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# GERMAN TEXTILE RECYCLING BENCHMARKING

Case I: CO




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## ABSTRACT

In the thesis, German textile recycling technology and the recycling process is analyzed. Therefore, because of the origin of countries and total population of countries every country has its own textile recycling approaches. In order to investigate different textile recycling processes German recycling technology is the main focus in thesis to make a development plan for Finnish textile recycling. This is the part of project with the corporation of HAMK and VIIHI project, and the commissioner of this thesis is Heikki Ruohomma, head of degree program.

In this thesis, the theoretical concept of waste management is applied. Therefore, there are many other aspects, which are taken into account regarding recycling textile technologies under the textile waste management. Waste management is the processes of collecting, transportation and processing, thus the processing technologies are applied in order to make the recycling process efficient. In order to implement and analyze, German textile recycling is benchmarked.

The main objective of the thesis is to find the possible solution and investigate, whether German textile recycling technology is possible to implement in Finland or not. I: CO German Textile recycling (Group SOEX) is providing the best technology in textile waste recycling; recently new corporation was made with H&M. Therefore, finding out valuable information for developing Finnish textile waste recycling system based on research. Furthermore, apply these developing and recommendation plans for Finnish textile recycling system. The main target of this thesis is to benchmark German textile recycling Technology. On the other hand, the advancement and making suitable plans for Finnish textile recycling business in efficient approach to apply in Finland.

The main goal of this thesis consists of target countries' research and evaluation. Mainly the German Textile recycling system and SOEX group (I: CO). In this thesis, the data is collected from internet resources' and some of interviewed are conducted face-to-face if applicable. Basically, the main findings are based on internet and some other resources. The author concluded possible way to implement SOEX textile recycling process in Finland, in order to undertake the current situation of textile waste in Finland, there are many other aspect like, share information in companies.

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**Keywords** Textile recycling, I: CO textile system, Textile waste management

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## 1 INTRODUCTION

The thesis will be focused on the best textile recycling technologies its implementation and complications from dome of countries. Therefore German textile recycling technology and the process of the (I: CO), its recycling process and corporation with H&M. German textile recycling technology is used for benchmarking for Finnish textile recycling industry.

In this chapter, the background of this thesis will be discussed. On the other hand thesis objective and limitations are mentioned. The structure and objective of the thesis will be discussed briefly.

### 1.1 Background

Today, in the world of modern technologies, the demand for production is increasing so rapidly in all aspects of the required living commodities. In order to meet all the required demands, over production and utilization of all resources seem not enough. Thus increasingly demand for production is leading to global warming in the use of chemicals and other fossil fuels. Therefore, the increasing demand for textile making huge clothing production is not only based on demand for more population but it's also changing new fashion habits as well. The problem is not for cheap or expensive clothing, but the problem is the working conditions and the standard earning of the people, those who are working in these sectors especially in developing world. Since, today the world is fully aware of global warming issues, which is affecting our environment and causes more problems regarding to CO<sub>2</sub> in our space. Today, we need more concern to Renewable energy and recycling processes, in order to utilize resources in efficient way. In addition to that material waste, re-use and recycling is the integral part for utilization these resources, environmental protection and recycling products are necessary to deal with.

There is legislation available for other types of waste in the source of handling all kinds of solid, bio and electrical wastes. These rules are made and protected for the consumer and waste handling companies under the origin of the country. When we talk about textile recycling process, the main focus comes to energy sources which are utilized in the process of textile recycling. Therefore, there are few resources which have to utilize efficiently while environmental issues and economic issues taking into account therefore reducing CO<sub>2</sub> and Implementation of best recycling technologies, in order to make recycling process more precise. Therefore, companies need to more collaborate with each others from raw material to recycling process, from transportation to collecting points. Meanwhile, the increasing future challenges and rapidly increasing, the awareness of environmental issues and economic issues, people from different background like, manufacturer, customers, sellers and private governance, they have developed and made a new trend in recycling technologies.

The increasing awareness of textile recycling and its benefits to environment and economic issues, Finland is taking part in the field of recycling

textile waste. Today, many countries in the world are already using the best technologies under all perspectives from raw material to waste to generating new products. German textile recycling technology is one of the best technologies available at the present in the world. Germany and the UK have the best textile recycling systems. In Germany, there are many companies which are providing services in the field of textile recycling, but (SOEX Group), has best solution than other, which are collaborating more than 10 partners in across the globe. In the recent time, they have made new corporation with Swedish company H&M. H&M will collect all second hand clothes at its shop and will give discount for new clothes to customers. Moreover, all second hand collected clothes will be handled to SOEX Group for recycling and making new products. Finland is new emerging market in hand used textile, in order to develop plans and recycling facilities for textile waste recycling. In the recent times, it was news that in Helsinki region, which is the biggest textile waste generating region in Finland. In order to generate more energy, it was decided that they would burn all textile waste and make energy; in the result textile waste system will get negative effect on the recycling and textile activities in the region. In order to make accurate efficient usage of textile, the main purpose of this thesis is to analysed and benchmarking German textile recycling technology and finds out from investigation and conclusion the implementation in Finland. In order to support the outcome of author, different textile recycling projects and studies cases will be taken into account furthermore; waste management and environmental issues will be discussed. Online research and possible interviews will be taken from H&M in Helsinki. Mainly, the project work is online and self study.

The outcome and recommendation of this thesis will be textile recycling development plan in the filed of textile recycling technology in from different approaches in Finland. The conclusion will be consideration used for further research and studies in this specific project from different points.

### 1.2 purpose, restrictions, research approaches and questions

The main objective of this thesis is to find out and investigate possible applicable outcomes, while, studying some other countries successful textile recycling system. In order to implement recycling technologies in Finland, it is necessary to investigate and evaluate the entire system of Finnish infrastructure under recycling material and environmental legislation. Furthermore, in the end make conclusion of research both in positive and negative from findings. Therefore, there are many countries in the world having developed textile recycling system. The main focus of this thesis is to benchmark German textile recycling technology, in order to find the best and suitable way for Finland to work on it. It is necessary to focus on the modern textile recycling technologies and its advancement in recycling processes. The worldwide framework on textile recycling technology is the supporting in background theory. Thus, the main focus on German textile recycling technology and I: Collect which is the part of (SOEX Group), leader in Textile recycling technology not only in Germany but also across the globe. It is necessary to benchmarking and establishing

good textile recycling system in Finland. Secondly, other focus of this thesis is to investigate and find out the corporation with Swedish Textile Company H&M and German companies like, I: CO, In order to make it more clearly, it is necessary to make research in depth and in the end useful information and recommendation to apply in the project.

The questions that come in the research are How to implement developed textile recycling system in Finland? What is available in Germany?

Under these questions, there are other questions occurring in order to support and achieve the main objective of this thesis.

- How I: CO company is recycling the textile waste which company is receiving from partner specially H&M?
- Are there any other partners from where I: CO is collecting textile waste material?
- How much annually they are recycling the Textile waste?
- What is I: CO making from raw material?
- What is the total amount of waste that they are recycling?
- Products sales and recycling?

There are many limitations and obstacles in the thesis; mainly there are survivals other factors, which have to be addressed in the processing of textile recycling. Therefore, there is only one country which is target to achieve the main objective of this thesis. In other words the information is realistic and practical based which is already in process and in the system. On the other hand, there is only one way to focus on this project which is on textile recycling technology system in Germany, other issues like, environmental and isolation of recycling processes are not possible to fully cover because of limitation and objective of the thesis. Since, it is not possible to access all kind of data from I: CO because of their policies. In the end, the research and investigate should be real time access to all resources and other factors can that influence at the end of conclusion.

### 1.3 Structure of the report

The main goal of the report is based upon general textile recycling technology. Based on findings, the specific target country and target company is the turn out of this report. In the introduction chapter, the main purpose of the thesis and background theory of this thesis is included.



## 2 TEXTILE INDUSTRY AND RECYCLING PROCESS

### 2.1 General Information on Textile Industry

In the chapter, the author will describe the daily usage of textile and wastage amount of textile, in addition to that, the author will also describe textile recycling process and its effect on the energy sector. The target will be from basic consumption of textile from different sources like, fiber, cotton and its consumption for different product of use. It will include the basic theory of textile industry and its recycling process; on the other hand different recycling technologies will be introduced. The aim of this chapter is to make clear and understand to reader about textile industry and its recycling process. This is not all, but mainly the author objective is to set target for this thesis.

- Fiber process

Fiber process is a long way to produce clothing from different fibers; meanwhile, the productions and source of producing fibers are also long way to process to ready to use end products which are made from fiber. Thus, increasing demand of clothing with respect to increasing total world population, the demand of producing fiber is also increasing which is proportional to world population. At the large scale, cotton and other kind of fibers are also increasing. According to world fiber year 2010 the average total amount of cotton production is increasing at the rate of 0.8% on average, which is quite high. (Fiber year 2010) Furthermore, there are different methods to produce fiber; on the other hand the processing system of fiber is pricey. Manmade fiber and staple fiber is the long process to produce. At the moment, there is no such whole system available in the same place where all kind of fiber process can be completed, for example for dyeing purpose fiber is sent to America and then knitting and weaving are sent to India and China, after that ready to use fiber is forward to final destination to producing different kind of some other destination when clothes are ready then most of them are sent for sale to for example Europe where products are sold out to customers. So the whole supply chain of producing fibers until its final destination is complex and expensive. In the whole process, different technologies, labor, transportation and warehousing cost effect to buyers and retailer companies as well. On the other hand, during the process of fibers other natural resources are also used, at the same time increasing CO<sub>2</sub> emission which causes environmental issues. Therefore, in the light of these aspects, the system of textile waste recycling is introduced. Through recycling textile, the whole process of making new clothes takes only 20 to 30% of total resources to use. Meanwhile, it also saves lot of time and other resources. Today in the world of full of people and its highly increasing population, there is need to use new technologies like textile waste recycling in order to make environment better and save other resources which can be used of other purposes.

