ADVICE REPORT ON

DESIGNING THE DISASSEMBLY PROCESS OF E-WASTE

TWENTE MILIEU

Group 4

Evelien Gosenshuis	S1826560
Laura Ooms	S1605704
Lydia Antonides	S1605925
Rosemarijn Kramp	S1625454

Supervisor: dr. Ir. S. Löwik

Friday, the 27th of January

MANAGEMENT SAMENVATTING

Op dit moment wordt door Twente Milieu en De Beurs e-waste verzameld en soms gerepareerd. Graag zouden zij in het recyclen van e-waste een volgende stap zetten. Daarom worden er door Twente Milieu nu al plannen gemaakt voor een nieuwe centrale locatie, zodat er op één plaats e-waste verzameld kan worden. Voor het uitbreiden van dit recyclingproces is het voor Twente Milieu en De Beurs van belang dat er werkgelegenheid is en blijft bestaan voor mensen met een afstand tot de arbeidsmarkt, de sociale werknemers.

Met dit onderzoek wordt Twente Milieu en De Beurs inzicht gegeven in het proces van de demontage van e-waste, waarbij de focus ligt op witgoed. Daarbij wordt eerst, door middel van literatuuronderzoek, bepaald welk type proceskaart het best te gebruiken is om het demontageproces van e-waste in kaart te brengen. Daarna wordt er voor het bepalen van het demontageproces van e-waste een methode opgesteld. Deze methode wordt toegepast voor één soort e-waste, de wasmachine. De processtappen om de wasmachine te demonteren, worden hiermee in kaart gebracht. Daarna wordt de gekozen proceskaart toegepast op dit demontageproces. De laatste stap in dit onderzoek is bepalen of het demontageproces van de gekozen soort e-waste, de wasmachine, uit te voeren is door sociale werknemers. Hierbij wordt er onder andere bepaald of de uit te voeren stappen gemakkelijk te doen zijn, en of er niet met gevaarlijke stoffen moet worden gewerkt.

Op basis van het rangschikken van verschillende variabelen is de flowchart gekozen als meest geschikte proceskaart voor het weergeven van het demontageproces van e-waste.

Door een lijst op te stellen van onderdelen van de wasmachine en deze onderdelen in kaart te brengen met behulp van een onderdelenschema, worden de eerste twee stappen van de gebruikte methode gedaan. Daarna wordt met behulp van een YouTube video de demontage van een wasmachine stap voor stap beschreven. De in kaart gebrachte processtappen voor het demonteren van een wasmachine worden uiteindelijk weergegeven door middel van de flowchart.

Nadat het betreffende apparaat uit elkaar is gehaald worden de onderdelen verdeeld op basis van type materiaal. Deze grondstoffen kunnen vervolgens worden verkocht of hergebruikt. Dit leidt tot toegevoegde waarde van de e-waste.

De benodigde vaardigheden die hierbij naar boven komen voor het demonteren van de wasmachine, zijn voornamelijk het losschroeven en losknippen van onderdelen van de wasmachine. Daarnaast bevat de wasmachine geen, of in zeer kleine mate, schadelijke stoffen. Daarom achten wij het demonteren van een wasmachine zeker binnen de mogelijkheden van een sociale werknemer. Daarmee voldoen we aan de vraag van Twente Milieu en De Beurs om werkgelegenheid te (blijven) creëren voor sociale werknemers.

Door de methode voor het bepalen van het demontageproces van e-waste op andere types e-waste toe te passen, kan er ook voor deze types een flowchart opgesteld worden.

Aan de hand van dit onderzoek adviseren wij om eerst de flowchart van de demontage van de wasmachine in praktijk te brengen op de nieuwe locatie. Hiervoor kunnen sociale werknemers worden aangenomen. Aangezien er op dit moment waarschijnlijk onvoldoende wasmachines binnen zullen komen om te recyclen is een continu proces in het begin nog niet haalbaar. Zodra het proces van de demontage van de wasmachines goed werkt kan de beschreven methode worden toegepast om meer flowcharts over de recycling van e-waste te ontwerpen. Twente Milieu en De Beurs kunnen samenwerken doordat De Beurs kan controleren of de binnenkomende e-waste nog werkt. Als dit niet zo is kan het afval doorgestuurd worden naar de nieuwe locatie. Daarnaast kan De Beurs bekijken welke sociale werknemers geschikt zijn en kunnen ze controleren of de vaardigheden geleerd kunnen worden aan een sociale werknemer. De Beurs kan zich richten op het begeleiden van de sociale werknemers en Twente Milieu kan zich richten op het demontageproces.

MANAGEMENT SUMMARY

At this moment, Twente Milieu and De Beurs collect e-waste and sometimes repair it. But they would like to take the recycling process of e-waste to the next level. Therefore, plans for one new central location are being made, so e-waste can be recycled at one site. For expanding this recycling process, it is important that employment is and will be available for social workers.

This research gives Twente Milieu and De Beurs insights on the disassembly process of e-waste, in which the focus is white goods. Firstly, there will be determined, by the use of literature research, which type of process map will be the best to use for the disassembly of e-waste. After that, a method to describe the disassembly process of e-waste is set up. This method will be applied for one type of e-waste, the washing machine. The process steps for disassembling the washing machine, will be mapped by means of this method. Afterwards, the chosen process map will be applied for this disassembling process. The last step in this research is determining whether the disassembling process of the chosen e-waste, the washing machine, can be executed by social workers. Therefore, there will be determined whether the process steps are easy to do, and if there are hazardous substances present.

Based on ranking the various established variables, the flowchart is chosen to be the best process map for displaying the disassembling process of e-waste. The process steps charted for the disassembling of a washing machine, are therefore rendered by means of a flowchart.

By establishing a list of the parts of the washing machine and mapping these parts through a parts diagram, the first two steps of the used method are applied. After that, the disassembling of a washing machine will be step by step outlined by watching a YouTube video.

After the disassembly of the device, all the components are sorted based on type of material. These resources can then be sold or reused, which adds value to the e-waste.

The required skills that are necessary for the disassembling of a washing machine are mostly disconnecting, unscrewing and cutting loose the parts of the washing machine. Besides that, the washing machine does not, or in a negligible degree, contain hazardous substances. Therefore, we deem the disassembly of a washing machine in the capability of social workers. Therewith, we satisfy the issue of Twente Milieu and De Beurs to (keep) creating employment for social workers.

Based on this research, we advise to bring the flowchart for the disassembly of the washing machine into practice at the new location first. Social workers can therefore be employed. At this moment it might not be achievable to make a continuous process, because the number of washing machines alone might not be sufficient. As soon as Twente Milieu and De Beurs are comfortable with the process of the disassembly of washing machines, the method can be applied to design more flowcharts for other types of e-waste. Twente Milieu and De Beurs can work together in a way that De Beurs can check if the incoming devices are working, if not, they can send these to the new location. Also De Beurs can see if the social workers have the required skills and can check if the skills can be taught to the social worker. De Beurs could do more guiding activities of the social workers as well. Twente Milieu could focus more on the disassembly process activities.

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1. INTRODUCTION

Twente Milieu and De Beurs are two collaborating institutions who want to make an effort for the environment by expanding their range of activities in the recycling process of (e-)waste. Next to that, they aim to help social workers reintegrate into society. At this moment the recycling process of e-waste is being outsourced to Omrin, a recycling company in Friesland.

Twente Milieu and De Beurs want to improve themselves by increasing the value out of the collected e-waste and by taking the next step in the recycling process on a new central location. By doing the recycling process more locally, Twente Milieu and De Beurs hope to increase their social return. Unfortunately, at this moment Twente Milieu and De Beurs are not yet able to implement these changes for improvement.

This research gives Twente Milieu and De Beurs insights on the disassembling process of e-waste, in which the focus is on white goods. By doing this research we will formulate an advice on what actions to undertake which will help Twente Milieu and De Beurs increase their added value to e-waste and provide a plan on how to integrate the further steps of recycling of e-waste. Twente Milieu and De Beurs already have plans for one central location, so this will be our reference point.

The following chapters will describe the research that is done. Chapter 2 gives a clear overview on what the current situation is and gives a description of the core problem that has to be assessed. Chapter 3 states the research approach, containing the different research questions and the corresponding research methodology. Chapter 4 then gives us the key concepts used in this study. In chapter 5, 6 and 7 the answer to the three research questions can be found. And in chapter 8 we conclude our research with some limitations and the recommendations can be found in chapter 9.

2. EXPLORATION OF THE PROBLEM

Twente Milieu and De Beurs want to take their current practice of recycling to the next level. At this moment, there is no direct problem. In order to assess this case systematically we will approach the desired changes of Twente Milieu and De Beurs as if they did were a problem. The focus of the problem area lies at the question: 'What is better to do? Organizing product flow for collecting, sorting, disassembling, repairing and selling based on processes by employees, or by yield in the type of components?' (problem 3). In this research we will focus on the process of disassembling.

The problem can be identified by assessing which problems are present (paragraph 2.1); relating these problems in a problem cluster (causal relation) (paragraph 2.2) and choosing the core problem (paragraph 2.3) (Heerkens & Winden van, 2012).

2.1. PROBLEM IDENTIFICATION

First of all, all problems that are present are uncovered. These problems are collected from the information provided by Twente Milieu and De Beurs in their presentation and by interviewing them during the company visits. A number of problems are assessed.

Twente Milieu and De Beurs want to achieve two things: having more social return in Twente and adding (more) value to e-waste. To increase the social return in Twente and to add more value to the e-waste they have to do the recycling at one location, because this will increase the size of the processes that Twente Milieu and De Beurs can do. Working at a larger scale, will increase the available places for social workers and can extend the recycle process of e-waste. The further processing of the e-waste will add value to this e-waste. Twente Milieu and De Beurs are already planning on getting one central location which will be used for disassembling or repairing e-waste.

