companies that have taken the initiative to design upcycled products with a lack of knowledge in the engineering field. With expertise as textile engineers, our mission is to analyze production chains to be improved and more effective. Upcycling challenges our way of thinking and so the system. This way of thinking will strive towards accomplishing the UN goals by 2030.

In the traditional supply chain, the sheets for production are one of the most important parts. The sheets contain all the information and requirements for producing their garments. It is essential to have well designed sheets to attain good communication between the actors in manufacturing. Unfortunately, for a remanufacturing/- upcycling clothing company, the sheets are not so well designed. This can lead to unwanted challenges along the way.

1.5 RESEARCH QUESTIONS

- What are the identified weaknesses in the communication and production processes between small-scaled actors in a design driven upcycling supply chain of fashion products?
- What parts of the communication and production processes must be improved between the small-scaled actors in the design driven upcycling supply chain of fashion products?
- How can the identified weaknesses be improved in a design driven upcycling supply chain for small-scaled actors?

1.6 DELIMITATIONS

The report researches the production processes and communication tools used for a small-scaled design driven upcycling business in Sweden. The report does not contain any research on costs. The report is focused on post-consumer waste for upcycling. The criteria for the input materials are limited to home textiles. Since upcycling businesses differ, a general understanding of the whole upcycling industry cannot be adopted. For a more general conclusion more upcycling textile chains should be investigated.

2 THEORY

Before discussing the answers from the research questions. An understanding of the garment manufacturing process and the different systems that can be developed in the supply chain is needed. In this chapter, the focus will be explaining the loop systems in different supply chains such as the traditional way and the remanufacture loop systems. The theory about the communication tools will also be provided in this chapter.

2.1 REMANUFACTURING PROCESS

The pre-production process flow chart for remanufacturing looks a bit different from the traditional flow chart for the supply chain (see Figure 3). Partly that there are almost no/- or no new raw materials for the products. The raw material used is discarded garments and other materials that can be redesigned. The manufacturing looks different because of the materials that need to be analyzed before it can go further in the process design and remake (Sinha et. al 2016a).

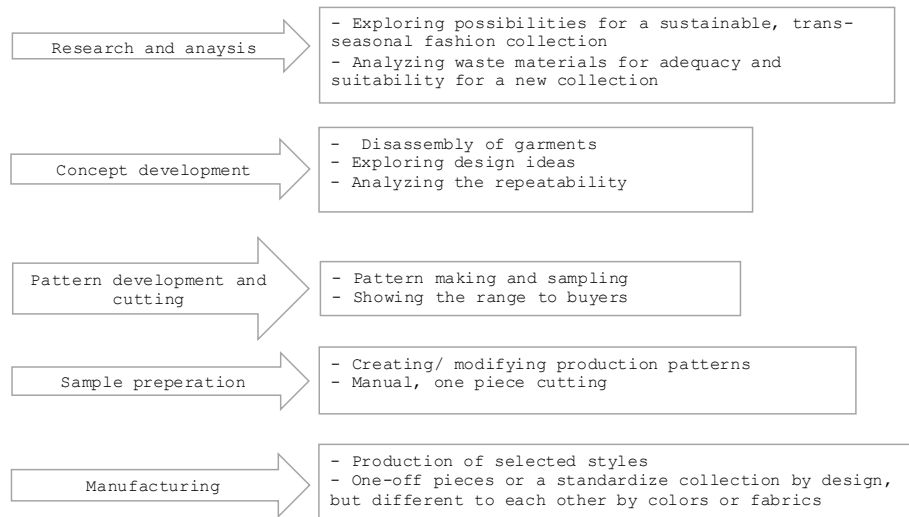


Figure 3. Remanufacturing process flow chart (Dissanayake and Sinha 2015) (Runstrand 2020)

2.1.1 Input materials in remanufactured fashion garments

Post-consumer waste from second-hand clothing is used as the input material for the remanufacturing process. In Sweden, the collection of second-hand material is taken from different sources such as charities, waste collectors, second-hand retailers and sorting facilities. Another waste is the pre-consumer waste, which in the fashion industry refers to products that are not sold. In plenty of business models, companies have their own return station where they receive their own products that are no longer in use, in exchange for a value check.

Sorting – In the report “Feasibility of Fashion Remanufacturing” authored by Rudrajeet Pal et al. the sorting process for a charity, which is one of Sweden’s largest, was described. Their process started with the supply of input material that

in this case were second-hand clothes. The second-hand clothes are sourced from sorting plants, but they also receive donations from fashion retailers. When the clothes arrive, they undergo a quality check. A large amount of what is received returns to the sorting plant. What is left is then sorted into different categories such as fabric material, size, style, the degree of how complicated it is to acquire the input material. Another factor that is important is which level of degree required for conducting the remanufacturing operations where the most difficult, according to this report, is the disassembly and reassembly stages (Pal et al. 2018).

Home textiles – TAUKEO is a design company in Finland working with upcycling. Their strategy to maintain a continuous material flow for the production is to work in close collaboration with Finnish and German textile service companies. Up to 60% of TAUKEOs input material is flat home textile materials such as bed linen or tablecloths. In an article written by Mila Moisio, TAUKEO arguments that home textiles are made to withstand heavy use yet feel silky and soft.

During the home textiles first life, the quality diminishes due to permanent stains, and/or the textile is worn out in certain parts. The defect textile is then considered discarded. The first life is considered shorter by hotels, restaurants and healthcare systems where they do not reach the quality needed for their service. This results in tons of waste of still high-quality material.

During their upstart of collecting materials, TAUKEO discovered quality differences between textiles produced before and after the year 2000. A conclusion drawn by the two designers and entrepreneurs of TAUKEO design was: the older the textile the better the quality and also, it fits better for fashion (Moiso 2018).

2.1.2 Quality standards and labelling remanufacturing garments

In the traditional clothing industry or any industry, there are certain quality standards that can be required to ensure the customer of the quality of the material. One example is furniture clothing that usually goes through a Martindale test. The test determines the abrasion resistance of fabrics. The test is conducted with a Martindale abrasion testing apparatus in the pre-production process (SIS 1999). Currently, the quality standards for remanufacturing are a bit difficult to implement. It is up to the designer and operator to have the knowledge and expertise of remanufacturing in good quality. Therefore, there is no guarantee that can give consumers the security of quality in remanufacturing garments. As a remanufactured clothing company, going from a small remanufacture market to a bigger mass market, the quality inspection must be standardized. This because quality is the key factor in the industry and that many remanufacturing companies today not fulfill the same standards as in the quality traditional industry (Sinha et. al 2016c).

Garment labeling is one of the most used quality standards in the textile industry and has the same base requirements for every country. It contains an identification of the garment fiber content, country of origin, and instruction of wash and care. Some countries have more strict requirements of the garment information than other countries, this because of the consumer protection purposes. Countries with more

strict rules are United States, United Kingdom, and Canada (Sewport 2020). There are also EU labeling requirements that have certain mandatory (Your Europe 2020).

One organization that is working with garment contents is the International Organization for Standardization (ISO), they have their own labeling standards that companies need to follow to get a certification on their product (Sewport 2020). GINETEX is a wash and cares labeling system with universal symbols for the textile industry. This system is for international use and has 22 members from Europe, South America, Africa, and Asia. They provide correct information care treatment of the textile products for the consumer and textile companies (GINETEX 2020).