The processing methods of fiber is complicated and need advanced technological machines are required and it's the long way to process from different place to processing like dyeing, chemical processing, weaving, knitting, in addition, there are more technical aspects in order to make fiber efficient for garment use which are not available at the same place like, Gel spinning, stretching and orientation, Melt spinning, Wet spinning and dry Spinning and on the other hand the processing is time consuming and also expensive. The more process fiber, the more it increase the total cost of producing clothes (Textile fabric production, 2013c).

### 2.1.1 Textile Waste Recycling

Textile Waste recycling is the process to take into reuse all kind of recyclable material, from material making different types of products for customers use. Furthermore, waste is the process to dispose of or destroy the things which are not in use or we do not need them anymore. Instead of through them away, there are other options which can complete the demand of needy persons while using the charities. Textile waste recycling is the process which tends to recycle clothes and make new clothes to reuse in the different form of other products and the same kind of clothes depending on the nature and substance and type of recyclable. The idea of textile waste recycling system is quite old but it has been neglected for a years. At the moment, in order to increase demand and textile recycling is the best and efficient way to develop new products under sustainability.

There are different techniques to recycle textile waste; one is based on post consumer textiles, where the resources are used at minimal level, like energy and raw material. Therefore, post consumer is the technique where only 4 to 6 percent of total residual waste can is generated which is minimal compare to producing new products, in the post consumer textile includes clothes, towels, blanket, rags, socks curtains and shoes, table clothes and bed sheets. (Overview of textile waste recycling, 2013c) Similar there are other type of techniques as well for example, pre consumer materials and chippings and cuttings are the efficient methods. Moreover, in the post consumer material are included such waste which is generated from processing apparels, textile manufacturing process, knitting and nonwoven materials are included. On the other hand, chippings and cuttings are also one of the huge amounts of textile waste; this kind of waste is generated at the time of finalizing products scrap material. Thus, there are different types of materials needed to be recycled but the mostly single component fiber will be more feasible to recycle under the minimum process at low level processing prices. (Overview of textile waste recycling, 2013c).

### 2.1.2 The Consumption of textile

Today in the world of fashion industry, we are using clothes in the form of different fashions and styles. We cover and decorate ourselves in an attractive way. In order to make these clothes, different kind of material is required in order to make this fashion clothing, which is surrounded all around of us. The material that is used in the clothing comes in the form of different shapes. This includes raw material, manufactured material, cotton, fiber and recycled material. In textile recycling industry, 4Rs are used (reduce, recycle, reuse and reprocessing), before we go into detail the conception of textile material and other issues have to be taken into account. (Fiber year 2009)

### 2.1.3 Textile fashion and industry

There are different sources to get raw material for clothing, there are two main sources to get material for clothing polyester and cotton. Therefore, third source of getting raw material is from used clothes and textile waste material. In the waste material, the technology and the system of recycling has not been taken whole process of recycling in the textile industry. There are other sources which are increasingly the demand of textile, like, low chemical cotton, hemp and Lyocell that brings reducing the amount of water in the process. On the other hand, Fiber contains main two types: natural fiber, raw cotton and raw silk; the fiber which is cellulose's, (Jing 2012, 3).

According to the research (Jing 2012), there are different sources to have natural fibers; these sources are mainly plant or animals. Therefore, another form of manufactured fibers are made from different materials that come from variety of sources, some of them are included like, plant, animal and synthetic polymers, the detail is given in the Table Level.

Natural Fibres	Manufactured fibres		
plant	Animal	natural polymers, vegetables and animals	from synthetic polymers
cotton	wool	Regenerated cellulosic Fibres	poly-condensate fibre
Linen	silk	viscose	polyester fibre
Hemp	cashmere	Modal	
Jute	Mohair	Lyocell	Acrylic
Ramie		Acetate	
Sisal		Triacetate	
Banana		regenerated protein fibre	Polypropylene
pineapple		Soya bean	PVC
Natural Bamboo		bio-degradable polyester fibre	

Table 1 Textile fiber types

#### 2.1.4 The Fibres Consumption

Since, the population and rapidly increasing demand in clothing and fashion has made much other impact on the consumer and fashion behaviour. Today, at the time of buying clothing like, garments and other textile products customers do not pay attention about labelling and other product raw material from where product has been made. This is the simple and easy way to just select the desired types and fashionable clothing's with displayed prices.

According to The fiber year 2009/10 (2010), the demand for major natural fiber has increased so rapidly from 52.6 million tons in 2000 to 70.5 million tons in 2010. The increasing demand of annual fiber is the rate of 3.3% in a decade. For more detail see the table figure 1 (2010). (The Fiber year 2009)

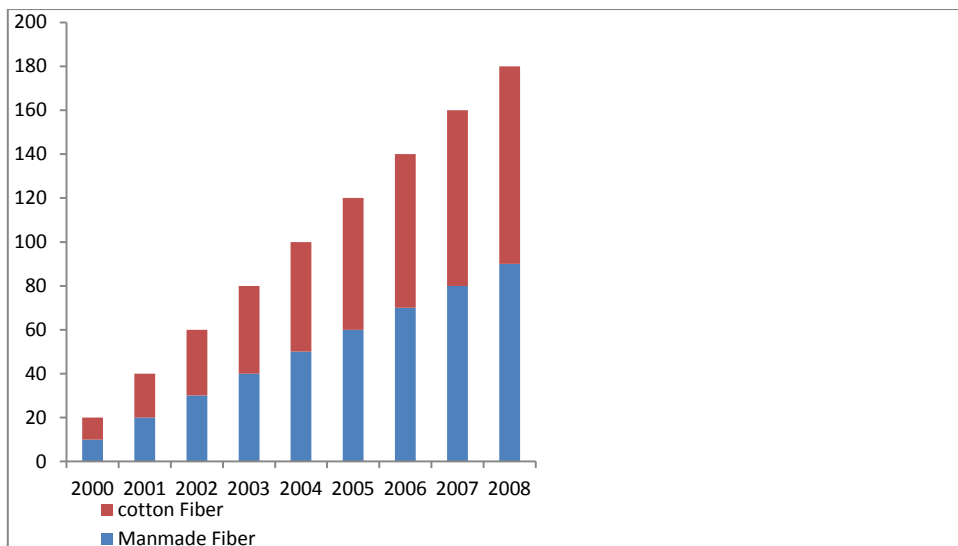


Figure 1 World Fibers supply 2010

The given chart above indicates that the demand of fibres and cotton is increasingly slowly by slowly even the impact of recession has changed the living life the countries. Thus, it shows that the world demand of fibre is dominated by natural fibres. The average growth and increasing rate of fibres at the time of 2010 was 4.0% annually. On the other hand, when we talk about other types of material which are like, wool, cotton and polyester, it was time when nearly 1950s the demand of wool decreased and at the same time the demand of cotton and fiber was increased (The Fibres year 2009/10, 21.)

Fibers Growth Rate 2000-2009

Name of Fibres	% increased/decreased	Tonnes in Million
<b>cotton</b>	+2.6%	25.2
<b>Synthetics</b>	+4.0%	40.3
<b>Celluloses</b>	+3.6%	3.8
<b>Wool</b>	-2.2%	1.1

Figure 2 Fiber growth rates 2000- 2009

In the given table above, it shows that the total amount of consumed fibres from 2004 to 2009 was shown below. Therefore, according to the world table of fibres consumption, there were about 44, 000 tonnes where only fibres was used and out of this figure 8, 000 was only taken from natural fibres on the annually consumption. It shows that the annual average of increased natural fibre was about 6.1% in average, (The Fiber year 2009/10).

World Fiber Use

year	Natural	Manmade tonnes	Total	Population Billion	Consumption Kg/ capita
2004	26,392	44,134	70,526	6.76	10.4
2005	25,260	42,430	67,690	6.68	10.1
2006	28,092	44,425	72,517	6.61	11.0
2007	28,268	41,106	69,374	6.53	10.6
2008	26,719	39,750	66,469	6.46	10.3
2009	25,049	37,533	62,582	6.38	9.8

Table 2 The consumption of Fibres worldwide

At the same time, there are some other factors which have to taken into account, but we cannot look at this consumption whereas, energy/fuel, gas/oil and water during the process of fiber. Therefore, we can have a look at the three other sort of materials, we can analyse. These materials are like, LCA (Life Cycle Assessment); under the LCA, there are other main there different categories which are targeted to analyse such as Cotton, Polyester and Organic. (Jing 2012)

	Unit/Kg	Polyester	Cotton	Organic
Energy Consumption	MJ	97,4	59,3	53,3
Non-renewable resources	Kg	2,4	1,4	1,3
Water	Kg	17,2	22200	24000

Figure 2 The Average consumption of three main fibres

In figure 3, the three main categories of fiber are shown. The figures are shown in average consumption of there materials. The information that is provided to consume fibers in the processing, it shows that in order to process fibers there are some other resources include renewable energy and pollution generated varies material to material to process. (Jing 2012).