In order to realize the process at one location, a plan for an effective and efficient disassembly process is necessary. There are several things required to be able to get a complete process that is effective and efficient. First of all, sufficient amounts of e-waste are needed in order to execute the recycling processes at a larger scale. Working at a larger scale means that the same action is done more often. This will make the recycling steps easier, which might be required for social workers. Second, Twente Milieu and De Beurs need a building for their activities at their planned central location. For this building a lay-out need to be made to set up their process. Third, to achieve an effective and efficient process the organisation of the process has to be clear. This can be accomplished by making a process map. A process map will make clear what activities have to be done. Fourth, Twente Milieu and De Beurs need the right resources in order to have an effective and efficient process. These resources consist of skilled employees and tools like screwdrivers. Fifth, to be legally allowed to recycle e-waste, Twente Milieu and De Beurs need to be aware that there are some legal regulations. One of these is the WEEELABEX certificate (NVMP, 2017).

2.2. PROBLEM CLUSTER

The relations between the problems stated in paragraph 2.1, are shown in the problem cluster, figure 2.1. At the top of the figure is shown what goals Twente Milieu and De Beurs want to achieve. The arrows are represented in such a way that the arrowhead describes how the antecedent can be achieved. Social return can be accomplished by local recycling for example.

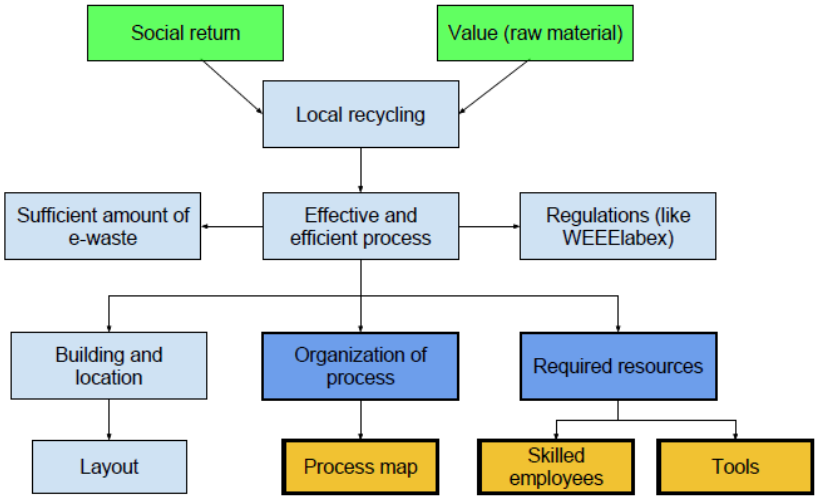


Figure 2.1: Problem cluster

2.3. DEFINING THE CORE PROBLEM

The core problem is the problem that underlies the other problems. This core problem can be extracted from the problem cluster which can be seen above in figure 2.1. There are a few rules which the core problem must satisfy in order to be a core problem. First, the core problem must be an actual problem. Second, the core problem cannot contain any causes. Third, it must be possible to influence the core problem. Fourth, in the case of several core problems the most relevant problem has to be chosen (Heerkens & Winden van, 2012).

As can be seen in the problem cluster in figure 2.1 at the core there are several problems. These are: sufficient amounts of e-waste, lay-out for the (new) building, process map, skilled employees, tools and regulations. As emphasized before, these 'problems' stated here are not actual problems. However, they can be seen as problems if they represent a lack of something. The problem is then that these core problems, which are required for the two goals Twente Milieu and De Beurs want to achieve, are not there yet.

The fact that sufficient amounts of e-waste are required is a problem, because it has a discrepancy between norm and reality: according to Twente Milieu and De Beurs there is not enough of the same types of e-waste coming in at this moment at each of their separate locations in order to be working at a large scale. This problem does not have any direct causes within the organization of Twente Milieu and De Beurs. This problem is however possible to be influenced. As a matter of fact, this problem is not the most relevant problem to be chosen as the core problem, because this problem will most likely be solved

as soon as Twente Milieu and De Beurs start collecting e-waste at one central location. Then the assumption can be made that there will be enough e-waste to raise the opportunity to standardize the recycling procedures which will make the activities of the disassembling more accessible for social workers. It will be more accessible, because the social workers can perform the same tasks over and over again and therefore need less skills.

The lay-out for the new building at the new, central location for Twente Milieu and De Beurs lies beyond our field of interest as can be read in the introduction of chapter 2. Also designing a lay-out was part of one of the problems assigned to another group.

The lack of a process map for the disassembly of e-waste is a problem. The discrepancy between norm and reality is that Twente Milieu and De Beurs want to start doing these activities and therefore need a process map. They currently do not have information on the activities, because until now these activities have been outsourced to Omrin. Omrin is a recycling company that currently recycles all the e-waste that Twente Milieu collects. The lack of a process map has no causes that can be solved within Twente Milieu and De Beurs, so it is a core problem. It is definitely possible to influence this problem, simply by making a process map. However, there are different types of process maps. Of course an effective and efficient process for Twente Milieu and De Beurs is desirable.

For this effective and efficient process also skilled employees are necessary. The 'problem' of skilled employees can be approached from two sides. Either attract employees that meet the required skills for the job the employees will have to do or adjust the activities that have to be done to fulfil the organizations' aim. At Twente Milieu and De Beurs there is a gap between what the employees (mostly social workers) have to do and what the activities for the process of disassembling e-waste involve. So in order to start on disassembling e-waste there may be adjustments need to be made. There are no other causes that underlie this problem. Twente Milieu and De Beurs want to keep employing social workers and even expand their group of social workers. So the problem cannot be solved from this side. Although it still could be influenced from the other side: so, adjust the activities the employees have to do if they can't perform the required tasks.

Possessing the right tools to disassemble e-waste is also important for executing the process. It is not clear whether Twente Milieu and De Beurs have the right tools for the activity of disassembling e-waste, because they only collect the e-waste.

The last potential core problem that is identified is the fact that Twente Milieu and De Beurs need some certificates before they are allowed to do the activity of disassembling. One of these certificates is the WEEELABEX certificate (NVMP, 2017). Twente Milieu stated that they are aware of this and they are willing to get this certificate.

After reviewing all these potential core problems, a choice has to be made, since it is not convenient to be working on several problems at the same time. The most relevant core problem in this case is the lack of a process map. It is important to have a process map for the disassembly of e-waste, this will provide job opportunities for social workers, because by having a process map it will be easier for social workers to execute these activities. For them a clear plan must be available on how to take electronical devices apart in order to recycle these devices. Also as soon as the new site for Twente Milieu and De Beurs is realized, Twente Milieu and De Beurs would want to have a plan on how to do the next steps of recycling e-waste: disassembly. It will also be very useful to have this plan ready on beforehand in order to take this plan into account during the building process of this new site.

Although it is better to focus on one core problem, we will simultaneously work on two other core problems. These are: ‘skilled employees’ and ‘right tools’. In this case it is very well possible to take these three problem together, because while making the process map, we can directly decide what type of employees and what kind of tools are necessary.

3. RESEARCH APPROACH

3.1. DELIVERABLES AND SCOPE

In order to deliver a clear recommendation on creating an efficient and effective process about the disassembly of e-waste, we will elaborate a method which will guide the process of making a process map. For one category of e-waste products we will provide the process map for Twente Milieu and De Beurs. We have decided to focus on the e-waste category 'white goods', because this is the product group that provides the most kilograms of e-waste according to the WEEE report on Dutch e-waste (WEEE, 2016).

To set up this method to provide process maps for all white good types that come in at Twente Milieu and De Beurs, we have decided to implement this method for one device within the white good category. This will be the washing machine. Focussing on one device rather than on all different types of e-waste, will allow us to get a detailed advice for Twente Milieu and De Beurs instead of a broad superficial advice which they cannot implement. According to Marktplaats washing machines are commonly offered for second-hand use. Out of the data from Marktplaats we may conclude that washing machines will also regularly come in at Twente Milieu and De Beurs. Another reason for the focus on washing machines is that the different types of washing machines are very comparable to each other.

In conclusion we will provide Twente Milieu and De Beurs with two deliverables. A method which describes how a process map for the disassembly of e-waste can be derived. Also we will deliver a worked out process map for washing machines which will be derived by using this method. In the following paragraphs we will explain how we will arrive at these deliverables.

3.2. STAKEHOLDERS

Twente Milieu and De Beurs are not self-sufficient in their activities in the recycling process. They cooperate with other companies and also need input from other suppliers. When Twente Milieu and De Beurs are going to change their activities they need to take their stakeholders into account. The most important stakeholders for Twente Milieu and De Beurs are: social work companies, households, social workers, Omrin and Wecycle/WEEE (Waste Electrical and Electronic Equipment).

Social work companies are government institutions which provide employment for social workers and make sure that these people reintegrate in society. These companies work often in commission of the councils which get the orders from the Dutch Government (Rijksoverheid, 2011). Their interest is to provide workplaces for social workers. An example of a social work company in the region is Sociale Werkplaats Hengelo (SWB) (SWB, 2016). SWB is already collaborating with Twente Milieu, since they recruit social workers for them (SWB, 2014). SWB can provide social workers for Twente Milieu and De Beurs, which Twente Milieu and De Beurs want in order to increase their social return.

However, in an interview with Wecycle, that has a lot of contact with councils, appeared a footnote. Although councils want to create local employment, their commitment to help the waste organizations, according to Wecycles' experience, is low. This means that there is a discrepancy in the expectations and the real commitment of the councils. So Twente Milieu and De Beurs have to consider that the collaboration with the councils can be difficult to receive social workers (Wecycle,

Verwerkingsproces e-waste Wecycle, 2017). A summary of the interview can be found in appendix II.

The households are interested in accessible places where they can bring their e-waste. It is important to take into account that as soon as Twente Milieu and De Beurs will work at one central location, households will have to travel further to get to a place where they can bring their e-waste. However, this can be solved by still having different locations in Twente where households can bring their e-waste. This can for example be done in cooperation with electronical stores like Mediamarkt. At this moment there is already a collaboration with Mediamarkt.