A remanufacturing company requires the same rules of having garment labeling as for the traditional clothing industry. According to P, Sinha et al. (2016a), there is some confusion regarding the definition of “remanufactured fashion” and how to develop a significance for that kind of fashion. The problem today is that it is a complex regulation system when it comes to the license and quality standards for a remanufactured garment. A protentional way is to have some sort of international eco-label for a remanufactured garment (Sinha et. al 2016a).

2.2 OPEN AND CLOSED LOOP SYSTEMS

An open loop system means a supply chain for a company that works with a “straight line” of producing textile products. This leads to a negative effect on the environment because of not reusing the waste. Instead, emissions and energy are released to the environment. Other factors that affect the environment, as a consequence of the open loop system, are the chemicals, waste of water, landfill problems, toxicity to humans and animals, and other resources (Batelier 2018).

A discarded textile product can go to the landfill or incineration, meaning that the product is burnt, with or without making use of the generated energy. If possible, the product can be recycled, resold for reuse, used for internal reused, remanufactured, or be used for refurbishing (Sinha et. al 2016b). In the textile industry, many companies are trying to take care of its own material- and energy waste, called a closed loop system. A closed loop system is simply the opposite of the open loop system (Batelier 2018).

Companies that are working with this type of system result in a more sustainable way of producing textile products. In a closed loop system, the waste (water, energy, textile, and more) that comes from making the products are carefully taken care of. For example, the fashion remanufacturing industry collects garments from their own company or other suppliers and organizations and remake it to new fashionable garments.

Clothing companies have experimented to put their non-sold garments into a remanufacturing process to create a closed loop system and save energy and waste. One example is Lindex AB, one of the leading European fashion companies that have women- and kids wear and lingerie. In March 2017, they launched a collection of six garments for women, upcycled from their own Better Denim jeans from earlier

seasons. The collaboration and remaking of the denim were made with Re:textile at The Swedish School of Textiles in Borås (Lindex 2017). This type of action and others are one of many examples that clothing companies are trying to implement in the fashion industry.

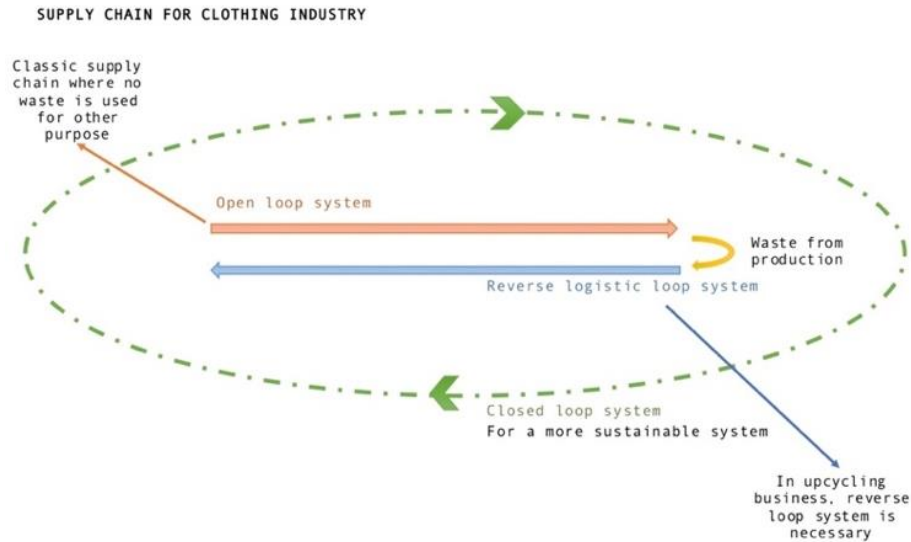


Figure 4. A clothing industry supply chain describing with the three different loop systems.

The closed loop system, shown in Figure 4, is the frontier when it comes to the responsibility of fashion. There is some difficulty for a closed loop system to be implemented in a viable way (Well Made Clothes 2017). In 2014, a Swedish company called Re:newcell collaborated with Smart Textiles in Borås and became the first in the world to make a garment completely made from recycled cotton (Höghskolan i Borås 2014). This technology method became the new generation of recycling textiles and was shown the ability to produce a fiber with comparable quality and price (The Guardian 2014). Even if companies have achieved this method in their textile chain, it is still a long way to be a fulfilled closed loop system. The responsibility also lies in the consumers who need to implement the recycling of their garments and not to send it to the landfill (Well Made Clothes 2017).

2.2.1 Reversed supply chain

Harvard business review explains a reversed supply chain as a series of activities required to retrieve a used product from a customer and either dispose of it or reuse it (see Figure 4). At manufacturers in different types of industries, the reversed supply chains are becoming an essential part of their business. There are five key sections which each can be analyzed concerning different variables such as costs and challenges. The five sections are Product Acquisition, Reverse Logistics, Inspection, and Disposition, Reconditioning and Distribution and Sales. Two sections are highlighted for this report for further investigation, that are presented below (Guide, Van Wassenhove 2002).

Product Acquisition – The quantity, quality and timing of the used products need to be carefully managed. It would be impossible to be efficient if having a huge stock with variable quality (Guide, Van Wassenhove 2002).

Inspection and disposition – The task to test, sort, and grade products are usually labor intensive and time consuming. The process could be more effective if the company subjects the products to quality standards. It is possible to use technology to automate the tracking and testing with sensors or bar codes. To organize the stock based on quality, product configuration, or other variables in the earliest possible stage will eliminate logistics costs and gets the remanufactures products to the market faster (Guide, Van Wassenhove 2002).

2.3 TRADITIONAL GARMENT MANUFACTURING PROCESS

In the manufacturing chain for a fashion clothing industry, there are several steps from the start of design to the finished product (see Figure 5). Some steps in the chain may vary, for example, the manufacturing process looks different depending on what materials to use, for what purpose, for what using area, the characteristics of the finished garment, production place, and so on (Sarkar 2013). The garment manufacturing process is divided into three steps, briefly described below.

Pre-production process – Different *samplings* are done for the buyer, so it fulfills the requirements. Examples of samples are fit sample, size set sample, salesman sample, production sample, shipment sample. The next step is production planning. After receiving the order, the sourcing of the right raw materials starts. The raw materials include the main fabrics, sewing threads, packing materials, hang tags, and accessories. FOB price (Freight On Board price) includes direct labor cost, finishing cost, raw material cost, overheads cost, profit, and margin. The last step is process planning and is the schedule of cutting and sewing the materials to garments (Texhour 2018).

Production processes – In this step, the production process can start. That includes cutting and sewing the garments (see Figure 6). In this part, it is decided how the production set-up line it is going to be and what quality tests should be performed (Sarkar 2017).

Post-production process – This part is the finishing part of thread trimmings, ironing (if required), folding, last inspections, packing, and shipment shown in Figure 7 (Sarkar 2017).

Figures 5, 6, and 7 are a major flowchart for a fast fashion garment manufacturing process. This flowchart can be described as an open loop system (see Figure 4) (Sarkar 2017).