2.1.5 Textile Processing and Production

In order to understand the process of textile production, it is necessary to get familiar with key process of entire textile making. Therefore, in order

to manufacture clothes, there are four steps to go through the process. These steps are such as first to harvest and clean the fibre, secondly spin it into threads, thirdly, to weave the threads in the shape of cloth and, finally fashion and sew the cloth into different fashionable clothes. On the other hand, there are some other phases like, carding, spinning; warping and weaving these four steps are mostly important. (Bhushan 2009, 165). In order to convert raw material into finished products, there are some other factors which make it possible, such as Labour, energy, water and other resources are utilized. Therefore, the manufacturing process, in general, is the major of water user. (Jing 2012, 7) In general, in order to improve the entire process of textile wastes, under the technology prospective, managing and utilization of whole process is necessary for efficient outcome.

According to textile processing (Jaspal Singh 2009), there are very important and major stages which are from raw material, fibre, to yarn and then fabric until at the end of ready products. Therefore, these activities are included like, spinning, weaving, sizing, sourcing, bleaching and printing and finishing.

Basically, knitting, spinning and weaving are the most technical processes; all these processes include the different application of lubrications (in the spinning), oils (in knitting), and size (in weaving) in order to protect fibres from the stresses of processing, in addition to this, at the final phase of products which consist of bleaching, dyeing and printing. Bleaching is the most important part of the process, in order to produce white fibres that will be dyed to place and improve colour, because of most of the natural fibres are off white colour. Other type of fibres which is called manmade fibres is also bleached as it gives the sparkling and graceful shining after dyeing, this process is also useful for even black shade colour and its remove the last traces of enduring impurities. However, bleaching does fibres strength and thus the durability of products. Today, it is common in the Europe to bleach with hydrogen peroxide in a wet process; the process of dyeing can be different according to the nature of fibres. The dyeing bath contains processing chemicals as long as dye. Therefore, printing is one of the most and important phases in the processing of textile, which is a chemically complicated process. The printing involves the accurate application of colour paste, which is made up of dye or stain, a thickening agent and other chemicals onto fabric. The methods of printing are for example, flat screen, roller, transfer ink jet. At the end of these two processes which are dyeing and printing, the fabric is hand over to the textile processing techniques, in order to get finalizing treatment. For instance, mechanical treatment, such as calendaring, where fabric is pressed between rollers, in order to give it glaze and increase its destiny; on the other hand there are some other treatments which are given and these are called like chemical treatment where water is provided repellence and crease resistance. Following fabric finishing, cloth is cut and sewn into garments or on the other hand in the different form of clothes. The cut-trim- make (CTM) is the process which most of the time have manually operation. (Jing 2012, 7-8).

### 2.2 Clothing demand and awareness of customer point of view

As the economies are fast developing, with the development of advanced technology, today people are more aware and curious to know about processing of textile as well as the impact of environmental issues. Today, the technology and other fashion industries made customers cautious about product they buy which includes, fashion and the life cycle of the product, for example, at the time of buying product people think of washing and durability of the product. On the other hand, at the time of processing, designing and making and selling new products, companies pay attention to durability, life cycle and sustainability of the product. Since, the environmental issues have arisen so rapidly at the global scale; organizations also think of environmental issues and make new legislation and environmental laws, in order to prevent environmental pollution and increasing emission in the space.

In the light of sustainability and textile processing/recycling, the environmental management and textile recycling aspects will give more opportunities and generate new businesses ideas. Therefore, it shows that managing and recycling textile will bring more efficient way under the environmental and recycling textile technologies. On the other hand, the new concept of green, sustainable and textile recycling process will be adapted by the people, and the people will think in sustainable way. This is not only about textile recycling, but it also interrelated to our lives on this planet, regarding to the future threat of our planet. People will adapt new way of fashion and style in their daily lives.

### 2.3 Textile - waste process

Since, we know that in order to live on this planet clothes are our basic commodities. Awareness of clothing and textile in the modern world is important, there is also required to have basic awareness of product sustainability and life cycle. According to (Jing 2012, 8) waste is kind of discarded materials which have to be discarded, in order to make new raw material for reuse for new products.

#### 2.3.1 Materials in Textile

There are different materials, which are used in the processing and making different kind of clothes and garments. At the time of processing materials accurate processing time at each stage is necessary, the basic sources of material are being used in the textile are fibers, cotton, wool and polyester. These materials are first hand used. Therefore, it is said that the average growth rate of end-use textile fibre consumption has decreased over the last three decades. (Gale, Kaur 2004, 35) The main reason behind of this is the developing recycling textile technologies and the awareness of sustainability and other impact like, environmental and scale of economies.



It is estimated that the total life time cycle of products in textile made of recyclable material, is approximately 3 years. The main reason behind of it are the following, waste can be out of fashion, broken, discolour and size, most of these textile waste goes as a charity. And the remaining goes to landfill or on the other hand they are collected in the recycling facilities in order to recycle all sorts of materials. (Jing, 2012, 9) For example, in UK, it is estimated that around 1.5 to 2 million tonnes of clothing and other sort of textile are discarded annually, the total amount of textile waste which is recycled in the UK, is about 16% and rest of the textile waste is going to landfill. (Background of issues in the textiles industry)

### 2.3.2 Textile - waste management and Environmental Impact

From the aspect of European textile waste management, there are important activities which are included in the field of waste management. thus the term is called reserve logistics, reverse logistics is the process of implementing, controlling the efficiency, making cost effective flow of raw materials, updating and keeping information within logistics activities which are interlinked to each others such as, process inventory, finished goods and other information from the point of origin to the point of consumption and other process of disposal (Dale & Ronald, 1998). It is obviously shows that the reverse logistics is contrary to normal logistics, normal logistics process from end user to raw material and from raw material to end user, and all the activities which come in the process that is called traditional logistics'. Thus, its make clear the applications of logistics in textile waste management are important, when the process of logistics comes into the category of green logistics; "green logistic" is the process which manages all the activities at minimum cost of process. In other words textile waste management involve in the industrial supply chain, in order to improve the environmental quality in the waste generating and managing activities. (Jing 2012, 9).

There are some other facts that depend on the condition and accuracy of fashion industry, therefore, there are four different categories lies in the textile waste management and recycling process of textile, four categories are; used/wasted textile products, hand textile, energy and in the end, the waste which is land filled. (Jing 2012, 9). Therefore, in the Europe the waste prevention and treatment of landfill and disposal, these two options are most suitable in the European countries.



Figure 3 European textile Waste Management

In the process of textile waste recycling and sorting it form the solid waste management, which is the main and big source of waste recyclable material. Therefore, in the textile recycling process, there are 4Rs strategy can be implemented which is; collection, reuse, recycling, energy recovery and landfill (Jing 2012, 10).

- European Environmental management system

Environmental problem is increasing rapidly because of over production and the huge amount of productions in order to make available demand by the people. Managing environmental issuing is getting complicated with the passage of time and with the development of technologies. Thus, in the Europe biodiversity is getting more complicated form. In order to tackle all these issues in whole Europe legislations and environmental policies are made alongside of policies there are some kind of environmental permit system also used. In the environment issues, there are some other factors which are included on the other hand it also to reduce damaging environment activities. Therefore, solid waste, municipal waste, Bio waste and paper and electronic waste are included.

### 2.3.3 Textile waste strategy and its Environmental impacts

Today, with the development of technological advancement, and applying services technologies in the textile waste management there are a number of strategies that can be implemented, in order to make textile sustainable and environmental friendly. Thus, the implementation of 4Rs is the most common way to approach textile waste management. In the past, it was 3Rs, but later on, with the help of research and development 3Rs came into new existence. In these days, it is called the 4Rs. Therefore, the purpose of applying 4Rs managing recycling technologies and making textile waste management more efficient 4Rs is important to use in recycling.

#### Reduce

The term reduce is used, in order to reduced waste and waste generating activities, at the same time to decrease the total consumption of energy on the reducing the total flow of over production and over processing, in which also effect on the environment in addition to this protecting and making our environment friendly for human on this planet. The reduce strategy is applicable in the presence of material information and production knowledge.

- Optimisation of production resource

Optimised production resource, it makes clear that the process and flow of making efforts in order to reduce total amount of waste. The optimised production recourse tells us that at the time of begging, it is important to utilize raw material and other resources as per need. It is also tell us the sometimes over production and over processing and over transportation can cause huge loss and wastage of resources, that can be used in other productive way. Therefore, in order to achieve objective it is also important to know about technology and its relevant process and the imple-

mentation and innovation of production process based technology, thus company can achieve its objective.

- Reuse

As it is mentioned in the previous strategy of 4Rs, it is possible to reduced raw material from production process. In order to reuse the raw material, it is also possible to reduce the waste that comes at the end of products. (Wikipedia.)

- Over wastes control

It is said, over waste and unnecessary waste can be controlled which comes from over processing and using the raw material in excessive way. That leads in the end over wastes and there is no use of it after the product is completed. (Wikipedia.)

The recycling process of textile waste, take a place in different forms, distribution channels and other resources which are utilized such as, resale, redistribution and online shops which sale second hand products. Like, Tori, Huuto, Amazon and ebay are the good example of using the informal reuse.

### Recycling

Today, the technology has changed the way to business for organizations. Recycling technology is not new invention, but this is the oldest system of recycling among other processes of productions. Therefore, it is estimated that it was last time when the recycling technology was improved about 200 years ago. The separating methods of fibre and fabric have not changed. There are basic fundamental of textile recycling such as, reclaiming fibre, shredding fabric and re-spinning in the yarn. Other mechanical methods are also used in the fibres processing chemically; most of these fibres are included like, polyester, nylon and polypropylene. The basic processing idea behind of this involves in order to breaking down the fibre into different integrated form and then re-polymerising the feedback and in the end it tends to predict most accurately quality of fibres. The main reason to process it chemically is to treat the natural content out of mixed material, the processing of dyeing make enables natural fibre can be reused. (Jing 2012, 11).