The social workers will be interested in a place where they can work. This will give them a chance to get back into the society. However, they might get to Twente Milieu or De Beurs via a social work company. Twente Milieu and De Beurs have to make sure to provide a suitable workplace for these people. Also they should have a number of supervisors available to guide the social workers.

Twente Milieu and De Beurs currently outsource most of the recycle activities to Omrin. In the future Twente Milieu and De Beurs possibly want to do the whole cycle of recycling e-waste by themselves. This means that their relationship to Omrin will change. This does not necessarily mean they cannot work together anymore. It is important for Twente Milieu and De Beurs to know how they want to maintain their relationship to Omrin. If they do want to work together in the future, it might be important to keep Omrin informed in order to prevent a negative relation.

Wecycle/WEEE has the same objectives as Twente Milieu and De Beurs (Wecycle, Verwerkingsproces e-waste Wecycle, 2017). It seems that Wecycle already has set up a similar process that Twente Milieu and De Beurs want to achieve (NVMP, 2016).

3.3. PROBLEM APPROACH

A number of steps are necessary to get to a complete process map for the disassembly of white goods. We need to gather information and we need to apply some theories to practice. Our action plan will be as follows:

1. Describe our key concepts and key variables in order to have clear from which starting position we will start.
2. Do research on how a process map should be derived and on what methods are possible.
3. Decide what method of process mapping is best applicable in this situation.
4. Formulate a method on how to get to a process map of the disassembly of e-waste.
5. Apply this method in order to make a process map of washing machines.
6. Check whether this process map can also be applied to other types of white goods.
7. Do research on how many social workers can be employed and also what they can do. In case of incapability's do research on what other personnel is necessary in order to bring the process map designed in step 5 into practice.

3.4. RESEARCH QUESTIONS

The core problem of this research consists of three parts, which are the lack of a process map for the disassembly of e-waste and the lack of skilled employees and the right tools for performing this process. The action problem is the gap between the reality (the situation now) and the norm (the desired situation). The gap here is that there is no plan for the process of disassembling of e-waste yet (reality) while there should be a concrete plan for the design of this disassembly process to add value to the recycling of e-waste and ensure more social return (norm). From this action problem the research question can be derived. The research question is: How should the process map for the disassembly of e-waste be designed?

For the necessary information on being able to answer the research question, knowledge has to be gathered. Therefore, three sub questions are created:

1. Which process map is the best to use for disassembling e-waste?
2. What is the process map for the disassembly of white goods?
3. Which process steps should be done by what type of employee?

3.5. RESEARCH METHODOLOGY

To gather the information needed to answer our research question and the corresponding sub questions, research will be done. This will include a qualitative research on how the process for the disassembly of e-waste can be designed.

In order to make this into a trustworthy research, validity and reliability have to be assessed. This is dependent on how the collected data is retrieved and applied. Below, validity and reliability will shortly be defined.

Validity is further identified as either internal or external. When the drawn conclusions about a relationship truly imply the cause, internal validity of a research design is assessed (Cooper & Schindler, 2008). This means that the effect that is measured, cannot be caused by any other factor. The external validity of the research can be assessed when “an observed causal relationship can be generalized across persons, settings and times” (Cooper & Schindler, 2008).

When an instrument can be interpreted consistently across different situations, it is reliable (Field, 2009). A measurement that is reliable, will show the same results when repeating the research (Bouter, Dongen, & Zielhuis, 2010). The collection of data and the processing of this data influences the reliability of the data.

The problem approach from paragraph 3.3, describes the steps of the research that will be done. The result of this research, a process map, will eventually contribute to the main ambitions of Twente Milieu and De Beurs. These ambitions are more social return and more value from raw materials from the disassembled e-waste.

To determine which terms are evident for the research, concepts and variables must be described. When it is clear what definitions are used for the concepts and variables, the further research steps can be taken.

For defining the process map, step 2 of the problem approach, literature will be used. In this literature the definition of the different process maps can be found, as well as their (dis)advantages. There

also will be done a literature review on process mapping and e-waste. This literature review can be found in appendix I. Based on the found literature and the literature review, together with the criteria that will be established for a process map for our situation, a deliberate choice for the process map can be made (step 3). The theory about the pros and cons of the different process maps is already proven, the most suitable one only has to be applied for our situation.

Describing the disassembly of e-waste is the fourth step in the problem approach. This can be done by searching literature on disassembling e-waste, but the information can also be retrieved by analysing (YouTube) videos of disassembling e-waste. Next to that, one of the market leaders for the recycling of e-waste (Wecycle) can be asked to do a semi-structured interview with. The reliability of this interview however, cannot be fully guaranteed because it is to be expected a market leader will not give the full information on their process. Next to that, Twente Milieu and De Beurs now are in a strategic state, so the interview must be done with words that are carefully chosen.

When the disassembly process is defined, a process map for visualization of the disassembly process can be made (step 5). In step 3 the decision on which process map should be used is already made. The resulting process map can be measured by rating how well it is defined for the use of social workers from Twente Milieu and De Beurs.

In order to find out whether the method to determine the process steps for the disassembly of a washing machine can also be applied for other white goods, literature research will be done on the parts of other white goods devices in order to compare them to the parts of the washing machine.

The last step of the problem approach is researching whether the defined process steps for the disassembly can be executed by the social workers of Twente Milieu and de Beurs. When the (new) disassembly process can create (more) work for the social workers, the ambition of Twente Milieu and De Beurs of assessing social return, will be met. To attain some insight on how and in what way social workers already are working in the e-waste environment, the interview with Wecycle, a market leader in the recycling of e-waste, can be used.

4. KEY CONCEPTS AND CRITERIA

4.1. DEFINITION OF WHITE GOODS

For our research we want to look at the category of the e-waste that provides the most kilograms, which is the white goods. For defining white goods, the Merriam Webster dictionary was used. Here white goods are defined as “major household appliances (as stoves and refrigerators) that are typically finished in white enamel” (Merriam-Webster, 2017).

From this definition we know that white goods are major household appliances, but we do not have a list of the types of appliances that are categorized as white goods. To find out these types, the information out of the report on WEEE flows in The Netherlands is used. In this report the collecting of e-waste is explained, focusing on the recycling in The Netherlands. The WEEE which is “The Waste Electrical and Electronic Equipment Directive” (WEEE Directive) is the European Community directive on waste electrical and electronic equipment (WEEE).

For collecting e-waste, the WEEE has categorized the products into groups. This list is made to be able to construct lifetime profiles per category which is given by a UNU key (from the United Nations University), instead of having to make individual profiles for all 900 e-waste products (Huisman, et al., 2012).

For our research we will use the major household appliances, which are the collection Category A: Large Household Appliances (LHA) in the WEEE report for The Netherlands. These are shown in table 4.1.

UNU KEY	PRODUCTS	ABBREVIATION	COLLECTION CATEGORY
1-02	Dishwashers	1A2 Dishes	A LHA
1-03	Furnaces and ovens	1A3 Kitchen	A LHA
1-04	Washing machines	1A4 Wash	A LHA
1-05	Wash dryers + centrifuges	1A5 Dry	A LHA

Table 4.1: Category A Large Household Appliances (Huisman, et al., 2012)

So our definition of white goods will be the definition from the Merriam Webster dictionary in combination with the products that have a collection category of A LHA. The following definition of white goods will be used: “White goods are major household appliances that are mostly finished in white enamel. These appliances are dishwashers, furnaces and ovens, washing machines and wash dryers and centrifuges." However, if these appliances are finished in another colour, they will also be defined as white goods. These appliances are visible in figure 4.1.

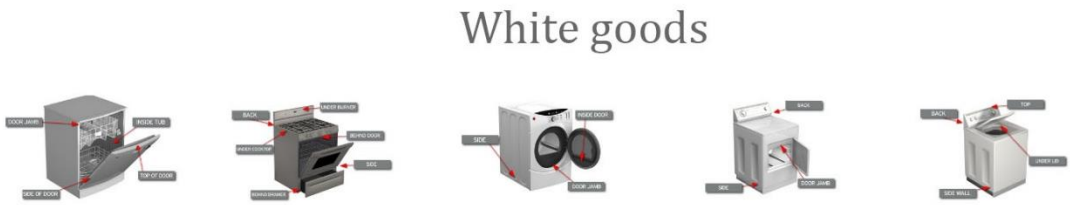


Figure 4.1: The types of white goods

4.2. DEFINITION OF KEY CONCEPTS

From the main research question the main concept is process map. According to Cooper and Schindler a concept is "a generally accepted collection of meanings or characteristics associated with certain events, objects, conditions, situations and behaviours" (Cooper & Schindler, 2008). Since a process map is a collection of meanings and characteristics of the mapping of processes, a process map is a concept.

A process map contains the tools and methods used by a person, institution or organization to map a process from start to completion. Process mapping involves the description of the relation between the activities within a certain process (Slack, Chambers, & Johnston, 2004).

In order to make the concept 'process map' measurable we will define some variables in the next paragraph.

4.3. OPERATIONALIZATION

Our concept process map, needs to meet certain requirements to be convenient for Twente Milieu and De Beurs to use. These requirements are then operationalized in criteria which the process map needs to satisfy. The requirements are developed through the goal of getting towards a first good efficient and effective process. Therefore, we need a process map that focuses on the process activities, is easy to use and gives a clear overview of the process. These requirements are important because a social worker has to do the disassembly of the process and therefore needs a clear and convenient process map. From these requirements there were seven criteria on which the process tools were evaluated which can be seen in figure 4.2. These criteria are developed using the literature found in the literature review (Rybicka, Tiwari, Campo Del, & Howarth, 2014). Based on these criteria the best process mapping tool will be chosen. This will be described in chapter 5.