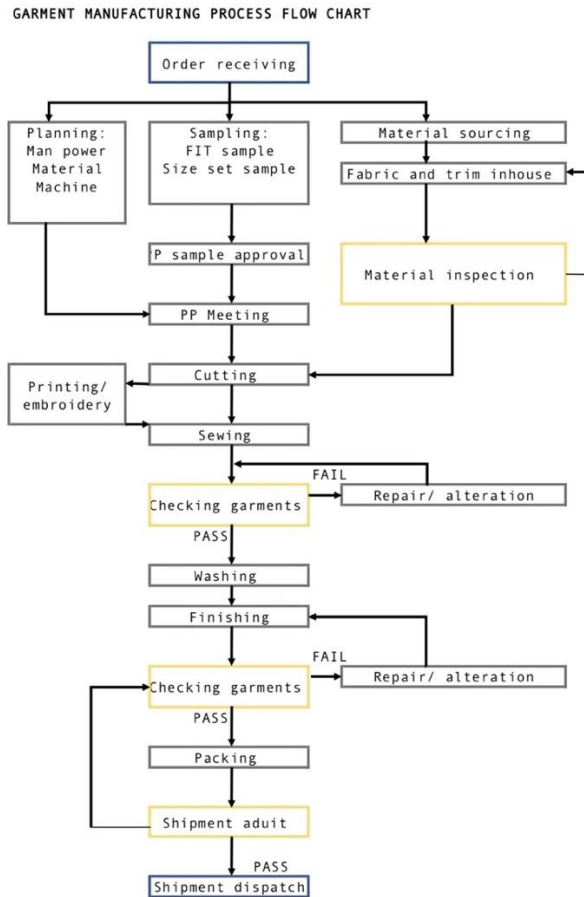


Figure 5. Garment manufacturing process flow chart (Sarkar 2017) (Runstrand 2020)

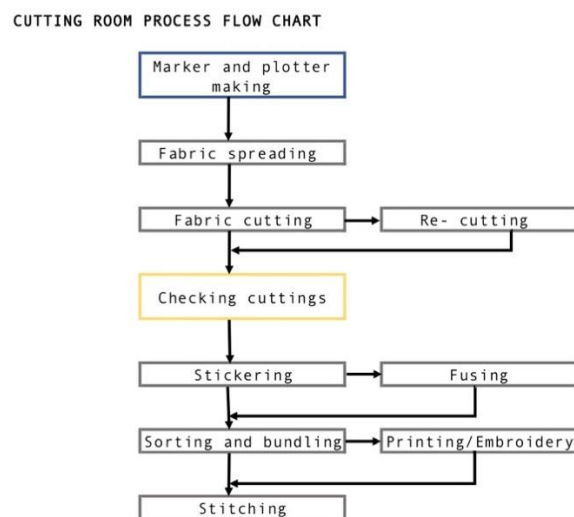


Figure 6. Cutting room process flow chart (Sarkar 2017) (Runstrand 2020)

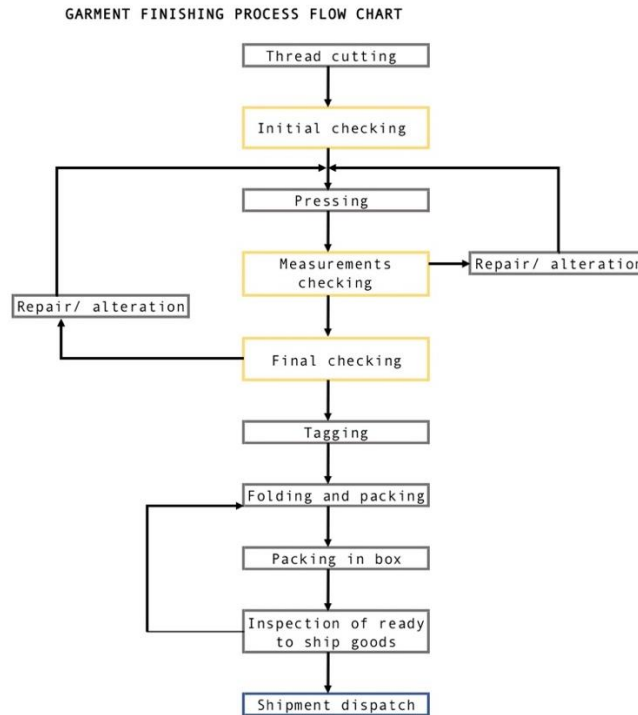


Figure 7. Garment finishing process flow chart (Sarkar 2017) (Runstrand 2020)

2.4 COMMUNICATION TOOLS FOR TRADITIONAL PRODUCTION

As a buyer/consumer, it always starts with the pre-production process that includes the research, design development, collection planning, line selection, and marketing of the product at their head office. After the product research, Tech Packs for the planned product is developed. A Tech Pack is the sheet of all the technical package. This document is necessary to have all the sources for the needs of creating an apparel product. The other communication tool is the Specification Sheet and this sheet gives more detailed information from all parts of the production chain. So, for a company in big or small quantities, there is a requirement for production to provide a Specification Sheet at the first step, followed by a Tech Pack (Fashion Insider 2017).

The Tech Pack includes:

- Styling details (front and back flat sketches of the product with and without color)
- Fabric and trims details (what materials that are going to be used and in what quantity)
- Color combo details
- Stitching details
- Graded specifications (that means the sizes of the product)
- Embellishment details (if required)
- Accessories details (buttons, zip strap and more)
- Labelling information and fabric details
- Quality control of fabric and garment

The purpose of the Tech Pack is to ensure the manufacturer that they have the same agreements of the product. It gives better efficiency in the production process and is more cost- and time saving (Shopology Project 2016).

The Specification Sheet includes:

- Product description
- All costing information
- Placement details (where it is going to be produced)
- Cutting info and sizes of accessories on the product
- Supplier details
- Product codes
- Quantity of products
- Finishing that is required example printing of fabric
- Material and trims

The purpose of a Specification Sheet is mostly to have a financial security position. If the manufacturers do not follow the information and requirements, then it is their responsibility to take care of the problems (Fashion Insider 2017).

3 METHODOLOGY

This chapter includes a description of how the report was structured and motivation behind this study.

3.1 RESEARCH DESIGN

The flow chart used for this research design is visualized in Figure 8. The flow chart is based on Robert K Yin Case Study Research (Yin 2014). Since the report does not test any theory but aims to develop theories it has an inductive approach (Bryman 2015).

For the collection of primary data, a qualitative method was necessary, meaning a small strategic sample with qualitative data and theoretic generalization (Svensson 2015). Leung states that qualitative methods aim to answer the question “how, when, who, and why” with an objective to develop a theory (Leung 2015). For this report, the primary data was collected through interviews. The semi-structured interviews were held with three different key actors of the specific textile upcycle chain and one automatized sorting facility. The actors were collected due to their partnership with Re:textile. Because of time constraints, no other textile upcycling chain could be investigated. The interviews varied in method, from a telephone interview to a visit at head office. Information such as date, time, and business size about the different interviews can be seen in Table 1. The time of interviewing was varying as well, but none lower than 30 minutes. The shortest time on the interview was 50min, the longest 1h 40min (see Table 1). According to DiCicco-Bloom. & Crabtree (2006), 30 minutes is the lowest time for a semi-structured interview. The questions were constructed in a way to attain discussion and to know the participants opinions. Find interview questions in Annex. Each interview and a summary of the data collection is presented in Chapters 3.2 and 4. To collect secondary data, a literature review was made. Using keywords to search in databases such as Google Scholar and DiVA portal. The selection for use was made based on relevance for our research and preferably peer-reviewed articles.