- Carpet Recycling

According to the Carpet and Rug Institute (CRI) located in Dalton (Helms & Hervani 19-21), and other organizations which are working in the related field of carpet recycling, they say that carpet can be refurbished, on the other hand some organizations claims that the life of carpet can be extended, repair the tiles of carpet and reclaim extend the durability and life time of carpet. In order to do so, there are technologies available in order to recycle used carpets into closed-loop recycling system. (Carpet and rugs sustainability report 2008)

- Repair

The term repair is well known and widely used in every type of process. The repair concept in textile waste management has been used, since long time from generation to generation. Thus, repair can be used at homes privately or it also can be sued as a professionally. Thus, repair is interconnected to financial and time management while, utilizing small resources

and making life cycle of product prolong. It is highly recommended to apply where it is applicable. The new concept and fashion and designing in the textile industry mostly came from repairing, in the later time, it became more efficient and accurate. So it is clear that the process of repairing is important in the textile recycling and management industry. (Jing 2012, 12)

Combining and integrating the textile waste management create profitable opportunities and also give green clean technology with less environmental issues. It is said where is demand, there is business. Recycling textile waste not only has changed the reduced emission of carbon, but also has changed the habits and way of consumers. In order to give more clear view of textile waste management social media and other logistics companies affected the environment while, adapting green technology.

### 2.3.4 Environmental Technology and Waste management

Today in the world of modern technologies, the increasing emissions and its effects on global scale is at alarming stage. Companies and societies have to cooperate; in order to make this planet clean and environment friendly. Thus, solid waste is increasing because of productions and processing of new products, fashion and textile industry is one of the waste generating resources. Therefore, waste management and textile waste recycling is important to manage all resources in efficient way.

#### Solid waste management

Solid waste is one of the big human activities, which generate huge amount of waste which is somehow, useless, disposed off and unwanted products. The sources of generating activities comes form different sources like, it comes from private, homes, commercially and from agriculture, mining and production of textiles, for example fabric, fibres and cotton. Thus, solid wastes are included for example, municipal waste, domestic/residential, commercial, and institutional and construction waste. (Anjili, 2007, 135)

#### Environmental and social issues

When we talk about sustainable development, then there are many aspects which come under the sustainable development. However, it is said that sustainable is interconnected to long term plan of economy, so in order to make it clearer, it is necessary to define the type of sustainability meanwhile, when we talk about sustainability. Economic development plans is interlinked to environmental and green technology, the process of managing wastes, and over productions activities and the utilization of resources in efficient way. In the light of social and environmental issues, awareness of clothing and textile waste management is the key point, in order to solve all issues, cooperation among different organizations is necessary to tackle environmental and social issues. (Anjili 2007, 203). Furthermore,

social awareness is necessary to apply and gain the green technology through different social services.

### Recycling company

Waste recycling companies, they are providing their best services in order to protect environment and reducing the landfill because of waste. In the environment management recycling companies are interconnected to logistics companies and some of them are providing 3Ps logistics services. The statistics shows that there are more than 45.36 trillion Kg of waste which companies are directly and indirectly involve in the business of environment and recycling process. Most of them are providing services in the collection of textile waste. On the other hand, at the facility there are more employees and other processing units operated by the skilled persons. According to the given figures (Jing 2012, 15), 45.36 million kg of textile, that was collected by the recycling companies. And these textiles were sold to the clothing dealers: wiping tag and other method of managing textile waste and then sending it to the other countries where production and processing is cheap. This process is done after the sorting of textile according to textile nature and its process to burn or change it into new substance. In the field of textile waste collecting agencies/organizations, the number of workers are 30- 50. (Jing 2012, 15.).

There is one important point, in the process of recycling that there are no special requirements and responsibility about companies which are collecting textile waste. In Finland, there are certain types of companies which are working in the field of collecting wastes from households and selling them on the second shops for example, FIDA, UFF, and the collected money from selling second hand product go to non profit organizations or to charity. The collector companies in fact are not involved in the process of recycling; in fact they are just providing logistics services. On the other hand, recycler have to be more accurate and required more detailed information for example understand the nature of material and processing waste material in the right and efficient way, some certain types of techniques are also required in the process.

### 2.3.5 Clothing production & Behaviours

Managing supply chain and demand at minimum expenses is the first priority for companies today. Thus, in order to achieve the target, logistics and supply chain playing its role transportation raw material from different locations and products are assembled at different locations. Moreover, In order to understand in detail of the whole process, it is necessary to have a look the wages which labour is getting under poor producing clothing facilities at the minimum cost. Therefore, workers life is also at risk to work there, in the recent time some clothing factories collapsed Karachi Pakistan and in the last month, it's also happen in Bangladesh where more than

300 people lost their lives. Thus, in these countries, working environment and poor condition of production facilities put thousands of people life at risk. Furthermore, in the mentioned countries there are other facilities available for workers in case of this kind of mishaps. Therefore, the garments are made in such conditions effect on customer behaviours as well. The attitude of customer's does not make them happy even if they are buying cheap clothes, psychologically it affects customers at the time of buying clothes, on the other hand its also gives a message that because of their cheap clothing thousands of people are working while putting their lives at risk. On the other hand their pay is not good enough to sustain their monthly expenses. It is shows that the processing and producing cheap clothing in such conditions their life cycle period is not longer enough as well, so customer's at the time of buying clothes, they tend to buy expensive their life cycle can be last longer, on the other hand expensive clothes are costly and longer process at the different stages of processing from printing to stitching and dying it is also the long process to produce this kind of clothes.

The system of producing clothes in developing countries shows that we can save many people lives and other natural resources. In order to save resources which can be used for other purpose, there is second option for that to recycle textile waste and produce clothing at minimum cost while using few raw materials. Textile recycling is the best way to serve more people at the minimum cost. Therefore, in order to achieve the target, it is necessary to corporate in different organizations and companies, at the same time there is need to give awareness to customer's retailers, social media and manufacturer. With respect to customers point of view, mostly customers at the time of buying clothes they think and look at the clothes that they are not good looking and also not fashionable. In response to that manufacturer should make fashionable clothing while recycling textile waste and getting raw material from recycled waste. Therefore, manufacturer should give awareness to retailers and then this information transfer to customers which change the attitude of customers. Firstly, companies do practice and produce clothe from recycled waste then give advertising in social media and on internet. There is much other option to use fiber and recycled materials like, cotton, organic cotton and mixed raw material which can save processing time and reuse textile waste.

### 3 THE PRESENT SITUATION IN TEXTILE WASTE MANAGEMENT/RECYCLING

#### 3.1 Background Theory

In this chapter, the main focus will be on German textile recycling technology and I: CO; textile recycling process. Therefore, using online resources and finding information about German textile recycling technolo-

gy is to implement the German recycling technology, in Finland. The purpose of German textile recycling technology is not only target because of they have done lot of work in this area, Germany have done lot of back ground studies in specific field. Germany has done lot of research and development in textile recycling, at the moment, Germany is the leader in textile recycling technology in Europe. Thus, benchmarking theory is supporting towards improve textile waste management in Finland.

### Textile Waste Management in Germany

In Germany, the management of textile waste and recycling is the best leading system in the world. According SOEX group in Germany, they recycle annually 2721.554422 trillion Kg of textile waste with the percentage of 98%. In order to tackle this waste, Germany has introduced the technology of “Green Dot” this technology had reduced huge amount of waste. (I: CO 2013c).

- General Textile information in Germany

The basic ideas which are implemented in the Germany regarding to textile recycling, that is 3Rs; Reduce, Reuse and Recycle. On the other hand of this, other factors are also included like, Logistics, Environment and Sustainable development.



Figure 4 3Rs, source

#### 3.1.1 Textile waste recycling Companies in Germany

There are many companies which are working in the textile waste collecting and recycling in Germany. Therefore, mainly there is one leading group in Germany which is called (SOEX GROUP). On the other hand, there are many small medium size companies which are connected to this group in Germany; they are not only working in Germany but also other part of the world as well. Like, in the United States of America. These companies are lead in the world of textile recycling technologies.

3.1.2 German Textile Recycling company I: CO (SOEX GROUP)

I: CO stands for I: collect. The company is part of SOEX GROUP which is originally German based company. I: CO is committed to protect environment globally. Sustainable development is the vision of the company. I: CO is the leading in the field of collecting used clothes, shoes, belt bags and other similar kind of accessories across the globe. I: CO is recycling textile waste in the system of closed loop system. Therefore, from recyclable materials, new products are made and then come back to market for sale. (I: CO). According to I: CO, in order to produce one T-shirt 10,000 and 30,000 liter of water is required. On the other hand, the amount of CO<sub>2</sub> is also increased by 3.6 kg. The same T-shirt can be produced with recycling total consumption of these resources only 5 to 10 percent only. Thus, in order to collect used clothes and shoes, I: CO has many other partners which are working many countries in the world, like I: CO Blue is working in the field of collecting shoes and other leather belongings. At our homes, there are many things like, clothes, clothes and other stuff which we do not use. Therefore, instead of throwing them away, the best way to utilize these options is to apply the theory of I:CO, Rethink, Reuse and Recycle, most of them clothes are sort out at the collection point and good condition clothes are given to charities organizations which help poor people and give them clothes. (I: CO SPRIT 29, 2013).