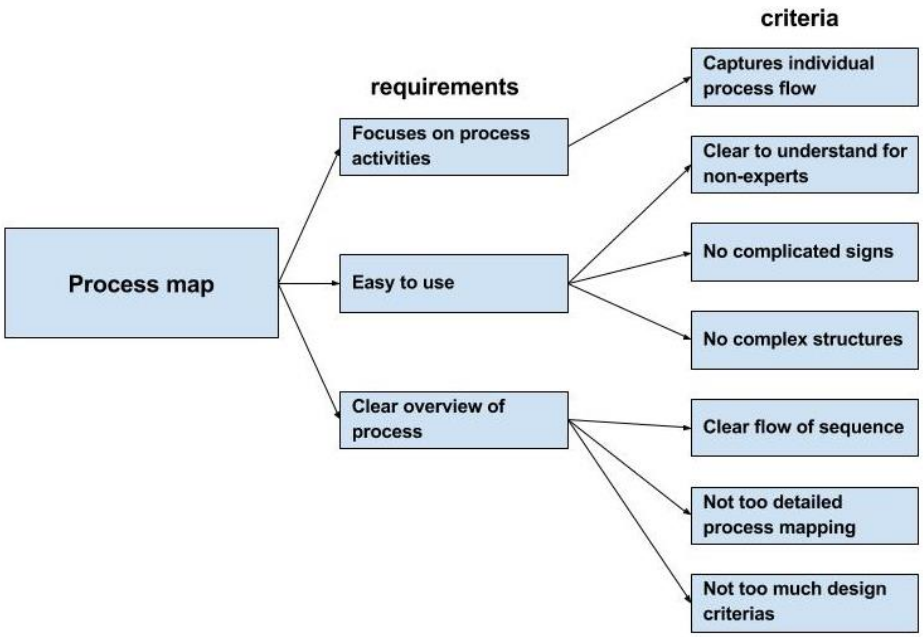


Figure 4.2: Relationship between concept and criteria

According to Cooper and Schindler a criterion is a combination of a decision variable and a decision rule (Cooper & Schindler, 2008). Therefore, the decision variables for this research are the criteria stated in figure 4.2. In the following paragraphs we will give an answer on the different sub questions. We applied the theory to practice to answer these.

5. WHICH PROCESS MAP IS THE BEST TO USE FOR DISASSEMBLING E-WASTE?

This chapter assesses the first sub question, and will define a process map and will describe which types of process maps exist. Finally, there will be discussed which process map will be the best to be used for describing the disassembly process.

5.1. DEFINITION OF PROCESS MAP

One of the deliverables of this project will be a process map. A process map is the description of processes in terms of how the activities within the process relate to each other. There are many tools which can be used for process mapping. However, every tool identifies the different types of activities that take place during the process and show the flow of materials, people or information through the process (Slack, Brandon-Jones, & Johnston, 2013).

5.2. EXISTING TYPES OF PROCESS MAPS

According to the paper "Capturing composites manufacturing waste flows through process mapping" (Rybicka, Tiwari, Campo Del, & Howarth, 2014), which was retrieved through the literature review on process mapping (appendix I), there are four process map tools that are used most often in manufacturing. These process map tools are flowchart, Material Flow Analysis (MFA), Value Stream Mapping (VSM) and Integrated DEFinition method (IDEF0). In order to decide which type of process map to use, these four different process map tools will be considered (Rybicka, Tiwari, Campo Del, & Howarth, 2014).

A flowchart is defined as "a graphical representation of a system that describes the logical sequence of the steps within a process" (Rybicka, Tiwari, Campo Del, & Howarth, 2014). It uses different symbols to represent operations, data, flow direction and equipment, to eventually become a graphical representation of processes (Aguilar-Savén, 2004). These symbols are described by Slack as process mapping symbols which are used for making flowcharts (Slack, Brandon-Jones, & Johnston, 2013). In figure 5.1 these process mapping symbols are given. These classify different types of activity and can be arranged in order, in series or in parallel, to describe any process (Slack, Brandon-Jones, & Johnston, 2013).

The only standard given for the flowchart is the notation. The way the blocks are put together can be decided by the developer of the chart. In a flowchart there is a variety of ways in which the process can be described which gives the developer a lot of flexibility. It is also often easy to recognize the process that is being described through the notation. This communication ability of the notation of the flowchart is the main strength. Besides, this process map tool is easy to use and to understand. Another strength is that it can quickly help identify inefficiencies and bottlenecks, as a result of the overview and the interrelations of the process which a flowchart clearly represents. These inefficiencies and bottlenecks can then be improved (Aguilar-Savén, 2004).

Although the flexibility is often found to be a strength of the flowchart, it can also be a weakness if the boundaries of the process are not clear. These boundaries are necessary to declare which part of the process the flowchart represents. Next to that, there are no differences between main and sub-activities given in the notation. This makes that a flowchart can become too large which makes it difficult to read (Aguilar-Savén, 2004). In a flowchart it is not possible to describe responsibilities or connect the organizational departments to activities (Aguilar-Savén, 2004).

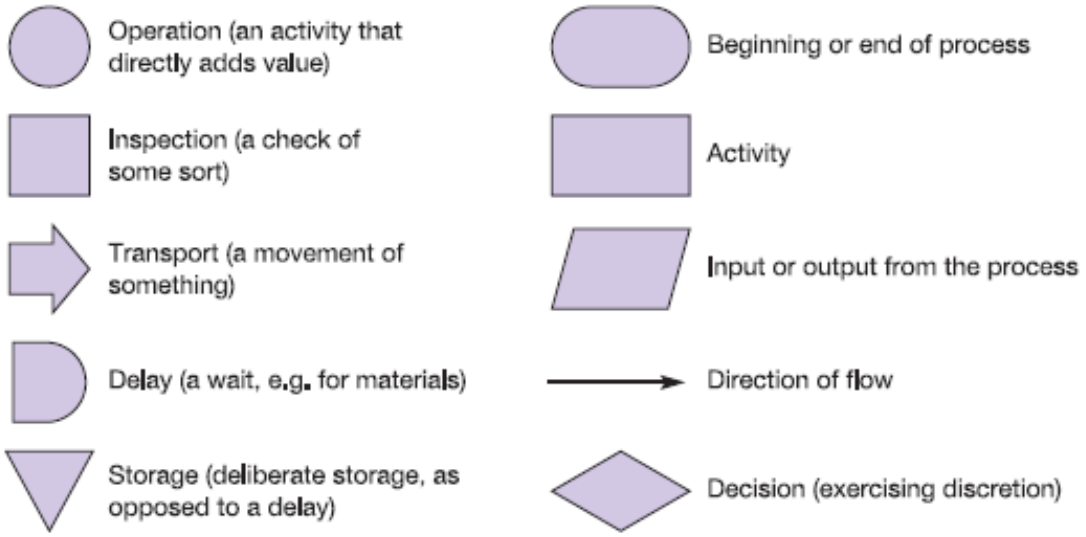


Figure 5.1: Process mapping symbols (Slack, Brandon-Jones, & Johnston, 2013)

A Material Flow Analysis (MFA) is defined as "a systematic assessment of the flows and stocks of materials within a system defined in space and time" (Brunner & Rechberger, 2004). The result of MFA is managed by a material balance in which output, stocks and inputs of a system are compared. This material balance can control the result because of the law of the conservation of matter, which states that "Matter cannot be created or destroyed by ordinary chemical means" (Dull, Metcalfe, & O. Brooks, 1854).

A MFA can deliver information on all the flows and stocks of a particular type of material and its quantity. The flows and sources of waste can become visible through balancing input and output when using MFA. Through the detailed flows and stocks of material, small changes become obvious (Brunner & Rechberger, 2004). This makes MFA a very useful decision-support tool for environmental management or waste management (Brunner & Rechberger, 2004). The detailed flows and stock of the material can also become a weakness because the focus lies more with the material flow than the process itself (Rybicka, Tiwari, Campo Del, & Howarth, 2014). Figure 5.2 gives an example of what a MFA could look like.

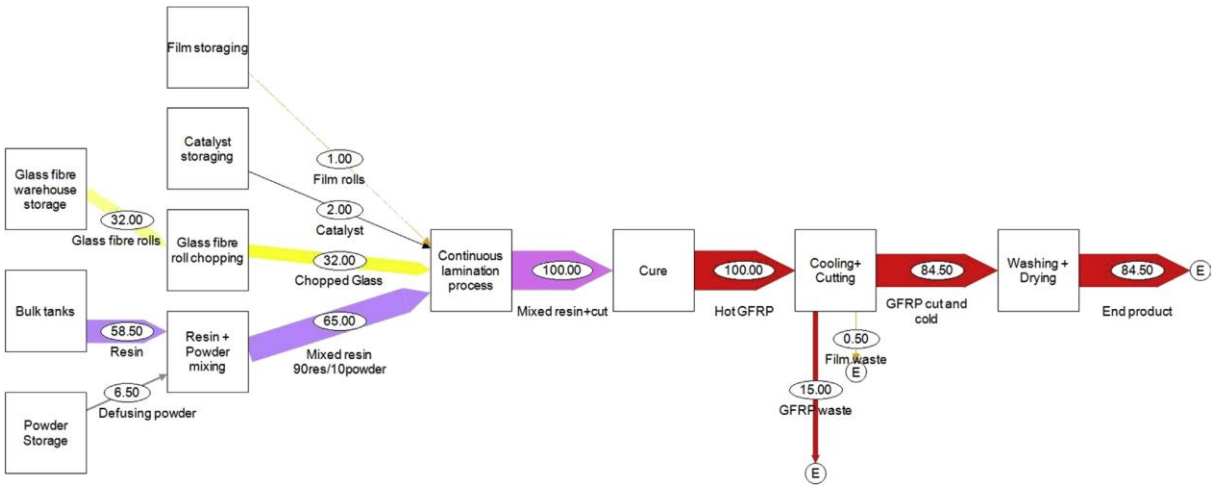


Figure 5.2: Material flow analysis (Rybicka, Tiwari, Campo Del, & Howarth, 2014)

Value Stream Mapping (VSM) is defined as "a collection of all actions (value added as well as non-value added) that are required to bring a product (or a group of products that use the same resources) through the main flows, starting with raw material and ending with the customer" (Abdulmaleka & Rajgopal, 2006). The VSM tool is often used in organizations to get towards four objectives: maintaining inventory control, eliminating waste, financial and operation control product and quality improvement (Rybicka, Tiwari, Campo Del, & Howarth, 2014).