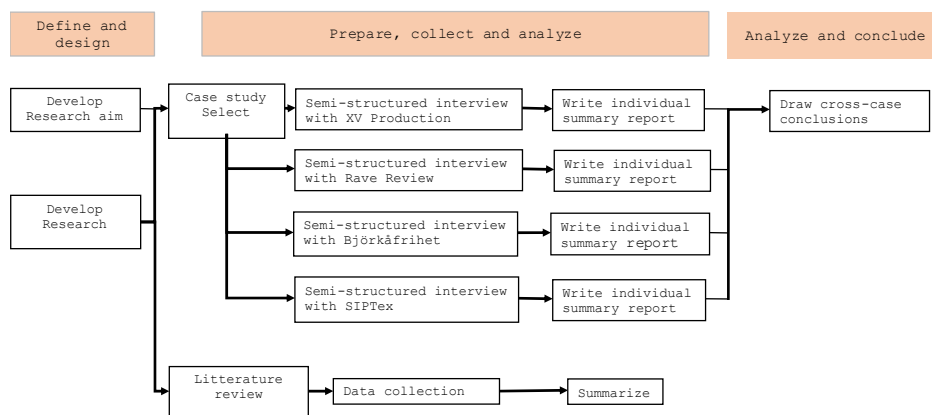


Figure 8. Flow chart of the reports research design.

3.2 COLLECTION OF DATA AND THEORY

To examine communication tools for upcycling production chains, the decision was made to build it on semi-structured interviews, focusing on production processes and communication tools. Table 1 is a summary of the interviews with the four companies.

3.2.1 *XV Production*

Based in Borås, Sweden. XV Production runs an in-house production. In-house production enables full control, a fair and just production environment, and minimizes the impact on the environment. They offer local design and production services for other fashion and textile brands where a close relationship is created and where both parts are involved in the development of the idea and prototypes. XV Productions (XVs) work seek to promote a circular textile industry by repairing, remaking old textiles instead of producing new ones (XV Production 2020).

3.2.2 *Björkåfrihet*

Based in Gothenburg, Sweden. The organization is the first nonprofit second-hand organization with quality- and environmental management certifications. Björkåfrihet works with social responsibility, sustainable development and international solidarity. Their main mission is to develop better methods of recycling and reuse of textiles. Besides that, the association is supporting organizations that are working for countries around the world against poverty and oppression. In Sweden, Björkåfrihet is giving support for asylum movements and working opportunities for people that do not have that possibility to apply for a job (Björkåfrihet 2015).

3.2.3 *Rave Review*

The company is a sustainable Stockholm based high fashion brand that works with upcycling. The brand has been recognized with awards and press attention for their designs. They aim to change the fashion scene and show the combination of high-end fashion and remake. Their input material is second-hand clothes and fabrics, this to enable them to work with creating clothes without contributing to bigger changes in the environment nor socially (Rave Review 2019).

3.2.4 *SIPTex*

A Swedish innovation platform project for textile sorting that started 2016 in the lead of the IVL Swedish Environmental Research Institute (IVL 2020). The project is funded by Vinnova. An industrial-scale fully automated textile sorting plant is built within the project with Sysav (municipal waste management company in the south of Sweden) as an operator. The SIPTex facility is using NIR (near-infrared) and VIS (visual spectroscopy) technology, which enables to sort textiles according to fiber type and color (Vinnova 2017).

Table 1. Summary from the interviews

Date	Company	Respondent	Expertice	Business size	Execution	Time limit
28-04-2020	XV-Production	Linnea Magnusdotter	Design and Styling	Small	Personal interview	1h 30min
11-06-2020	Björk & Frihet	David Njie	Collection Manager	Big	Personal interview	50min
06-05-2020	Rave Review	Livia Schück	Co-Founder and Creative Director	Small	Telephone interview	1h 40min
15-05-2020	SIPTex	Ambjörn Lätt	Project Leader at SIPTex	Average	Telephone interview	55min

3.3 ETHICAL CONSIDERATIONS

The information has been considered of ethical aspect for the current research of these subjects. Interviews have carefully been sourced for information that only refers to the reports research questions. The participants have been informed of where the report will be published and presented. The affected are informed of their publicity rights.

4. RESULT

This chapter presents summaries from the interviews with the selected companies.

4.1 INTERVIEW WITH XV PRODUCTION

XV Productions main partner is the fashion upcycling clothing company Rave Review. XV work as the manufacturer for Rave Review. Linnea describes collaboration as exciting but also challenging in many ways. The manufacturing process can be seen in Figure 9. Linnea describes the process with Rave Review in the next subheading.

4.1.1 Manufacturing for Rave Review

Rave Review have their studio in Farsta where they make the prototypes and sheets for their design ideas. Thereafter they travel to XV Productions office, located in Borås, with the prototypes and materials for a review of the process. During the meeting, Rave Review goes through the garments step by step. According to Linnea, their products contain a lot of remakes, hence there could exist complicated sewing moments. For every order, there are an amount of 10-12 garments of every model. When the meeting is over, there is a handover with the elaborated documents. The documents are not written according to any principles, there are sketches and one observe moment list. There has been some misunderstanding in the process of remaking the garments. One example is that a load of sheets was delivered folded together. This resulted in clear folds that affected the process. Another example of misunderstanding happened in the cutting process. Without a lay plan to know which material goes to which side of the garment (left or right side of the body). This led to accidentally cutting the wrong fabric. Confusion could also be the determination of the reference line direction on the fabric. This confusion caused the finished garment because of the miscommunication of a description for the position of the reference line direction.

Linneas analysis of the situation is the lack of resources. "We know that they are working hard for their company, but a production manager had facilitated the communication very much". The designers seem to have their main focus on the design than to create a better and more effective production chain. When it comes to mistakes and confusion for production processes between XV and Rave Review, it is difficult to locate with whom the responsibility lies. This permeates other collaborations as well. With unclear rules, it can sometimes feel unsafe to work. Linnea tells that another important observation is that Rave Review differs greatly from other collaborations XV had. One example is that usually there are two t-shirts upcycled to one new t-shirt, or a jacket can simply get new details. "With Rave Review, the material becomes something completely different and new".

4.1.2 Manufacturing for other designers

Another collaboration was done together with Björkåfrihet. In this collaboration, David Njie from Björkåfrihet came to XV's studio and showed garments he considered had good quality but were not able to be sold. He asked for XV to upcycle

the garments to a more attractive design. After an analysis, XV ordered men suit jackets with specific colors. This order was communicated through a sheet with clear instructions on what they wanted. To the jackets, they added a drawstring along the sides that enabled the consumer to change the shape of the jacket. The shirts were sent to a company where the shirts were dyed in the same dyebath to fulfill the same color. XV considers easy fix solutions as a smooth and effective way of cooperating. Easy solutions are appreciated because of the efficiency and the cost decrease. Materials in second-hand have different qualities. For example, a mens suit jacket is a good example of keeping high quality, also wedding dresses.