3.1.3 I: CO Textile waste collection and recycling process

I: CO has a formula to apply; this is REWEAR & UPCYCLE. It is said that the clothes or other products that are possible to wearable is worn again. In other words its means that, the energy and other resources have been used for this product to make, in the case of worn again means, lot of energy and other resources can be save. In the second terminology, the meaning of recycling is to discarded textile or shoes, in order to make new clothes and shoes form those discarded products. Therefore, I: CO is trying to implement formula with the help of its partners around the world, partners are from different specialized expertise like, logistics, Environmental, recycling, materials and energy. (Prof, Brungart, 2013c).



Figure 5 Figure shows the formula of I:CO



- I: CO Textile waste collecting process (SOEX Group )

In homes, there are many clothes and shoes that we use or we buy, instead of throwing them away, I: CO has the solution to recycle it in sustainable, closed loop system. In Germany, I: CO has network with others logistics providing partners to collect used clothes and shoes and all kind of textile waste. Therefore, in order to make it more efficient, they are providing services 7 days and 24 hours from different collecting points to the main warehouse. Where clothes are sorted out and useable clothes are sending to charities organizations, in order to help people in least developed countries like some of them are in Africa. In the sorting process, there are different types of classes of clothes which are used at the time of sorting them according to the condition and types of textile waste.



Figure 6 The flow chart of waste collecting

In the Figure, it is shown the system of I: CO textile waste process. I: CO has the simple solution for operation to old textile waste. Therefore, I: CO not only collecting clothes but all kind of stuff like, old leather bags, carpets, shoes, toys and other isolation materials are also processed and recycling at recycling point in Germany. In this flow chart only I: CO waste managing and collecting process of all kind textile waste.

I: CO has made collecting points where used or unwanted clothes are thrown away. I: CO has made computerized machines for collecting used clothes at retailer shops. Where used clothes are collected, in the machines sensors are fixed. The purpose of fixing sensor and making it computerized system is to count the clothes given by the customer and on the other hand also counting the total price of the clothes. The system not only gives the information about clothes it also counts the money that is charged for each piece of clothes. Therefore, when garments /products are finished, there is a button; on pressing that button, a printed voucher is given to cus-

tomers that can have minimum 10% or more discounts for new shopping from the retailer shop. I: CO has good logistics services, when box is full of used clothes, then clothes are collected by transport. (How does I: CO work? 2013c).

In the research, it is found out that there are many other partners in I: CO, they are providing logistics service, in order to collect textile under the strategy of zero waste and reduction of CO2 emission. These partners companies are; EFIBA, East West and some small size transport companies. From all over Germany textile waste is collected in the main warehouse and from there with big container all waste is sent to SOEX Wolfen textile recycling plant. Thus, in the Wolfen textile recycling plant all kind of textile waste is processed accordingly the nature and substance of product. (I: CO services, SOEX WOLFEN, products, 2013.)

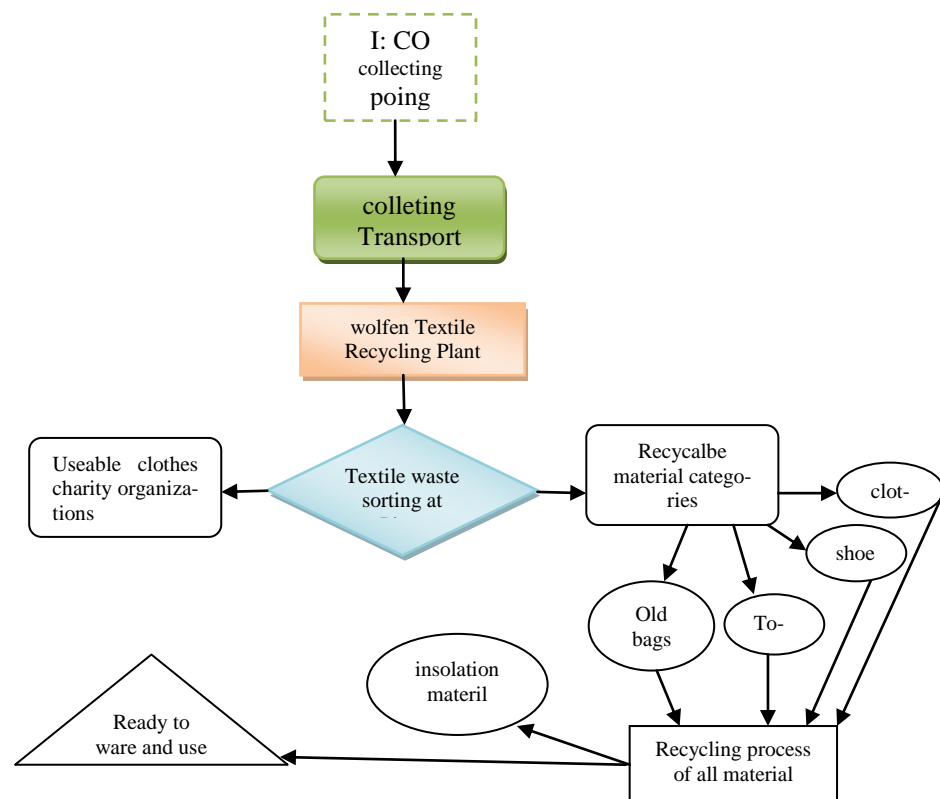


Figure 7 The figure of processing flow of textile material

The flow chart shows the flow of recycle material in Wolfen textile recycling plant. Thus, sorting and processing all kind of textile waste from collecting points is categorised. The process of textile waste is varying to vary the nature and substance of products. In the plant most of the textile waste is recycled and clothes and other stuff is made like, bags, shoes and other fashionable apparels. In addition, the good condition of clothes is given to charities organizations which send clothes to some countries, in order to help poor people.

In order to understand, the depth of entire process of textile waste recycling in I: CO. The basic strategies of the company are necessary to describe here, in order to give more clearly and in detail vision and process of the SOEX Group. Thus, the different use of all recyclable material, the implementation of the feature is the core strategy of the company which includes, Re-wear: the clothes which are in good conditions are sold in second hand shops. Re-use: the textile that has no use of it anymore, is converted into other types of materials like, single colour t-shirts, make it use in the cleaning clothes and sweatshirts. Up-cycling: the textile waste materials are converted into high or low quality clothing; later on these clothes are in use. Thus, shoes and old textile entirely converted into new textile. The last terminology of recycling in I: CO is “recycling” the main focus of all textile materials under I: CO. The textile which is into suitable to produce new clothes or any kind of these products, they are changed into other form of products such as, recycled fibres and non woven fabric, and rest of the material that is into even able to convert into non woven fabric, then it is changed into insulation materials such as, automobile manufacturing. (I: CO FAQ, 2013c.). The strategy of SOEX is applied in whole Germany which is totally implemented in German textile recycling under the one single strategy Zero waste, meanwhile taking all aspect into account like, environmental friendly, social cooperate responsibility.

### 3.1.4 SOEX Group global operation

SOEX is the leading and most experienced company in the field of textile waste recycling on global scale. Therefore, company is recycling textile waste at the percentage of 98% which is the highest amount of recycled textile waste under the sustainability and environmental friendly. Thus, the strategy of SOEX is zero waste; the company is operating textile recycling on global scale. At the moment, the company is still making more development how to more all resources more efficient. SOEX has main three affiliations to the companies mainly in Europe and USA, in Europe I: CO, I: CO stand for I collect. The company is working in different countries, but I: CO has main operation in Germany and in the UK and in Europe. Re: CO; which stands for re-collection is mainly working in the United States of America. Thirdly, SOEX has an affiliation with charities organizations. On the other hand the company has many other operations in fourteen countries. The main strategy of SOEX is re-use, re-wear and recycle, according to SOEX Group; company is recycling 300,000,000 ponds of clothing annually, while only producing 20 to 30 percent of residual waste. (SOEX GROUP, 2013C.).

- I:CO in Europe

I: CO is working in Europe in the field of textile recycling, collecting wastes in other European countries and brining them in the recycling point in the Wolfen recycling facility. In Germany all kind of textile waste is recycled and makes different kind of materials. I: CO has operations in the United Kingdom as well. Products are made and sell them in the stores back in the market. There is certain amount of material which is used for other purposes than clothing; this kind of material is send to other facilities

like in the USA. Clothing from textile waste and other products like, bags, toys, insulation material that are used in automobile industry are made in the Germany. On the other hand, some of material is sent to USA for redesign and other purposes. Therefore, in the flow of material between two countries transportation and logistics play an important role in order to make possible.

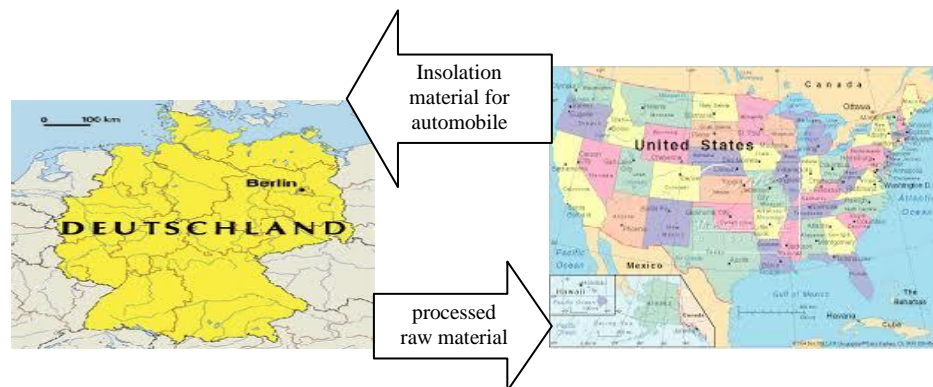


Figure 8 Figure shows the flow of material

So it is obvious from the map of two countries, the flow of processed material in Germany is sent to USA and from USA, after redesigning and ready to use products are then sent to Germany in order to use insulation material in cars.