With VSM, the flows of materials and information are both considered in the whole supply chain. The main purpose of the VSM is to eliminate all wastes present in the value stream. The VSM focuses on the big picture by visualizing and connecting the information flow and nature of materials through the whole supply chain. The VSM gives an overall production process in which it provides the user to make thoughtful decisions on how to improve the value stream (Abdulmaleka & Rajgopal, 2006). The VSM does not focus on individual processes, because it often shows a higher level of 5 till 10 activities which is small in comparison to other process maps (Slack, Brandon-Jones, & Johnston, 2013).

The VSM tool uses its own predefined sets of standardized icons. These icons are shown in figure 5.3

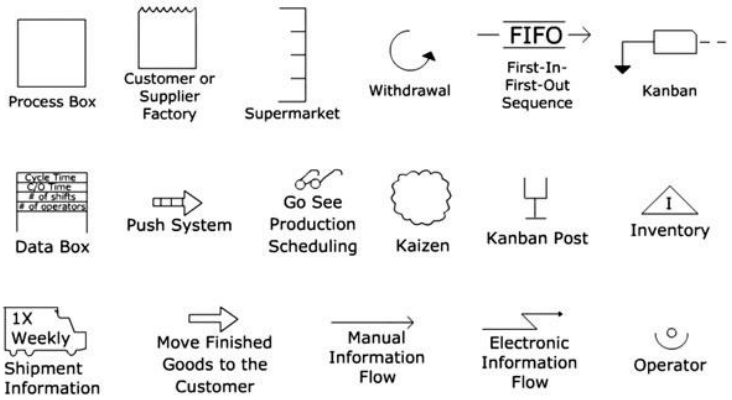


Figure 5.3: Value Stream Mapping Icons (Howell, 2013)

Before making a VSM, a product or product family has to be chosen as the target for improvement. Then a first draw can be made of the current state map which is a snapshot of the current situation. Often this first draw is made by walking along the process that will provide the basis for analysing and identifying weaknesses in the system.

As a third step in making the VSM, the future state map is made. This map is a picture of the system after the inefficiencies of the current system have been removed. This future state map is created by answering questions on issues of efficiency and on technical implementation that are related to lean tools. Then this map will become the basis for improving changes to the system to eliminate inefficiencies (Abdulmaleka & Rajgopal, 2006).

The definition for IDEF0 is as follows: “IDEF0 represent complex systems by mean of simple graphical diagrams” (Rybicka, Tiwari, Campo Del, & Howarth, 2014). IDEF0 stand for Icam DEFinition for Function Modelling, where 'ICAM' is an acronym for Integrated Computer Aided Manufacturing.

The IDEF0 process map tool is recommended as format for Material, Energy and Waste (MEW) process flows, in which the IDEF0 provides structure in the activities within a system. These activities are drawn as boxes where the in- and outgoing arrows represent Input, Control, Output and Mechanism (ICOM). The input enters the box on the left, and the output leaves on the right. The control feeds to the box comes from above as where the mechanisms enter from below. To show how this is done an example of an IDEF0 is shown in figure 5.4

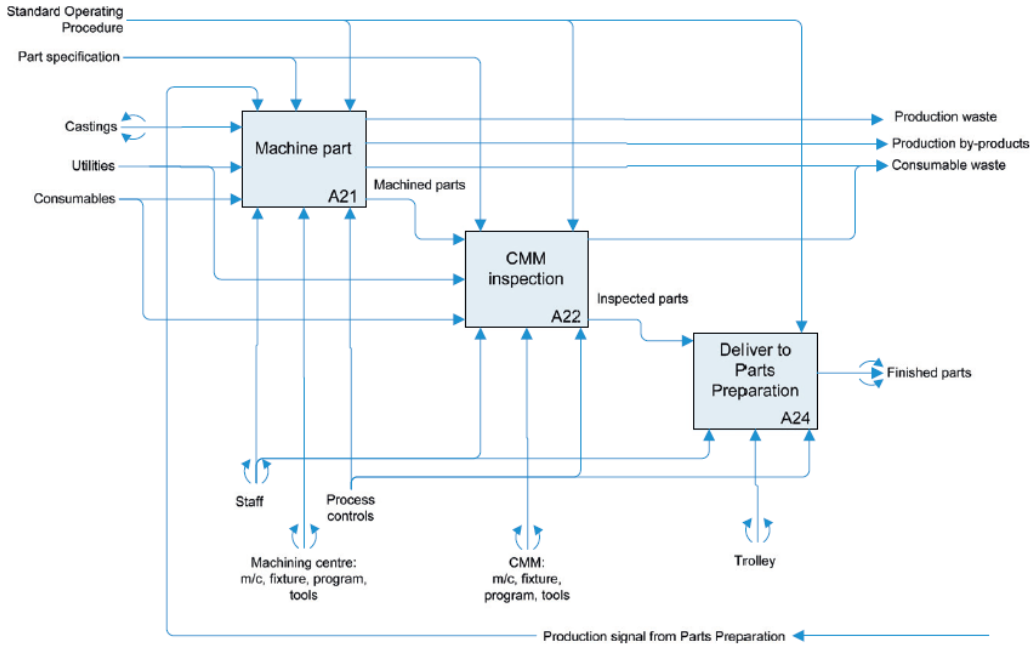


Figure 5.4: Example IDEF0 map (Smith & Ball, 2012)

In the IDEF0 the MEW flows are subjected to a quantitative analysis (Smith & Ball, 2012). These detailed description of flows can make it difficult for organizations to keep the confidential data out of an IDEF0 process map which can lead to confidential breaches (Rybicka, Tiwari, Campo Del, & Howarth, 2014). Also there are a lot of rules that need to be followed in order to set up an IDEF0. This can be a disadvantage.

5.3. THE CHOICE FOR A PROCESS MAP TOOL

The process map tool which is the best suitable for this study, must satisfy a number of criteria. First of all, the tool must be understandable for everybody. It must be clear what is meant by just looking at it. So it should not contain any complex structures or complicated signs. This is important because we want to achieve that social workers can work as independent as possible on the disassembly of e-waste. The social workers have to be able to use this process map. Secondly, the process map must clearly show the sequence of steps that have to be taken in the disassembly of white goods. This is important because the sequence is important for Twente Milieu and De Beurs in order to set up their disassembly operation. Also the process map should not be too detailed because this can cause the process map to become less understandable. All these criteria and the scores for each process map tool are shown in table 5.1. The signs are given based on the information described in paragraph 5.2.

Process mapping tools	Captures individual process flow	Clear to understand for non-experts	No complicated signs	No complex structures	Clear flow of sequenced	Not too detailed process mapping	Not too much design criteria
Flowchart	+	+	+	+	+	+	+
MFA	+	+	+	-	+	-	+
VSM	-	-	-	+	-	+	-
IDEF0	+	-	-	-	-	-	+
+ meets the criteria, - does not meet the criteria							

Table 5.1: Criteria for process mapping tool

For this case the process mapping tool VSM does not look sufficient, since this tool does not capture the individual process of disassembling. The VSM is often used for large overviews of the whole supply chain which we do not need. Also the representation is not very user friendly and at this moment there is no current state at Twente Milieu and De Beurs to base the VSM on (Rybicka, Tiwari, Campo Del, & Howarth, 2014). So the main reason for not choosing the VSM as our process tool is, because we want to look at one specific process and not the overall value stream.

Another process mapping tool that does not fit for the Twente Milieu and De Beurs case is the IDEF0. This type of mapping is difficult to understand for non-experts or people who have not taken part in the development of the model because of the material, energy and waste flows described. Also the mapping does not focus on the activity of the process and needs more detailed data on the MEW flows before it can be developed. Furthermore, this tool is not intended to be used for creating activity sequence overviews (Knowledge Based Systems, Inc., 2017).

The last two options, MFA and flowchart are more suitable in our case. They both clearly describe the flow of materials and are both easy to understand. However, the MFA focuses on the material flows and does not clearly state the actions that are taken in a process. A MFA usually contains more information and has a more complex structure, which makes it less easy to be used by the social workers. So, a flowchart will give a clearer view of the process than an MFA.

The flowchart fits the required criteria for a process map which can be seen in table 5.1. It has symbols which are easy to understand and it can give a good sequence of steps that need to be taken for

disassembling white goods. Another advantage of the flowchart which is very useful in this case, is its flexibility by not having a lot of design criteria. This provides a lot of opportunities in the design phase of the process map. It makes it possible to focus on the content of the steps in the process map instead of wasting too much time on formal notations.

Using a flexible method can become a problem if the developer does not know in what direction to go with the process map. We however have a clear view on how the process map should look like, what the start and end point will be and on what sort of level the description should be done. That is why we chose the flowchart. A MFA could however be useful for the following steps in the recycling process, like the processing of the materials taken from the e-waste.

6. WHAT IS THE PROCESS MAP FOR THE DISASSEMBLY OF WHITE GOODS?

This chapter will provide an answer to sub question two by discussing a method for describing the process steps of disassembling white goods. Next, this method will be applied for describing the disassembly of a washing machine. These process steps will then be represented in a flowchart. The last paragraph will provide information on how this flowchart can also be applied to other white goods.

6.1. METHOD TO DESCRIBE THE PROCESS STEPS OF DISASSEMBLING E-WASTE

In order to describe the process steps for the disassembly of e-waste, a method is developed. By applying this method, a process map can be developed which will visualize the steps which need to be taken in order to disassemble different types of e-waste.

The first step is to know which parts can be removed from an e-waste device. For this all parts of which the device consists, have to be determined. This can be done by searching for these parts on various websites, such as www.europart.nl and www.onderdelenwinkel.nl. These websites contain information on which small and big household appliances consist of.

The next step is to get insight in where these parts are situated within the device. In order to get this clear, parts diagrams can be queried. These parts diagrams can be found on www.searspartsdirect.com, when a device's model number is searched for. An example of a parts diagram can be seen in appendix III, where a parts diagram of a dish washer is shown.