Another collaboration XV did was with Cheap Monday and Berendsen. Together they created an upcycled collection. Cheap Monday delivered detailed descriptions for every design they wanted for production, which made it easier to manufacture. Linnea was satisfied with the cooperation and moved on with the opportunities to work with industrial clothing and with other industries. A chip with information on the history and construction of a garment can be a huge deal of sorting garments and therefore have more control over the garments.

As a company, knowing the material and design construction of a garment will make it easier to do a remake. If the fit of a garment is wrong in the beginning, that default fit will remain wrong after remake. Gina Tricot and Cheap Monday are companies that are able to identify the reasons why some of their garments do not get sold. They have the resources to analyze the problems, that smaller companies miss.

Control of the garment is another important point. Linnea mentioned that several companies have good control of their own garments. Examples are industrial clothing that only can be washed several times and then be sent to its owner. Sheets and curtains for public places have high quality standards. All information included missed information, is very important when it comes to quality, which also concerns second-hand garments and textiles.

4.2 INTERVIEW WITH RAVE REVIEW

Their main partner for sourcing and purchase materials are Björkåfrihet. Other collaborations are with Göteborgs Syfabrik, Myrorna in Gothenburg. Earlier collaboration has been together with Textilreturen in Ullared. Rave Review buy deadstock material from Rekotex. Rekotex is a textile company that arranges the possibility to buy leftover materials from textile production. Rave Reviews design process scheme can be seen in Figure 9.

4.2.1 Sourcing materials

Rave Review is very specific on what materials, color, and pattern they would like for their design. Rave Review wants mono materials that have small- or no defects. Defects that are easy to handle are for example stains, more advanced defects to handle can be pilled and torn materials. The biggest challenge in sourcing materials is to get a big quantity of the same mono material with good consistent quality. “We would be able to produce more if we could get a big amount of same materials” Livia tells. Today, Björkåfrihet is its main supplier. Every delivery is around ten

boxes of blankets that contain an amount of around 50 pieces per box. In recent times, Rave Review has started to send specified lists on materials, colors, patterns, acceptance on quality, order amount, and date of delivery (See Figure 11). These lists simplify the sourcing process for Björkåfrihet. Due to the collaboration, Björkåfrihet has learned by time knowing what materials Rave Review is searching for. Another part of the communication is to send pictures of the materials that could be useful as a second selection. As mentioned earlier, Rekotex is a collaborator to get dead-stock materials. The deadstock materials are not the priority since they are working with upcycling but is a good solution when they need extra fabrics in the design. Rave Review has tested working with denim for the SS20 collection. The material felt more difficult to handle in the long term because of the lack of good quality. Also, it was more challenging to perform the cutting process on the denim material.

4.2.2 Design development

The fabrics are inspected when they arrive at Rave Review. Then, design and ideas are developed. This step differs from traditional production where the process often starts with an idea and design and afterward material sourcing (see Figure 5). For every collection, they are doing their prototypes and sheets for the actual garments before going to production. They also have sketches, Pinterest boards, mood boards, 3D-sketches as a specification of their garments.

4.2.3 Production meeting

During the production meeting, there is a review and a handover of the prototype/prototypes (toile) that Rave Review has constructed. The review's purpose is to see what materials are going together, styles, and cutting details meanwhile an operation list is done by XV. XV can apply their knowledge in solving difficult design elements when needed.

4.2.4 Manufacturing

In some cases, Rave Review assigns everything to the production for coloring, cutting, and sewing. Sometimes they are doing elements by themselves, for example, the cutting process. This is done before the handover just to make it more effective for both parties. According to Livia, the communication between them and production are fine and that they get their required finished garments. It had been easier in the process to have some kind of Tech Pack to have information collected. Today they are following the operation list that is created during the production meeting.

4.2.5 Quality inspection

After the manufacturing process, the goods are delivered to Rave Review, and quality control is done. The last touches are made before the garment can be delivered to consumers (see Figure 9). Transparent poly tags and care labels are attached to every garment because of the international rules and standards. It is important to know the raw materials to secure the requirements. Rave Review does not have any quality standards as the ordinary fashion industry have. They are not at the same level cost wise and quantity wise. Usually, they are doing their washing

tests to see the deformation of the garments. Because of Rave Reviews choice of using blankets, sheets, tablecloths with specific materials and construction, they do quality controls in their pre-production and post-production. Livia explains that it is difficult to predict how long an upcycled garment can last. Rave Review is one of the upcycling clothing companies that is trying to implement the best quality and clean materials as possible. When using materials that have been used and washed in earlier life, the materials retain good quality after being upcycled. The vision for the future would be to have a better purchasing process of materials to secure the textile fibers and therefore make it more effective. In the manufacturing process, Rave Review feels that the most challenging part is the cutting process and that it would facilitate to somehow make it more effective.

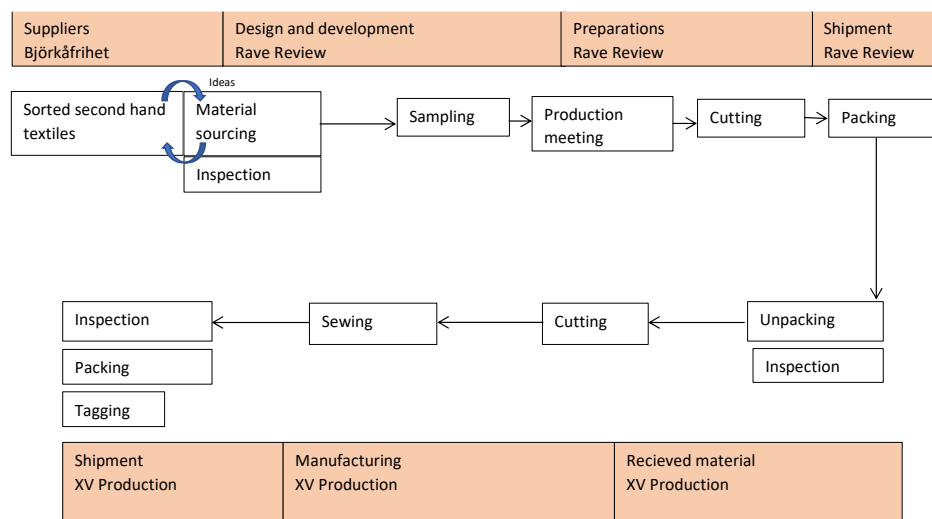


Figure 9. Manufacturing process at Rave Review and XV Production.

4.3 INTERVIEW WITH BJÖRKÅFRIHET

The process scheme can be followed in Figure 10.

4.3.1 Collection of textile waste

There are 25 to 30 people working with collecting the products from specific boxes at recycling stations around in western Sweden. These boxes enable consumers to give away the products that are no longer in use. Delivery vans go out to the different stations and return to the same sorting facility located on Hisingen in Gothenburg. The collected bags are placed in larger wagons. Each wagon holds up to 500 kg unsorted materials. The wagons are placed in a stockroom before being sorted.