- Re: CO

Re: CO is part of SOEX operating in USA, the main target of RE: CO is to redesign and restyle fashionable apparels and other clothing products. Thus, giving new shapes and new style to old clothes and make it more fashionable Re: CO has expertise in this field, like Tuxedo jacket is given other shape a little black dress. The company is making more fashionable dresses and giving new fashion and new design in minimum cost of processing and producing clothes. In the USA, company is working with many big brands like, Branyes New York; in addition, company has made many other corporations with many brands in USA. (Re: CO 2013c).

- SOEX as a charity star

The purpose of re-use, re-wear and Recycle is to bring all those clothes into use for the betterment of environment and desired people. In the United States, SOEX buys annually about 80 million ponds of used clothing from Salvation Army. SOEX has also affiliation with the German Red Cross organization (DRK). In order to utilize all these resources, the main purpose of all it is to prevent waste, make better environment and provide benefits to needy people as well. (Charity star, 2013c).

- I: CO Business Partners

There are around 27 business partners, that are working directly and indirectly with I: CO around the world. Furthermore, these partners are one of

the best brands in the world in different business lines. Like, Puma, Lidl, Adidas, C&A, Jack & Jones and one of new co-operating partner from Sweden, H&M. These partners are working with I: CO on global scale. In order to protect environment, Meanwhile I: CO is using the best recycling technology under the closed loop system. (I: CO Partners, 2013.).

Here is the list of all I: CO business partners

- Adidas
- Adler Alles PASSIT
- BACHLI
- BINGO
- BLACKOUT
- CALZEDONIA
- CARHARTT
- C&A
- Foot Locker
- RENO
- H&M
- Intimissimi
- JACK&JONES
- Lidl
- MAMMUT
- MAX SHOES
- Mayer Schule
- HEMPEL
- MTWTFSS WEEKDAY
- Name It
- Puma
- Schuh-Du
- Sport 2000
- S.Oliver
- TRANSA
- VÖGELE SHOES
- VOLCOMO

In all above, H&M is the first company textile selling brand which has made corporation with I: CO. I: CO will recycle all textile waste which will come from H&M and ready textile garments will be selling at H&M and other cooperating brads shops.

### 3.1.5 I: CO Recycling process (Wolfen textile recycling plant)

I: CO is the part of SOEX group, Wolfen is the plant of processing plant in Germany, where all kind of textile waste is collected, sorted and recycled with the cooperation of its partners. SOEX Wolfen recycling plant has recycling textile waste everyday more than 6000,000 pounds. The processing plant is working. When all kind of wastes is delivered at Wolfen Textile recycling unit, firstly, it is sorted by skilled workers as the criteria of sorting have been set 400, the sorting process is from fabric , to clothing

target, the sorting process continue until there is nothing left to waste which is called “zero waste strategy”. In the plant modern information technology applications are used. When the sorting is done, remaining textile waste which there is no use of it. Waste is sent to Wolfen computer-controlled recycling facility. Those kinds of textile waste are process and recycled chemically, the raw material from recycling process is mostly used in the automobile industry like, insulation purpose. (SOEX Wolfen 2013c).



Figure 9 sorting category at Wolfen recycling plant

In the given above image, it shows the process of sorting clothes according to clothes types. There are different categories about sorting with all possible sources. Therefore, the category of textile waste is sorted into 400 different types and materials in Wolfen textile plant. (I: CO System.2013c).

The processing and flow of textile waste is proceeding under the closed loop process. The material flow in this system is more efficient and environment friendly from collecting textile waste bring it to the end customer in the market.

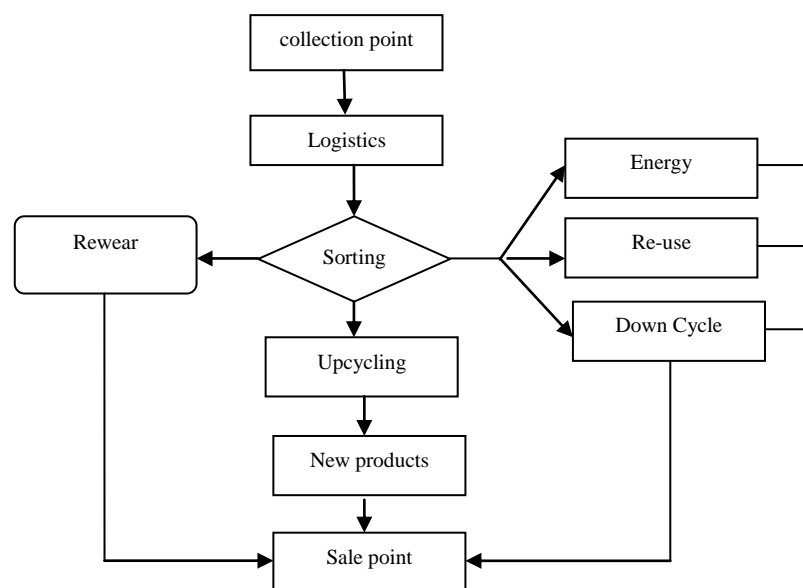


Figure 10 Process of textile waste closed loop system at Wolfen recycling plant

Closed loop system flow chart shows the processing flow of textile waste management at Wolfen Textile waste recycling in Germany. Therefore, the process flow of textile provides detail and the type of material which is used. Re-wear is and other factors which contribute to develop new products in textile waste recycling.

### 3.1.6 I:CO Textile waste collection system

In this part of the chapter the author gives an idea of collecting textile wastes from collection points, logistics plays and important role, in order to manage textile waste with the strategy of “Green Logistics” Environment friendly and transport cost saving and other factors are taken into account. Therefore textile waste collecting processes is important to manage.



Figure 11 I: CO textile waste collecting system

#### I: CO Box

In order to collect any kind of waste or products, boxes are the best way to collect the waste. Thus, I: CO is using the simple strategy to collect clothes and shoes. The box is place behind the cash counter where there is no direct access to customers; the sales team accept clothes and shoes directly from and in the return customer get discount coupon.(I:CO system.).

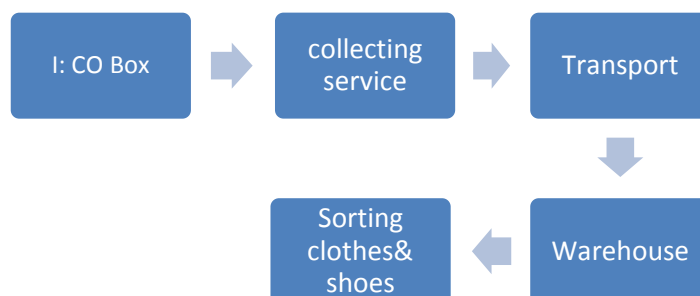


Figure 12 I: CO box textile waste process

I: CO display

Display system provides two types of benefits to retailer/collecting companies in the shops, it is used for advertising purpose, in order to give awareness to customers and sometimes discount is given to specific clothing. Customer put clothes and shoes directly and in the back they get coupon discount for shopping. Display is placed near the cash counter where in fact customer service and instructions are provided if customers need it. (I: CO System.).

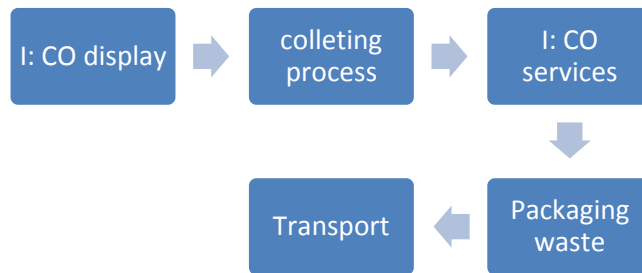


Figure 13 I: CO display system of collecting waste

I: CO counters smart Automatic

The system which runs based on power supplies, counter smart technologies are applied here in order to count and estimate the cost of each piece which is thrown in the counter. In this kind of system customers put directly clothes/shoes and get discount coupon. In order to maintain system, it is required to maintain in balance 1 to 2 years. The total capacity of these counters is about 6 Kg waste. (I: CO System.).

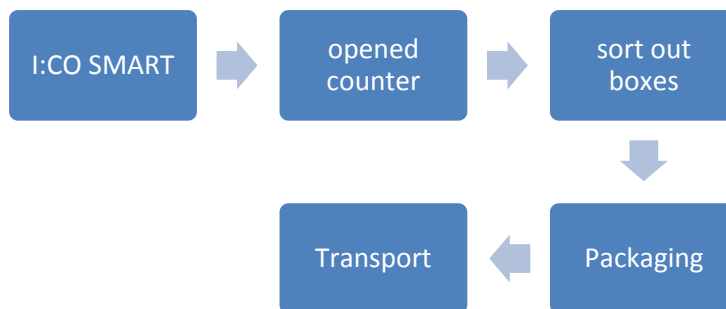


Figure 14 I: CO smart counter process of collecting waste

I: Container automatic

In order to manage and expanding the total capacity of collecting waste in low price level counter automatic is used. This type of counters are placed outside of the main branches, customer can bring and put clothes and shoes but in the return no coupons are issued to customers, the total capacity of collecting waste in counters is about 15 to 20 kg(I:CO System.).