The last step of the method for describing the steps for the disassembly process is distinguishing all the process steps for disassembling the e-waste. A simple way to find out these steps, is by analysing a video of the disassembly of such a device. In such a video all the steps are clearly described and shown. These videos can be looked for on www.youtube.com.

These steps together, defining the different parts and their position and analysing the process steps of a disassembly video, are a method to describe the steps that need to be taken in order to disassemble e-waste. By modelling these steps using a process map, this process can be displayed as a visual plan.

6.2. APPLYING THE METHOD FOR A WASHING MACHINE

This method, as described above, has been applied to describe the process map for the disassembly of a washing machine. A washing machine mainly consists of the following components: casing, motor, tub, heating element, counterweight, dumpers, control panel, drain pump, timer, soap dispenser, pressure switch, valves, hoses, door and table top (Romano, Santillo, & Zoppoli, 2009).

In order to completely strip down a washing machine, the following steps have to be taken (Accordioncafe, 2013) (Healty, 2013). First, the washing machine has to be unplugged from electrics. The front drain pump can be opened, to take out any water that is left in the washing machine.

Next, the casing of the washing machine can be removed by unscrewing the door and the upper-side- and front casings. The front casing also contains the front panel, which consists of a printed circuit board (PCB) that programs the washing machine. This PCB then can be disconnected from the front panel.

In order to get out the tub with the drum, everything has to be disconnected from it. The cuff surrounding the opening of the drum, can be removed by cutting an iron wire. The tub is connected to the soap dispenser by a hose, which can be removed. To decrease the weight on the tub, the counterweight can be removed. Next to these items, the shock absorber, string, engine, heating element and all hoses and electronics can be disconnected from the tub and can be taken out.

When most parts are taken out, the tub and barrel can be removed from the remaining carcass of the washing machine. The tub can be disconnected from the barrel. Now only the frame of the washing machine is left.

These steps for disassembling a washing machine and the required tools, can be seen in table 6.1. The required tools for the disassembling process we describe are; screwdrivers, pliers and box wrenches.

Actions	Required actions and tools
Disconnection from electrics	Unplug it
Empty front drain pump	Use screwdriver
Unscrew casings - Upper casing - Side casing - Door - Front panel	Use screwdriver
Disconnect electronics from front panel - Printed circuit board	Use screwdriver and pliers
Take out cuff from drum	Cut open iron wire with pliers
Take out counterweight	Use box wrench
Take out soap dispenser - Disconnect hose	Use pliers
Disconnect shock absorber from tub	Use screwdriver
Disconnect string from tub	Use screwdriver, pliers
Disconnect engine	Use screwdriver, pliers
Disconnect heating element	Use screwdriver, pliers
Disconnect hoses and electronics from tub	Use screwdriver, pliers
Take out tub and barrel	Lift
Disconnect tub from barrel	Screwdriver

Table 6.1: Actions and required tools

6.3. BOUNDARIES OF THE FLOWCHART

With this information, resulting from the method being applied to the case of washing machines, a process map can be derived. As described in chapter 5.3 this process map will be a flowchart.

The flowchart which is shown in figure 6.1 starts with placing the washing machine in the workplace for disassembling. This boundary as start of the process was chosen to make sure that the washing machine is near the required tools and can be worked on properly. Then the disassembling is done till the last process step described in the flowchart, which is the disassembling of tub from barrel. After this last step of the presented flowchart all the components are stored. After removing the tub, there are no parts left so the process of disassembling has ended. The dark blue circles are actions which do not require to be done in sequence. The light blue circles do require to be done in this specific sequence. It will depend on the type of washing machine which parts in the dark blue circles should be logically disassembled by the employees. So the reason for making a distinction between actions with a necessary sequence and not necessary sequence is that it depends on the type of washing machine which actions will be logical for a quicker disassembling. However, to make the process steps easy for the social workers, one sequence can be chosen for all types of washing machines. Twente Milieu and De Beurs can decide which sequence fits the best for their employees.

In this flowchart the process of the components into further recycling is not included. This depends on the component itself how it could be recycled. This also depend on the type of washing machine.

The flowchart is developed based on the actions that need to be taken to take apart a washing machine. There are no high detailed descriptions of the actions, because it depends on the sort of washing machine where each part is positioned and what small parts are present. Also a very detailed flowchart could become too large and confusing, which we want to prevent by keeping the flowchart as clear as possible in the description of the actions.

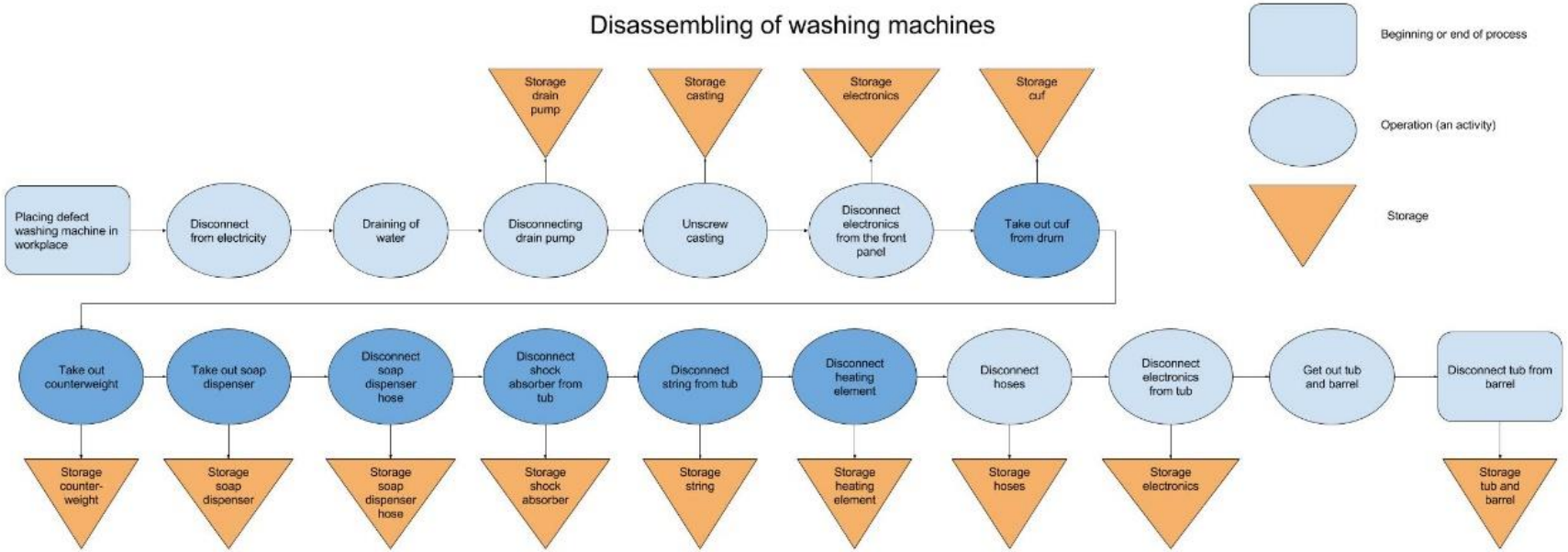


Figure 6.1: Flowchart for the disassembly of washing machines

6.4. INVENTORY COLLECTION IN GROUPS

In table 6.2 all the components present in a washing machine are given. These components are the output of the process and are collected during the disassembling of the washing machine.

The environmental and economic values of a washing machine in the end-of-life stage

Component of a washing machine	Weight (kg)	Environmental impact (person year^2/f.u)[a]
Washing tube (PP)	3.5	2.29E−04
Cover (ABS)	2.4	1.57E−04
Balance (PP)	2.3	1.51E−04
Others (ABS)	5.5	3.82E−04
Frame (steel)	11.6	5.25E−05
Others (steel)	1.6	5.13E−06
Motor	4.7	2.41E−05
Clutch	3.5	1.41E−05
Condenser	0.2	7.59E−07
Transformer	0.6	2.28E−06
Small electric parts	1.0	3.79E−06
Hose	1.0	8.24E−06
Electric wire	1.0	1.66E−05
PCB board	0.5	6.74E−05
Total weight	39.4	

Table 6.2: Washing machine components and values (Park, Tahara, Jeong, & Lee, 2006)

The storage of these components can be sorted by the material that they consist off. This is done because some of the material can be sold, for example steel can be sold again for reuse. The parts are therefore grouped into 4 categories which are the following:

- Plastic
  - Washing tube (PP Plastic)
  - Cover (ABS Plastic)
  - Balance (PP Plastic)
  - Hose (ACM Plastic)
  - Others (ABS)
- Steel
  - Frame
  - Clutch
  - Hose
  - Others
- Electronics
  - Condenser
  - Transformer
  - Electric wire
  - PCB board
  - Small electric parts
- Motor

Of all the materials the hose can be of different material. Depending on the sort of washing machines the hose is made of plastic or steel. The heaviest part is the frame, which is often completely made of steel. The second heaviest part is the motor, which consist of more materials. Therefore, the motor is grouped individually. For now, we do not recommend to disassemble the motor as a sub process, because it might be too difficult for a social worker to execute. It can be the case that the motors differ a lot per washing machines. In that case it is difficult to say whether it will add value for Twente Milieu and De Beurs. The disassembling of the motor can eventually be decided to be done by Twente Milieu and De Beurs. It depends on the value of the material if Twente Milieu and De Beurs want to resell the material. So they have to decide based on the current market prices for the material if they want to sell it to traders or recycle it.

6.5. APPLICABILITY OF THE WASHING MACHINE FLOWCHART TO OTHER WHITE GOODS

The flowchart gives a detailed description of the disassembly of washing machines. However, this flowchart is not only suitable for this type of e-waste. Most of the steps of this flow will also be applicable to other devices within our white good definition. For the following devices we will review whether the flowchart for washing machines is also applicable: dishwashers, ovens and wash dryers. These devices are included in our definition of white goods as can be seen in section 4.1.