4.3.2 Sorting of textile waste

There are about 20 people working with clothing and textiles. At every shift, they are around 6 people. One wagon drops out on a travellator that is surrounded by workers. Around 1 wagon/hour or 500kg/hour are sorted. Among the clothing around 70% is womenswear, 25% is menswear and about 5% is home textiles. Their primary focus is to collect clothing that is in shape for reselling. The clothing that does not live up to the standard is sorted as export materials. The workers have lists

of brands by their workstation, helping them navigating in their selection. Brands that are more exclusive can have lower worn out standard than clothing coming from low cost brands where almost brand new quality is demanded. These lists have been developed by Björkåfrihet themselves during a longer period. David mentioned there is only a small fraction that is suitable for upcycling, only about 1-3% have the criteria needed such as high quality. But if it is in shape for reselling the clothing has a higher value and is then prioritized (See Figure 10). Björkåfrihet is actively sorting out Nudie Jeans on demand from Nudie. Another smaller project was to sort out linen cloths to Ellos and they managed to collect 30 cloths in 3 weeks. At first, Ellos demanded 100% linen but later in the process, they accepted mixed fibers.

4.3.3 Sorting of textile waste for Rave Review

Rave Review sends out documents with specifications of what materials and products they are looking for. The documents are filled with pictures documenting types of textiles and patterns. In their specification, they demand 100% wool blankets, patterned 70 curtains, graphic printed bedroom sheets (see Figure 11). The sorting is done along with the sorting for Björkåfrihets own shops. The production rate is low. For the demand of 100% wool blankets, Björkåfrihet finds around 2-5 blankets per 17 ton (see Table 4). The older the wanted pattern or product is, the more difficult it is to find. The specification list helps Björkåfrihet to leave as little as possible open for interpretations. Rave Review does not come to the sorting facility but instead, they are communicating through pictures. The collaboration has been going on for 2 years.

4.3.4 Björkåfrihet own upcycling from waste

Their mission with this project is to save clothing from export or going to waste by giving them a new design. The redesign method accepted as the most effective one is coloring since it can handle high quantities. This rescue defected clothing with for example stains. They prioritize clothing with good quality and raw material that they know is more exclusive. Products that are chosen for upcycling are the clothing that will not sell. Some of the recolored clothes have been a part of the redesign as well. Together with XV, they have managed to reconstruct shirts and blazers by effective methods (see Chapter 4.2.1). For the rescued clothing they choose clothing with care labels to ensure the content of fibers and washing instructions.

The reason for the huge amount of waste is due to our consuming behaviors. Clothes are today too cheap, and the big industries adjust their quality thereon, David tells. Björkåfrihet sorting center can only handle a small amount of what is being thrown away each year. There is a need for scaling up a more efficient sorting center. One of the fears is if the material goes through a sorting without looking at it is possibilities to rescue it and it is shredded down.

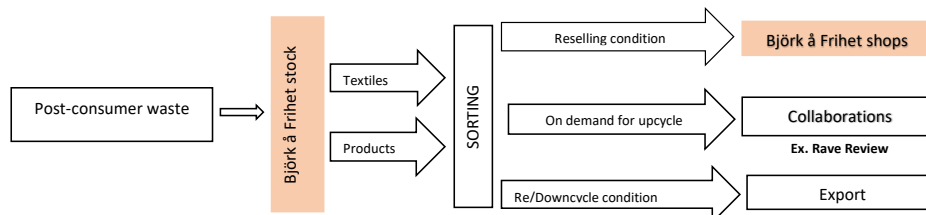


Figure 10. Textile flow into the sorting facility at Björkåfrihet.

RAVE REVIEW
Insamlingslista
Vid frågor kontakta info@rave-review.com
eller ring 0704487055

Det gör ingenting om textilen är smutsig eller har något litet hål, men det måste vara i bra skick!
Nopprigt funkar inte.

Typ	Kvalité	Färg och mönster	Storlek	Kvantitet
1. Filtar med och utan fransar	100% ull	Alla färger och mönster!	Alla storlekar	Så mycket som möjligt!
2. Kraftigt tyg med fransar. Gärna överkast	Alla material	Alla färger och mönster	Alla storlekar	Så mycket som möjligt!

Figure 11. Example of order specification from Rave Review to Björkåfrihet. Permission to use for this report.

4.4 INTERVIEW WITH SIPTEx

The aim of the project is to work as a sorting operator towards mechanical or chemical recycling operators that make new fibers from the sorted textiles. Depending on the market requirements the textiles need to be sorted due to fiber and color, which is possible with the technology used in SIPTex.

All input material to SIPTex need be presorted to some extent, to take the waste hierarchy but also Sysavs inbound requirements into consideration. In other words, the textile should have been considered for reselling, reused, or remanufactured before reaching the SIPTex plant that sort primarily for fiber-to-fiber recycling. One inbound flow is sorting rests from charities after sorting for reselling in Sweden. Other origins of the input material to SIPTex are pre-sorted recycling fractions from manual sorters and textile waste from industries. SIPTex is handling fractions that otherwise would be incinerated or downcycled. In SIPTex the textile will instead be sorted to be recycled to new fibers.

As SIPTex is optimized for fiber-to-fiber recycling, the focus is not on the redesign market. The sorting technology is developed to sort according to fiber type and color, not function or pattern. For Rave Review, Ambjörn states that it is probably

not possible for the NIR/VIS technology to discover specific patterned fabrics. There is also an economical aspect if it is defensible to sort out such small and specific fractions of the total input material.

But, for example, if a company requires white clothing with a high fraction of cotton to do a remake on, SIPTex would be able to produce that recycling product and have them as a possible customer. However, the project is focused on sorting for fiber-to-fiber recycling. The SIPTex project consists of 21 partners from the whole value chain, whereof several brands that have high sustainability goals where access to recycled materials is a key factor.

The facility has a technical capacity of 8000 tons/year for one shift, when scaling up to three shifts the capacity will be 24000 tons/year (see Table 4). The recycling products that SIPTex will be producing will be based on market requirements.

Ambjörn does not think there will be any competition regarding the textile waste in general, maybe for some waste streams. He motivates according to the amount of textile waste that today is produced contra how much that is collected and further how small fractions there is that is re-purposed for any win. The collected amounts of textiles will probably also increase due to the producer's responsibilities etc. *"The common goal in the textile industry should be to increase resource efficiency and reduce the textile waste that is going to incineration"*. All types of initiatives for reducing this problem are needed.

4.5 COLLECTED INFORMATION FROM INTERVIEWS IN THE STUDY

Below there are summarized figures of relevant data from the conducted interviews. The selected information concerns our research questions and will be discussed in further chapters.

Table 2. Communication tools within the companies XV Production, Björkåfrihet and Rave Review.

Communication tools		
SENDER OF ORDER	RECIPIENT OF ORDER	
	XV-Production	Björk å Frihet
	XV- Production	Specification list and pictures of: amount of ordering, material, color and quality of specific garment(s).
	Björkåfrihet	David comes to XV's studio with quality garments that have not being sold, XV remakes the garments to be more attractive product for Björkåfrihets consumers. No specification on design and style.
Rave Review	Prototype (toile) and sheets with sketches and style ideas. Meeting at XV for operation list.	Two way picture sendings of materials and pattern. Björkåfrihet has the sheet permanent to collect the right textiles.