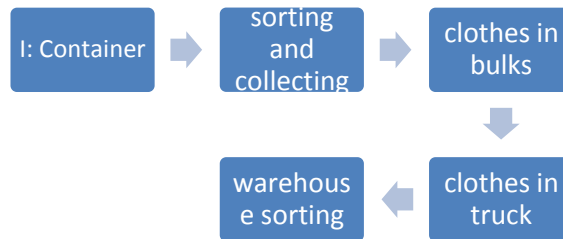


Figure 15 The process method of collecting waste from containers

### 3.1.7 I: CO and H&M partnership

In this part of chapter, the author provide background theory in the filed of logistics and sustainable development that is interlinked to textile waste management and it is also related to textile recycling, environmental issues, in order to give more detail and understanding to reader. Since, the increasing demand of clothing and other textile apparels, due to increasing rapidly total population. Therefore, today in the present world that dominated by sort of technologies and management studies. Furthermore, logistics, supply chain and sustainable development playing important role moving raw material from one part of world to an other part of world. Today most of the companies are outsourcing production to other countries where the cost of production is less than other developed countries. Recycling all kinds of waste provides less cost of producing new products and on the other hand it is also taking all the resources into use in order to make environment friendly. Since, most of the companies are working on the processing of wastes and producing different type of products. In the light of recycling and waste management, textile is one of the biggest sources to recycle. Therefore, in order to meet the future demand and providing cheap clothes to customers, recently two companies have made new cooperation to recycle textile waste. H&M Swedish brand made new connection with German company I: CO in the field of textile waste recycling, Swedish company is the first company in the world which made and took a stand utilized all the resources for the betterment of environment and its customers.

H&M will collect used textile clothes at shops and collected waste will be sent to I: CO in Germany for recycling. Furthermore, I: CO will recycle all kind of clothes and make new clothes and garments. Later on, these clothes will be sold out at the shop after recycling and making new clothes from second hand clothing.



Figure 16 Used clothes drop system at H&M

### 3.1.8 The income source of I: CO

The source of income is the basic and main function of the company; there are different type's financial sources. Charity star is one of the biggest sources of income which runs all the process of collecting, sorting and processing textile waste under SOEX Group. The charity star is the main resource of financial sectors that is sponsored by I: CO partners companies. Therefore, there are many other companies, which donate to charity star the partner organization of I: CO, every kilo of waste which is collected is donated by the partner companies. The estimated cost of collected textile waste is two cents of euros. The system of I: CO partners is like, when the total amount reach more than 1000 euros then amount is paid out to the company, so the collected money goes to project which are running under I: CO like, collecting, processing, sorting and recycling textile waste. Thus, Charity star is the main source of developing different projects, in the developing countries. (Every kilo count here, 2013c.).

### 3.2 Products from recycle material

I: CO is producing many products from recycled material; these products are made of such textile waste from the poor quality of textile which is not able to produce clothing and other stuff. Therefore, these products are made of material while processing textile waste at high level of processing. The process of recycling and changing material from one form to other is quite complicated. I: CO is making most of the products belongs to textile and few of them are used in automobile industry like non woven fabric is one example. Most of good condition clothes are recycled and making new clothes and bring back in the specified stores in Germany. On the other hand some of clothes are not in good conditions, from these kind of textile waste other type of products are made for different purpose. (I: CO FAQ. 2013c.).

Textile waste recycling brings all kind of waste into use, meanwhile waste recycling is categorised into different classes. The best class of waste recycling provides almost the same stuff from recyclable raw material. So, ready to use clothing and other stuff like toys, linen, other fashionable clothing is come to I: CO shops in order to sell. The most of the products are made in daily use, so it is possible to divide recyclable materials into two categories upper class and lower class, so ready to use products are sell at the shops with less processing while making different kind of products, it require bit more time to proceed.(I: CO System. 2013c).

Types of clothing is made into two categories, both of them are mentioned here.

- Clothing
- Footwear
- Accessories
- Handbags
- Home Textile
- Other Textiles

Rest of the recycled material is used for other products.

### Insulation Materials

Insulation materials are an important part in construction, material are used for the ventilation purposes and conduction, radiation and thermal insulation. Therefore Insulation materials are made from textile waste, insulation material is the key to keep balance of energy consumption. (Wikipedia).



Figure 17 The insulation material made from textile waste

### Geo Fleece

As textile waste is recycled in SOEX Wolfen plant, from the process of recycling textile. Geo Fleece is made for use in the winter time; it is made

for both male and female. Designing and making proceed happen in Germany in : CO company.



Figure 18 Example of Geo Fleece made from textile waste recycled material

### Carpet underlay

Generally carpet underlay is the thin layer of cushioning which is used in different form of carpets which are used for different purposes. Therefore, the categories and types of underlay vary like, sponge rubber, foam and crumb rubber. Thus, it is also used in the carpet in order to moisture noise and heat. (Wikipedia.)



Figure 19 Example of Underlay Carpet

### Rear shelves in car

The rear shelves in car and in other vehicle are used in order to make compartment normally in the back of cars where things can be placed. The rear shelves are varying the model and company of the cars. (Wikipedia.)



Figure 20 Example of Car shelves

### Stuffed toys

Stuffed toys are made of different type of textile, normally textile is recycled. In this kind of toys are made from plain clothes and pile textile, in addition there are other type of textile like, cotton, synthetic fiber batting and terrycloth. These types of toys are used for comfort as well as playing for kids. (Wikipedia.)



Figure 21 Stuffed toys made of textile waste

### Shoe insoles

Shoes insoles are important to make for shoes, they are used underneath in the shoes in order to make shoes more comfortable to wear, and they can be easily removed from the shoes. (Shoes about)



Figure 22 Example of shoe insoles

### 3.3 conclusion

With respect to the textile recycling system in I: CO, in naturally the realistic textile recycling technologies in Germany as a whole and specifically SOEZ Group; the system is the best at its recycling process as well as there are many mechanical, environmental and strategically specific on the

textile recycling, most advantaged system is used in simple way. In order to make it advanced simple and environment friendly and cost effective, while utilizing all kind of recourses in efficient way.

In other words, through the system of I: CO and SOEX Group study case, especially opportunities and similar logistics and transportation system is valuable information to country analysis.

Meanwhile looking at the whole process of textile waste recycling in SOEX Group like, reuse, recycle and reward creates a new system in the country analysis. At the present, the trend of reusing and recycling is becoming more required with the passage of time, using textile waste in efficient way provides excellent like, zero waste output through the process as a whole. In addition, there are many technical aspects as well as management processes are also included. The system of textile waste recycling in Germany as well as in SOEX Group is the highly automated and takes into use modern technologies like Information technologies and other sensors system in the processing of warehouse and sorting and categorising different type of textile waste. I: CO is not only working only in the textile waste but it also focusing on the sustainable and other environmental issues as well like, reducing landfill, burning waste and reducing CO<sub>2</sub> emission from the process of textile waste to end products. Further more, at the time of designing new garments and other clothing, in SOEX Wolfen recycling plant other issues are also comes into account such as, products are designed like they can be recycled easily with less process and the life cycle of the products is also an important phase of the process. I: CO has a simple but very efficient way to process textile waste, I: CO is the leader in recycling textile waste and its strategy to save environment.

### 3.4 Recommendations

In this chapter, the author will discuss recommendation and its feasibility from target country Germany, mainly the focus will be on I: CO and its strategy to possible implementation in Finland. Therefore, there are many aspects and technical aspects from which Finland can learn as well as can also implement the system of I: CO in Finland. There are many successful aspects and other technologies, which are applied in I: CO, they are feasible to apply in Finland as well as possible to make partnership and project sponsor from I: CO. It shows that in the light of processing and collecting waste till products are ready to use, there are many aspect included which are mainly based on the population and legislation of Finland, on there other hand logistics and transportation and environmental permits and solid waste also important to take into account. Thus, investing a huge amount of money is not the only the key point, research and development and expertise in sustainable and logistics are also important. On the other hand of this the corporation of transports and logistics companies is also important, warehousing and sustainable supply chain is the key point in order to develop new system, this is not all, there are some other factors are included like, charities organizations (UFF), (Fida) are key players in the way to develop new textile waste system as well. Today is not possi-

ble to progress and make more efficient way without the implementation of Information, mechanical and automation technologies. On the other hand of this, it is good to make corporation between Finnish companies in the different fields of products like, Seppälä, Stockmann, Tarjoustalo and local companies in Finland. These companies should not only include textile they can be vary from different line of business.

On the basis of previous research study on environmental issues in Envitech area under the project bright green Forssa, there are many companies which are working in environmental developing and logistics and transport system in the whole region. Therefore, the infrastructure of transport and logistics system is well developed in order to gain advantage of this system. With respect to the system of I: CO, in order to implement the system in the region, so in order to do corporation companies need to make common strategies and shared information through information technology system like, ERP from collecting textile waste to recycling, sorting and processing. It also will be good to utilize the services of the companies in the Envitech area. solid waste collecting companies can make more containers and drop box for textile and clothing, collection can happen when other waste is collected, in order to do so transport cost and other processing cost will be saved which can be spent other activities.

## 4 RESEARCH METHODOLOGY

### 4.1 The main purpose of research

The main purpose of this research is to analyse and find possible solutions for developing textile waste recycling system in Finland, recommendations and evaluation from target German Group of textile waste recycling with the name of I: CO. The whole process and project is supported by HAMK University of applied sciences ongoing projects, which provides useful information in order to implement I: CO system in Finland. Thus, the main research is based on conclusion of the author.

With regard to research on I: CO textile recycling system in Germany bring valuable information to implement textile recycling system in Finland. I: CO is the leader in textile recycling in the world; they have developed system in very efficient way since 1980S. Before that there were system existed but not efficient and reliable but Germans and specially I: CO have developed excellent textile recycling system in the world; which is

leading and processing millions of tonnes of textile waste in the different countries of the world.