First of all, the flowchart for the disassembly of washing machines is very well applicable to dishwashers. This device contains mainly the same components as a washing machine. Both devices use a lot of water and contain heating elements (Doityourself, 2017) (Khemani, 2009). By using logical thinking this flowchart can also be used at Twente Milieu and De Beurs to disassemble a dishwasher.

The second device, an oven, has less in common with a washing machine. There are a lot of loose elements that can easily be removed from the oven, like knobs, metal grills and the metal pieces on top for the stove part. The further disassembly of the casing of the oven is similar to the disassembly of the casing of the washing machine: mainly unscrewing al the (side) panels. Of course the steps of taking out the drum, counterweight, soap dispenser and shock absorber are not relevant for the disassembly of an oven (AdamDIY, 2013). Important to take into account while disassembling ovens is that if an oven contains refractory ceramic fibres these fibres should be removed carefully and processed further separately (ewasteguide, 2009).

The last device within our category of white goods is a wash dryer. This is very similar to a washing machine. These devices are build up the same way. They both contain a drum and a heating element. So the disassembly of these parts can be done in a similar way. The biggest difference between these two devices is that a drying machine does not use water like a washing machine. So the steps relevant for the disassembly of these parts can be skipped.

For all devices containing a sort of lcd screen greater than 10 by 10 cm, these must be taken out by hand and with care in order to prevent toxics being released into the environment (ewasteguide, 2009). This will probably not be relevant to most of the e-waste within the category of white goods, because they usually contain small lcd screens.

7. WHICH PROCESS STEPS SHOULD BE DONE BY WHAT TYPE OF EMPLOYEE?

To bring the previous described process map in practice at the planned new location, Twente Milieu and De Beurs need employees. These employees should be able to disassemble the washing machine and in the end also other e-waste.

One of the aims of Twente Milieu and De Beurs is to increase social return, which means helping more social workers reintegrate into society providing a work place for social workers. This is also an intention of the Rijksoverheid, since they included social return as contractual condition by purchase and procurement (Rijksoverheid, 2011). The aim of social return is increasing the employment of people with a distance to the labour market, which are mostly people with a social payment and with low education and work experience. Not only people with low education can be employed but also high educated people (Stichting Social Return, 2017).

Another organization Wecycle, is also concerned with collecting and disassembling of e-waste by using the workforce of social workers. This is done by the organization called Wecycle Service Center. An example of such a centre is 'Stichting Road2Work' in Ede. At this project Wecycle collaborates with several councils in the region in order to process the e-waste. Wecycle gives work to a group of 20 employees and helps them with professional guidance in disassembling white goods, in particular washing machines. Annually 6000 units of white goods are disassembled and 60 employees are using this workplace. Half of these employees move on to a regular job, which fits in the councils' social goals (NVMP, 2016). A maximum of 20 employees are working daily at the same time (Road2Work, 2013). Based on the number of employees at the Wecycle project Twente Milieu and De Beurs can decide how many social workers they need to attract in order to process all the incoming white goods.

Most of the steps described in the process map can be done by using hand tools, such as screwdrivers, pliers and box wrenches. The steps described are not very difficult and can be done by social workers with supervision. The skills required from the social workers to disassemble are:

1. Know how to use a screw, plier and box wrench
2. Unscrewing a screw or nail
3. Cut parts with a plier
4. Take out bolts with a box wrench
5. Lifting the loose parts to storage
6. Understanding the difference between the materials

For a good executing of the activities the social workers might need professional guidance. The main reason for the coaching is that the people are mostly not highly educated and motivated (Wecycle, Verwerkingsproces e-waste Wecycle, 2017). However, social workers are not comparable to each other, because they all have a different background. As a result, one person might need more supervision than the other. We expect that for a group of 20 employees 1 professional supervisor is sufficient. It is recommended that this supervisor has technical knowledge, because he should be able to answer the technical questions of the social workers and be able to explain the flowchart to the social workers.

According to the learning curve, doing the same activity over and over again will increase the performance of an action (Management Study Guide, 2017). This will also be the case for the social workers if they often perform similar tasks in the disassembly-process of washing machines or other white goods. This can increase their learning curve and it might also increase the throughput time.
In some of the other white goods hazardous substances can be found. If there are hazardous substances present in the white goods, PCB for example, these should be handled by a professional and not by the social workers because this could be too dangerous. This professional could be the supervisor which guides the social workers.

In the described situation, one social worker will disassemble a whole washing machine by himself. However, if there are many washing machines coming in or if other white goods will be disassembled too, this means the activities can be done at a larger scale. This makes is possible to make the process continuous. In this particular case, the disassembly of multiple devices can be done by a disassembly line with multiple social workers, where every social worker will do a specific part of the disassembly. This will mean that the social workers need less skills, because they can perform the same activities over and over again. Making the process continuous will make it more efficient because there would be little or no interruptions.

8. CONCLUSION

This research provides an answer for the research question: 'How should the process map for the disassembly of e-waste be designed?' The three sub questions which are formulated, all provide a piece of the information that is needed for answering the main research question.

From sub question 1: 'Which process map is the best to use for disassembling e-waste?' we conclude the best process mapping tool in order to visually represent the disassembly process of e-waste is a flowchart. This process map tool is the best choice because it has symbols which are easy to understand. Next to that, the flowchart gives a clear sequence of the process steps for disassembling white goods. Another advantage of the flowchart is its flexibility by not having a lot of design criteria. This provides a lot of opportunities in the design phase of the process map and makes it possible to focus on the content of the steps in the process map instead of wasting time on formal notations.

The next sub question: 'What is the process map for the disassembly of white goods?' describes a stepwise method on how to attain a flowchart for different types of e-waste. This method starts by giving insight in all the components of a certain device and how these parts are positioned in the device. The next step is watching disassembly videos. The disassembly steps can then be outlined and visualized in a flowchart. This method is used for making a flowchart for washing machines. This flowchart can be used by Twente Milieu and De Beurs to initiate the disassembling process for washing machines. After the disassembling process the disassembled parts are sorted by type of material. These materials can eventually be sold or reused separately. Because of the high level of detail, the flowchart for washing machines is also applicable to other types of white goods.

The last sub question is: 'Which process steps should be done by what type of employee?' In the described situation, one social worker will disassemble a whole washing machine by himself. However, the activities can be done at a larger scale when there are more washing machines collected or when other white goods can also be disassembled. This gives the possibility to make the process continuous. In this particular case, the disassembly of multiple devices can be done by a disassembly line with multiple social workers, where every social worker will do a specific part of the disassembly. It is to be expected that for a group of 20 social workers 1 professional supervisor is required.

These three sub questions together lead to the concluding answer on the main research question: the process of the disassembly of e-waste can be designed in a stepwise manner according to a flowchart. For each type of e-waste, a specific flowchart should be derived in order for it to be clear for social workers how to disassemble different devices. For doing the disassembly, social workers with the capability of lifting things and having basic knowledge about hand tools and different materials can be attracted.

In conclusion, by adding disassembly to the activities done by Twente Milieu and De Beurs they can increase social return, since they can provide work for social workers. Also disassembling the e-waste will add value to e-waste, because the disassembled parts are sorted by type of material which then can be sold or reused.

8.1. LIMITATIONS

This research has a number of limitations, because not every detail could be researched within the scope of this research. These limitations are important to keep in mind, when the results of this research are going to be implemented.

First of all, for achieving the two goals of Twente Milieu and De Beurs it is important that other requirements to fulfil these goals are discussed. These other requirements are elaborated on in chapter 2.2. As described in chapter 2.3 Twente Milieu is going to take care of the WEEELABEX certificate. This certificate will make sure the regulations for the recycling of e-waste are settled. Next to these regulations, sufficient amounts of e-waste are required when a continuous process is desired. However, this continuous process is not necessary right away. Thus, to first start on the disassembly of e-waste sufficient amounts of e-waste are not directly necessary. The last requirement that needs to be taken into account, is a layout for a new building at the new location. Before starting up the disassembly process it is important to determine this layout. If all these requirements are met, the method and process map described in our research can form the basis for setting up an effective and efficient process for the disassembly of e-waste done by Twente Milieu and De Beurs.

Furthermore, for the assessment on the different types of process maps, it is possible that when this assessment is done by Twente Milieu or De Beurs, they might get another result if they have different criteria for the best process map.

Also some assumptions are made during this research. One very important assumption is the assumption that Twente Milieu and De Beurs will start working together at one new location. This, and other assumptions were necessary to make, because a lot of information was not available. It might for instance differ how much each social worker can do. This can only become known by bringing the plan into practice. Results may differ when the assumptions made, are changed. Because of these assumptions and the different qualities of social workers it is not clear whether this plan will be feasible to achieve the goals of Twente Milieu and De Beurs.

9. RECOMMENDATIONS

There are a couple of recommendations we want to give to Twente Milieu and De Beurs. These are formulated as concrete actions that they can apply. The recommendations are as follows:

- First bring the flowchart for the disassembly of washing machines into practice at the new location. Get social workers to do the activities described in the flowchart and in this way start expanding the activities of the recycle process by the disassembly of washing machines. At this moment it might not be achievable to make a continue process, because the number of washing machines alone might not be sufficient.
- After the disassembly process of washing machines has been brought into practice, decide on in what ways the different materials should be processed further (selling or disassemble until it can be used as a resource again). This choice depends on for example how much money can be received from selling certain parts. For the further disassembly of e-waste an MFA would be a suitable process map to use.
- Then get insight in the average number of each type of e-waste that comes in at Twente Milieu and De Beurs. This is important for the further development of the other flowcharts. It must be clear if the amount of a certain type of e-waste that comes in is sufficient for it to be relevant to design a flowchart for this type of e-waste.
- As soon as Twente Milieu and De Beurs are comfortable with the process of the disassembly of washing machines, apply the method to design more flowcharts for other types of e-waste.
- Twente Milieu and De Beurs can work together in this way that De Beurs checks if its incoming devices are working, if not, sends these to the new location. Also De Beurs can provide the social workers as they are already working with them. De Beurs can see if the social workers have the required skills or can check if the skills can be taught to the social worker. Also De Beurs could do more of the social worker-guiding activities; Twente Milieu could focus more on the disassembly-process activities.