Table 3. Collected information from interviews

Identified weaknesses from the interviews
Direction of reference line
Information about input material
Design idea
Bigger quantities
Communication tools are not written according any principles
Cutting process
Ineffective sourcing of materials
Export
Operation list
Specification sheet for upcycling
Right actors
Complicated sewing moments
Manually process

Table 4. Data collection selected from the interviews.

Sorting rates			
Company	Rate	Home textiles	Sorting
Björk å Frihet	500kg/h	2-5 blankets/17 ton	Manually
IVL	8 000 ton/year 3,8 ton/h*	Unknown fact	NIR/VIS

*Calculation based on a normal working year in Sweden

5 ANALYSIS AND DISCUSSION

Regarding the communication between Björkåfrihet (supplier) and Rave Review (design actor), a strong relationship has been developed during the two years of collaboration. There is clear communication and an ongoing conversation about the material supply. Due to clear specifications (see Figure 11) the sorting staff can clearly see what Rave Review demands. Pictures do not leave much space for own interpretations. Moreover, the manager at the sorting facility understands their customers design language and could more precisely sort out what Rave Review would have demanded. Rave Review has a strong brand identity that could be one factor for facilitating the communication.

Compared to traditional material sourcing, XV collaboration with Björkåfrihet differs. Rave Review works with design driven upcycling processes which indicate they find inspiration from the materials that are accessible for them. Deconstructing the garments to a new unique design. Unlike XVs collaboration with Björkåfrihet where the original design is kept and only small adjustments are done to the garment for transformation. This type of redesign is effective and accessible. The importance and difference between the two design strategies are the handles of the low value waste. For Rave Review there is an increased level of creative solutions regarding assembly and design. It is driving research towards new ways of designing not from rolled flat fabrics but from already finished garments. There is also another value added to the upcycled garment in terms of a design contributing to a unique expression.

As Sinha et al (2016a) tell, one difference in the remanufacturing process is the need to analyze the materials before it goes further in the design process. For this specific textile upcycle chain, the analysis of the materials is done at Björkåfrihet. Tools that help Björkåfrihet pick out the right materials are one specification list (see Figure 11) but also direct communication through pictures and messages with the design actor.

Pal et al (2018) gave one example for a more effective sorting which is, to sort the fabric material into what level of the degree requires for conducting remanufacturing operation where the most difficult process-step is. In the investigated upcycling chain, the most difficult process step is cutting and sewing. Since Rave Review mainly designs from flat home textile material the most difficult step is somehow reduced for what can be done in the sorting step.

As Guide and Wassenhove (2002) stated for product acquisition in the reversed supply chain. It is impossible to be efficient in having a huge stock with variable quality. Since Rave Review is a small scaled design driven company the stock is not that huge. The quality can be managed to the extent manual labor can attain. Concerning the inspection and disposition in the reversed supply chain, the process could be more effective if the company subjects the products to quality standards. In the reports result, there are lack of standards. The technology could be helpful

such as automated tracking and testing. In our study, the NIR/VIS technology used at SIPTex could help to identify fibers and speed up the sorting.

What are the identified weaknesses in the communication and production processes between small-scaled actors in a design driven upcycling supply chain of fashion products?

Identified weaknesses are concluded in Table 3. Regarding the production processes, the most critical step for an upcycled fashion product and what is different from traditional manufacturing is how to cut and ensemble the pieces correctly (see Table 3). Due to limited material and design demands, creative solutions need to be taken into action and must be communicated correctly.

As the mapping of the production chains tells, there sometimes occur two cutting steps. One made by Rave Review and the other at XV. It does not necessarily have to be cut again at XV. The decision of cutting at the design actor instead of the manufacturer is made when the cutting is too complicated and there is limited material.

Communication, quality, and control are in relation. In this chain the quality controls that are being issued by Rave Review and XV. There is no budget for quality testing. The techniques for controlling the fiber composition (in absence of care label) are flame tests and wear tests. The material has in most cases been washed during its “first life” and therefore no deformation is common. In Rave Reviews specification they demand different types of materials, but no control is done by Björkåfrihet. Rave Reviews priority is their aesthetic. Other information regarding the products life, width, or product group could be useful for developing a future label and a more effective manufacturing process.

Due to the fact that Rave Review does not have the resources for developing clear instructions and specifications, communication in this case is more difficult compared to a more resourceful company.

What parts in the communication and production processes must be improved between the small-scaled actors in the design driven upcycling supply chain of fashion products?

Today the documents are not written to any principles. This results in mistakes and unclear conditions. Unnecessary mistakes such as the direction of the reference line for the fabric or rolled fabric instead of folded would be eliminated. Today the operation list is done by XV production during their production meeting with Rave Review described in Chapter 4.2.1.

Rave Review does not have any standardized patterns to work from, but it would be to advantage to develop. Since Rave Review mainly works from home textiles information regarding width and contamination of the fabric should be controlled and communicated before reaching the cutting step.

When Rave Review demands special patterns or colors from Björkåfrihet. A part of the design process is relocated to the sorter. That could be problematic since what Rave Review asks for is so specific (see Figure 11). This complicates the communication, sorting rate but also the requirement for quality demands and control.

The problem lined with the sorting process in the production is in this case due to the low sorting rate. The low sorting rate is due to the facilities size, finding the specific materials, where 100% fiber materials and older patterns are difficult to find, and the competition with the textiles with reselling condition.

How can the identified weaknesses be improved in a design driven upcycling supply chain for small-scaled actors?

The status regarding the communication between the design actor Rave Review and the manufacturer XV Production needs development. Communication tools such as Tech Packs and Specification lists are not only an order of what is required regarding quality and design, it also makes it clear with whom the responsibility lies (see Table 3).

XV manufactures for different types of companies. The methods and solutions gained from collaborating with them contributes to better design-solutions and also, help in constructing Rave Reviews clothing. Today the production meeting holds a central part of the communication where both parties exchange knowledge from different areas of expertise. Here, XV writes down an operation list and each style is explained based on sketches, mood boards, and a prototype, prepared by Rave Review. This creates a deeper understanding of the garments that will be produced. As actors exploring a new method of design in different ways new solutions for how ideas can become a realization.

Using the communication tools that are used in traditional manufacturing that is presented in Chapter 2.4, would not be that difficult to implement. Information regarding each style and operation list would work in favor of both parties and is not any difference for upcycled products.

How can the identified weaknesses be improved in the upcycling supply chain?

Based on the incoming material from Björkåfrihet and their efficiency rate a hypothetical outcome can be calculated at SIPTex facility, shown in Table 5.

Table 5. Hypothetical sorting rate for same output as manual sorting as with automatized sorting technology.

	Björkåfrihet	IVL
Rate	500 kg/h	3,6 ton/h
Input	17 000 kg	17 ton
Output	2 -5 blankets	2-5 blankets
Time	34 h	4,7 h

Having a 7 times faster output would not only decrease the lead time. A faster output under the same limited collecting period would result in a larger range of material selection for Rave Review. The result is only hypothetical but indicates the possibility of increasing the sorting rate.