In order to achieve the target of research, author mostly uses qualitative research methods, like literature research and in depth the target textile recycling company I: CO

### 4.2 Data collection methods

There are two methods to collect data qualitative and quantitative data collation. In this system, the author chose the qualitative data collation method in order to conduct research. The mainly focused on this project and data collecting research was basically qualitative in order to help and find useful information the reason behind of it is to find out information behind the scene as well as strong deception towards the main focus of the subject. Specifically, when there is a project on textile waste recycling, it is not so famous and wide known topic, in other words there is not enough information is available in order to make it more clear and explain it in precisely as well as specialist information regarding to textile waste recycling system.

In this research thesis, the author mainly focused on the primary data collection which is based on qualitative system. The system of collecting data is based on paper based and mainly on internet based-research such as, online us pages and video link also. The data is available at (<http://www.ico-spirit.com/en/homepage/>)

The data was mainly collected through the different sources of internet and the Target Company and country. The author has chance to look at the system of textile waste recycling system in Germany and the lead of the textile waste system which; is Germany and I: CO. On the other hand of this there are many other aspects which author got chance to know in detail at the time of making research, author made conclusion in efficient way to develop Finnish textile waste system. The main source of primary data was to collected different types of report and thesis and other related research as well. These resources were included like, Books, reports, government and electronic based and internet as well as. There were other sources of data and the main idea of the reoccurs which was taken from the main project such as European recycling textile system. The whole process of collecting data went smoothly, I: CO has best technology and best way to utilize all kind of natural and other resources.

The process of finding information for Finnish textile waste recycling from I: CO gave the author a clear view of the whole system of textile waste recycling process. The mainly focused was on I: CO and the new corporation with H&M. it has found that the corporation of both companies brought more clear and sustainable issues to take into account. However, the main aim is to find out useful information for the research of concluding internet based research.



## 5 CONCLUSION

### 5.1 Analysis and research evaluation

In this part of chapter, the main focused will be on applied and comparing approaches in case of I: CO and Germany which are expected the result of Finnish present situation, on the other hand author will conclude own opinion through I: CO textile recycling system and German textile recycling technologies.

#### 5.1.1 I: CO system implement in Finland

In this thesis, there is only one target country and the main focus on I: CO textile waste recycling system, which is the leader of textile waste recycling in the world with the implementation of modern technologies. Comparing I: CO system and the infrastructure of Germany to Finland have its own atmosphere for further progress.

Meanwhile looking at the system of I: CO, developing the same system in Finland, Finland develop more erotology and other transportation system and corporation between other companies as well. Similar like in Germany, the zero waste strategy given by I: CO in the whole Germany, the existed system of recycle, reuse and re-wear system in Germany provides useful and ideal situation for Finland. In the system of I :CO provides information which not only based on investing on transport and labour but it would be useful to invent in the process of textile modern technologies and machineries. Therefore, the target can be achieved though the system of I: CO while adopting automation processing, sorting and processing textile waste from collection points till recycling process. Dot Green is the best implement system in order to apply in the way of developing Finnish textile waste recycling. On the other hand of this the ideas and common strategies are important between retailer consumer and producer as well. There is some kind of other problems in the way to develop system in Finland which is resisting power; it can be developed by the system and the same way as in Germany, for this purpose the SOEX Group is has the best solution, it is also found that SOEX Group can sponsor and provide its expertise to develop Finnish textile waste recycling system under the modern technologies and very simple strategy.

In the target group, designing and recycling is the solution of terminal exist towards saving landfill and reducing CO2 emission. On the other hand it will save many other reoccurs which are going into waste and causes other problems like, environment, landfill and lacking of efficient way to

take into account. Implementing the system of I: CO in Finland will bring new trend to companies as well as to the population of Finland. Thus, from this waste many useful products will be made and the utilization of recourse will also save energy and other cost effective environment issues will be better in use. Further more, it will also create sustainability and provide cheap clothing's and other textile waste products, Finnish company Marimekko is already committed to reduce waste and make their product ecological. Mover over, I: CO has the best solution to provide 100% sustainable and reuse of all textile waste which in result save raw material of new products.

### 5.1.2 Cooperation among organizations

It is important to establish connection with different organizations in order to be successful, different companies play different roles in order to make all the process possible like, is had discussed and found out in Germany in the SOEX group. Textile recycling system is a system which cannot possible to achieve only focusing only on the one side of it. In Germany all the organization from different business lines are working together in order to gets success in the field of textile recycling. On the other hand when it is looked at in Finland, there is no such connection established yet, so companies need to be more open and cooperate. There are mainly many research and development centres which are only working in the field of textile waste recycling in Germany. The corporation with educational institution and other organization is important as well. Thus, at the moment there are only two main companies which are working and collecting used textile and selling them in the market which are only re-wearable; others are going to waste and landfill which is causing and destroying natural resources. In order to develop the system efficient project sponsor is required from I: CO. Likewise, I: CO is co-operating with other companies like, charity start I: CO Blue and I: CO and Re: CO. Moreover, there is need to establish the connection companies and customers also. The idea will be good if some of Finnish companies start to provide discount coupons to customers who bring used clothes to the shops or drop clothes in the colleting points, this kind of system is already exits but only need to make it more clear and integrate information between companies.

### 5.1.3 Research and development key point

Research and development is the key to innovate and bring new ideas into use. It is normally to develop more skills with the helping of research and development. The same system applies in textile waste recycling system, which has brought great success in the textile waste management in Germany under the SOEX Group. The methodology of news always works while developing and making it more innovate. On the other hand, there are other applications which are being used at the moment; they are like, establishing network among companies. On other hand the flow of product information at the stage of production and till end user of the products. Therefore, another way to make it flow is to make more effective communication and sharing information about products. Thus the implementation

of technologies is important as well like tag reading and smart cards are the key roles in the system of processing and sorting different products which are coming from different reoccurs of textile waste. So, I: CO is the best example to learn and apply that system into Finland which will bring excellent results. The system of collecting textile waste in Finland can be applied in the following way.

- Collecting point (Boxes)
- Clothe drop off
- Drop off location
- Transport system
- Recycling response
- Sorting of clothing
- Processing
- Recycling

### 5.1.4 Recommendation for further studies

The author will discuss the limitation in this thesis. Therefore, for further studies technical aspects have to be taken into account. The main purpose of this part of chapter is to define and make conclusions for future studies, technical and other aspects will improve the textile waste management system in Finland. So in order to get a target of the future studies, it is necessary to make a boundary of target studying, in this thesis other information technology and automating and environmental issues have not been taken into account. According to the current situation of industrial textile and solid municipal waste system in Finland, it is not wise to study these issues. With respect to the SOEX textile recycling in Germany, it is highly recommended to deeper study in chemical processing and its process to recycling. At the moment, in Finland there is no highly chemical textile processing system, therefore, in this thesis the main target is to benchmark German recycling technologies as well as the main focus is on I: CO.

As compared to SOEX, it is highly recommended to find second hand textile waste processing machines which are possible to find easily and cheaper from the main group of SOEX. How recycling system and the similar modern technologies can be implemented in Finland. According to findings from environmental and other solid waste process, it would be beneficial for further studies to deeper understanding of the project. Thus, a corporation among organizations, companies and public sector is necessary, in the deeper understating, financial issues and other corporations are important to take into account. At the moment, there are two main players in the field of collecting used clothes like, UFF and FIDA, their corporation and the system of processing and collecting textile waste can make more efficient while both of companies start to collect other textile waste. On the lager scale of findings, Governmental and municipal system is required to do research.

## 6 SUMMARY

In the following chapter, the author will present the summary of whole thesis project. The main goal and purpose of this thesis is presented briefly in this chapter.

In the main goal of this thesis, the main objective of the thesis as it is listed benchmark the German company I: CO. In the thesis, author presented the leader of textile recycling waste I: CO, the objective of benchmark I: CO textile waste recycling system is to finding the possible way to implement the same I: CO system in Finland. In order to make the objective of this thesis clear, author presented two supporting chapter introducing textile waste management and its recycling process and other is present situation of textile system. Furthermore, the specific I: CO case was mainly target, in order to do so different source of information and research was conducted. Textile waste recycling is not only single system but it is also connected to another process of supply chain which includes, transportation, warehousing, processing and collecting. On the other hand of this, there are other technological and environmental issues are inter-linked to whole recycling process. Alongside these issues, there are some other factors, which are connected with different scales like, different strategy have need used. With respect to I: CO case, I: CO has a very simple solution for recycling at the level of zero waste while using 3Rs strategy, Rethink, Recycle and Reuse. Meanwhile, studying and benchmarking German I: CO textile recycling system, there are possibilities to apply the same system in Finland, so in the theoretical part the basics ideas and sustainability issues were taken into account in order to improve the better recycling system and give clear idea to reader.

In order to approach the theoretical background and other recycling system of recycling at I: CO, mainly primary data collections system was collected in order to achieve the objective of the thesis. Therefore, the data was collected from different internet sources using I: CO web pages. On the other hand of this, some supporting theory was conducted as well, author mainly focused on I: CO textile system and its possible and developing aspects in Finland under the case of I: CO. AT the moment, I: CO has the best textile recycling system worldwide. In the conclusion, author also focused on the new corporations among companies and organization in order to implement I: CO system in Finland. So new corporations are always needed in the chapter present situation of textile, author also focused on the new partnership between H&M and I: CO, H&M is the first fashion clothing company which have taken huge step toward sustainability and utilization of all resources in efficient way to collect used clothes and recycle all clothes and then ready to use garments are sent back to stores for sale. Thus, social awareness and other factors like the effect of textile recycling on consumers companies and manufacturer. Finally, the main conclusion has taken from I: CO benchmarking theory, its possible way to implement in Finland.



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