Larger input material would increase a larger possibility to find selected fractions, such as the fractions Rave Review demand. However, technology can only detect color and fiber composition and not pattern. This report has not researched the NIR/VIS technology and its functions. The influence of the market demand decides the progress of the automatized sorting facility. Today big actors demand recycled fibers for the production of new clothing. The automatized sorting at SIPTex would also help to certain quality standards in fiber composition and care labeling. The worn out state is still something that must be analyzed manually. Still, competition with material that is in reselling condition will exist.

The opportunities for an upcycling company to be more effective and profitable is to see the solutions of sourcing for materials for higher productivity if that is a long-term desire. Home textiles have a small part of the whole sorting process (see Table 4). One solution that can improve the sourcing is to see if there can be another way of cooperating that have a higher possibility of collect home textiles. In Chapter 2.1.1, there is an example of a company that has to find a good solution to upcycle home textiles. Up to 60% of TAUkOs purchase of materials are from Finnish and German textile service companies. Therefore, they have a continuous flow of materials to production. TAUkOs view on quality is that the older the textile the better quality. To develop a more continuous production flow, you need to find good collaborations that have quality materials, and that any way of time is going to be discarded.

It is easier to order new raw materials with specific details on the garment, for used fabrics, it is more challenging to for sure know the result in quality and design. Both parties (XV and Rave Review) sees the long-term a more efficiency and profitability in having well designed tools for their ordering and receipt of orders.

One thing that is deeply rooted in us individuals is that clothes always contain a wash-and care label. All around the world, labeling is a required quality for selling garments, or any product, and it is the same rule for an upcycling company. This is something that upcycling companies struggles with because of the responsibility to have good knowledge of materials construction of fibers and finishes, also the high cost of getting labels for such a small productive clothing company. According to P, Sinha et al., a label that points the way of remanufacturing, that gives textiles and garments a “second life” is one of the more sustainable solutions, still needs new approaches because of the non-working communication tools (Sinha et. al 2016a).

Since Björkåfrihet does not have any regulation the difference can at times become injustice. For example, when you have men shirts with no label on (can be worn out or cut off by the previous owner) you sort it out to the second-hand store, but it is never going for sale. Then an upcycling company wants to buy that shirt to upcycle into new clothing because of the kept quality. As soon as the shirt is upcycled with other materials, then it must have care and fiber content because of the regulation.

6 CONCLUSIONS

The purpose of the report was to investigate the obstacles of the upcycling supply chain, which includes the research of communication and the production process for upcycling companies to the production and how it can be more effective. This is done by mapping out the restraints of the information flow in upcycling between the actors. According to the authors, the report has fulfilled its purpose by concluding the obstacles in the communication and production process for an upcycling supply chain. The study shows that more investigation is needed to fully understand the obstacles in the communication and production process for an upcycling supply chain.

The communication tools between the companies XV Production and Rave Review are undeveloped and creates misunderstanding in the design and construction of the manufacturing. The communication tools need to be designed for the upcycling supply chain and written to mutual principles (see Table 2).

The cutting process is the biggest challenge and is today not an effective process. From the interview with Rave Review (see Chapter 4.2), they are mentioned that they sometimes cut their textiles before going to production because it is more profitable and effective than letting production cut the textiles.

Another process step that needs to be improved is to increase the input materials, only 2-5 blankets sorted for every 17 tons of textiles in Björkåfrihets sorting stock that is presented in Table 4 and 5. This is a very small proportion of textiles that result in that Rave Review does not get the number of textiles they want, for greater productivity. The conclusion can be drawn that if Rave Review wants a higher quantity of textiles, one solution could be to broaden their range to obtain more raw materials and increase the company's turnover.

Rave Review is a unique company with a unique pattern and design. That can be one of the reasons why they do not get the quantity of materials that they wish to have. Another solution could be to have another collaboration of textiles collection. A larger sorting facility would also increase the quantity.

Sorting at SIPTex would lead to better control of the fiber composition and the faster sorting rate would increase the quantity under the same limited period. However, there is more to be investigated.

Concerning quality standards and clothing labels, there are some differences between the regulation of upcycling textiles and second-hand textiles. For a second-hand textile, there are no regulations for having a label, but for upcycled textiles, there are some requirements for the traditional textile industry, which means that it is a huge struggle as an upcycling company in cost- and efficiency wise to maintain that requirements.

So, is it necessary to have such a high standard for upcycling, that have the method to remake worn textiles, even if it is one of the better ways of managing waste (see Figure 1)?

The consumers at second-hand stores have lenience to buy clothing with or without a label. The question is, can it be the same for consumers that buy upcycled clothing?

6.1 FURTHER WORK

For further work in academia, research and laboratory tests done upon categorized textile waste materials could be beneficial for the upcycling industry. It would be relevant to investigate the implementation of NIR/VIS technology or other technology in the sorting process step. As for the textile industry in whole, specifications and organized communications tools could be developed to facilitate the work of upcycling activities.

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ANNEX

Interview Questions

XV PRODUCTION

Tell us about the company.

What companies are you working with/for?

Rave Review is one of the clothing companies you are working for, tell us about the chain from order to finished product.

How long does it usually take from the order to finished product?

In what collaborations do you have to perform other work, like for example coloring?

How large was the biggest order you have handled?

How do you get access to the materia? What are the challenges?

What communication tools do you use?

How do the other collaborations differ from Rave Review?

In general, what materials do you work with the most?

How do you prefer to work with upcycling? What could be improved?

How does the efficiency of your work feel?

Would you have wanted a larger quantity in the production?

RAVE REVIEW

Tell us about Rave Review as a company.

Tell us about the collaboration with XV Production. Why did you choose to work with them?

How does your process look, from idea to design (pre-production)?

What are your priorities when sourcing materials?

What are the main challenges to find the right materials?

When ordering materials from suppliers, what are the normal quantity?

How much information about the materials do you get from the suppliers?

How do you secure the quality of the garment?

What communication tools are used?

How is the process documented?

How many prototypes are done before production?

How many arranged meetings are there with the suppliers? What happens during the meetings?

What documents do you have with you to demonstrate elements?

How is the material packed and sent after production?

What quality standards do Rave Review have, and what standards do you wish to have?

How do Rave Review secure that no mistakes are made?

Are the result of the garments as you desired?

Which process is the most challenging? What could be improved?

Does Rave Review have any plans for the future?

SIPTEX

How much quantity will you be able to handle?

From where do you collect the materials?

What type of textiles will you get?

How will the sorting process look?

What does the collaboration look like with the companies you have?

How productive is the machine with the sensors, data collection (per hour/day)? How accurate are they?

Do you focus only on sorting intended for fiber-to-fiber recycling?

Is there a risk that garments that could have gone further in another strategy as reuse/repair will go through the sensor?

Do you work for upcycling companies that want your service?

BJÖRKÅFRIHET

What are your fundraising sources?

If you were to grade the textiles, which ones are the easiest to sort?

How does the process go from the time the material arrives at your sorting?

Do you sort textiles to other companies?

How does the process look like when you sort for Rave Review? What communication tools are used?

How do you think the collaboration with Rave Review is going? What could be improved?

How do Björkåfrihet work with quality and labeling on the garments?

Can you sell the garments with washed-out labeling?

What processes does the fabric go through to check fiber content, dirt, and more?

Do you have to follow any requirements of structures as a company with sorting of textiles?

Personally, what are your thoughts on upcycling and quality of textiles?



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