By undertaking these activities Twente Milieu and De Beurs can work toward achieving their two goals of increasing social return and add more value to the e-waste.

LITERATURE

Abdulmaleka, F., & Rajgopal, J. (2006). Analyzing the benefits of lean manufacturing and value stream. *International journal of production economics*, 223-236.

Accordioncafe. (2013, February). *BEKO washer STRIPDOWN*. Retrieved from Youtube: https://youtu.be/Ti4wMmG331M; https://youtu.be/Yi1dsz4ZeRg; https://youtu.be/VjmNIYA1vs8; https://youtu.be/bAlJezOrUrU

AdamDIY (Director). (2013). *Whirlpool Gas Range Oven Complete Tear Down* [Motion Picture]. Retrieved Januari 14, 2017, from https://www.youtube.com/watch?v=1KsHTMmkjTo

Aguilar-Savén, R. S. (2004). International Journal of Production Economics. *Business process modelling: Review and framework*, 129-149.

Bouter, L., Dongen, M. V., & Zielhuis, G. (2010). *Epidemiologisch onderzoek: opzet en interpretatie.* Houten: Bohn Stafleu van Loghum.

Brunner, P., & Rechberger, H. (2004). *Practical Handbook of Material Flow Analysis.* Boca Raton (Florida): Lewis Publishers.

Cooper, D. R., & Schindler, P. S. (2008). *Business research methods.* Boston: McGraw-Hill Irwin.

Doityourself. (2017). *A complete list of dishwasher parts*. Retrieved from Do it yourself: http://www.doityourself.com/stry/a-complete-list-of-dishwasher-parts

Dull, C., Metcalfe, H., & O. Brooks, W. (1854). *Modern Chemistry.* New York: Henry Holt and Company.

ewasteguide. (2009). *Hazardous Substances in e-Waste*. Retrieved Januari 5, 2017, from ewastequide.info: http://ewasteguide.info/hazardous-substances

Field, A. P. (2009). *Discovering statistics using SPSS.* Los Angeles, CA: SAGE Publications.

Healty, N. (2013, April). *Washing machine dismantle and rebuild Bosch Classixx 1200 Express drum noise fix*. Retrieved from Youtube: https://www.youtube.com/watch?v=sHibAx64ZY4&feature=youtu.be

Heerkens, H., & Winden van, A. (2012). *Geen Probleem.* Nieuwegein: Van Winden Communicatie. Retrieved November 30, 2016

Howell, V. (2013, August 7). *Value Stream Mapping: A Tool for Process Improvement*. Retrieved from Ceramic Industry: http://www.ceramicindustry.com/articles/93406-value-stream-mapping-a-tool-for-process-improvement

Huisman, J., van der Maesen, M., Eijsbouts, R., Wang, F., Balde, C., & Wielenga, C. (2012). *The Dutch WEEE flows.* Bonn, Germany: United Nations University, ISP – SCYCLE.

Khemani, H. (2009, Juni 16). *Parts of the washing machine and their working*. Retrieved from BrightHubEngineering: http://www.brighthubengineering.com/consumer-appliances-electronics/38895-working-parts-of-a-washing-machine/

Knowledge Based Systems, Inc. (2017). *Integrated DEFinition Methods (IDEF)*. Retrieved Januari 11, 2017, from idef: http://www.idef.com/idefo-function_modeling_method/

Management Study Guide. (2017). *What is Learning Curve ? - Meaning and Concept*. Retrieved Januari 24, 2017, from Management Study Guide: http://www.managementstudyguide.com/what-is-learning-curve.htm

Merriam-Webster. (2017). *White goods*. Retrieved from Merriam-Webster dictionary: https://www.merriam-webster.com/dictionary/white+goods

NVMP. (2016). Regionaal sorteren en demonteren voegt waarde toe aan recycling. *Retour*(2), 16-17. Retrieved Januari 5, 2017, from http://www.nvmp.nl/uploads/pdf/retour/Retour%20Winter%202016.pdf

NVMP. (2017, Januari 17). *WEEELABEX Standpunt*. Retrieved Januari 24, 2017, from nvmp: http://www.nvmp.nl/standpunten/weeelabex.html

Park, P., Tahara, K., Jeong, I., & Lee, K. (2006). Comparison of four methods for integrating. *Recources conservation & recycling*, 71-85.

Rijksoverheid. (2011, April 29). *Rijksoverheid zet Social Return in bij aanbestedingen*. Retrieved from Rijksoverheid: https://www.rijksoverheid.nl/actueel/nieuws/2011/04/29/rijksoverheid-zet-social-return-in-bij-aanbestedingen

Road2Work. (2013). *Over ons. Missie en visie.* Retrieved from Road2Work: http://road2worknederland.nl/over-ons/missie-en-visie/

Romano, E., Santillo, L., & Zoppoli, P. (2009). Transformation of a production/assembly washing machine lines into a lean manufacturing system. *WSEAS Trans. Sys. Ctrl.*, 65-76.

Rybicka, J., Tiwari, A., Campo Del, P. A., & Howarth, J. (2014, December 16). Capturing composites manufacturing waste flows through process mapping. *Journal of Cleaner Production*, 251-261. Retrieved Januari 11, 2017, from http://dx.doi.org/10.1016/j.jclepro.2014.12.033

Searspartdirect. (2017). *dishwasher-parts*. Retrieved from searspartsdirect: http://www.searspartsdirect.com/partsdirect/product-types/dishwasher-parts

Slack, Chambers, & Johnston. (2004). *Operations management.* Harlow: Prentice Hall.

Slack, N., Brandon-Jones, A., & Johnston, R. (2013). *Operations Management.* Harlow, United Kingdom: Pearson Education Limited.

Smith, L., & Ball, P. (2012). Steps towards sustainable manufacturing through modelling material, energy and waste flows. *International Journal of Production Economics*, 227-238.

Stichting Social Return. (2017). *Wat is social return?* Retrieved from Stichting Social Return: http://www.stichtingsocialreturn.nl/site/index.php/wat-is-social-return

SWB. (2016). *Over SWB*. Retrieved Januari 16, 2017, from swb: http://www.swb.nl/

SWB, H. (Director). (2014). *SWB - Belangrijk werk door samenwerking met Twente Milieu en Randstad* [Motion Picture].

Wecycle. (2017, Januari 4). Verwerkingsproces e-waste Wecycle. (L. Ooms, Interviewer)

WEEE. (2016, June 9). *Waste Electrical & Electronic Equipment (WEEE)*. Retrieved from European Commision: http://ec.europa.eu/environment/waste/weee/index_en.htm

APPENDIX

I LITERATURE REVIEW ON PROCESS MAPPING

The definition of process mapping is the tools and methods used by a person, institution or organization to map a process from start to completion. (Slack, Chambers, & Johnston, 2004)

What we want to know through this literature review is theory on process mapping of e-waste recycling and how this waste should be mapped out. To find articles on this subject a few search strings have to be defined first.

The search string we are going to use as based will be “process mapping”. The words to add to this search string will be “e-waste” and “recycling” as those are our main topic keywords. The problem with the keyword “e-waste” is that it can give only the articles that used that word so we also added “waste” as a search string.

One of the criteria’s for selecting the articles is to have articles with at least an impact factor of 1. According to Web of Science a journals Impact Factor is the amount of time a paper is cited. So we will only select articles which are at least once cited. We foresee that a lot of articles will have information on process mapping not related to e-waste recycling. Therefor the criteria for the articles that will be selected for review will need to have at least “waste” in their abstract. That is how we filter out the articles not related to waste. This still does not seem enough to filter out the articles related to our topic so we also want “recycling” to be in the abstract.

After these criteria we are left with one article on process mapping and waste recycling through Scopus and 2 articles through Web of science seen as one of them is a duplicate of the one article from Scopus. These 3 articles will be reviewed.

Search string	Scope	Date of search	Data range	Nr. of entries
Search protocol for Scopus				
“Process mapping”				
AND “e-waste”	Title, keyword and abstract	Dec-24	1980-present	1
AND “recycling”	Title, keyword and abstract	Dec-24	1980-present	1
AND “waste”	Title, keyword and abstract	Dec-24	1980-present	58
AND “steps"	Title, keyword and abstract	Dec-24	1980-present	106
AND “waste" AND "steps"	Title, keyword and abstract	Dec-24	1980-present	8
AND “waste" AND "recycling"	Title, keyword and abstract	Dec-24	1980-present	1
Search protocol for Web of Science				
“process mapping”				
AND “e-waste”	Topic	Dec-28	1980-present	7
AND “recycling”	Topic	Dec-28	1980-present	302
AND “waste”	Topic	Dec-28	1980-present	1,112
AND “steps"	Topic	Dec-28	1980-present	10,366
AND “waste" AND "steps"	Topic	Dec-28	1980-present	109
AND “waste" AND "recycling"	Topic	Dec-28	1980-present	59
Total in endnote Scopus				175
Removing duplicates				-19
Removing articles with less than 1 impact factor				-71
Selecting "waste" in abstract				-57
Selecting "recycling" in abstract				-27
Removed after reading abstract				0
Included after reading abstract				0
Total selected for review Scopus				**1**
Total in endnote Web of science				11955
Removing duplicates				-365
Removing articles with less than 1 impact factor				-3638
Selecting "waste" in abstract				-7206
Selecting "recycling" in abstract				-707
Removed after reading abstract				-36
Included after reading abstract				0
Total selected for review Web of science				**3**
Total selected for review				**3**

Figure 1.1: Overview of review process

It was difficult to find articles that are related to e-waste and process mapping. Often articles related to process mapping were based on environmental issues or chemical processes. When the articles were related to e-waste it was not related to processes but more on what the impact is socially and economically. That is why for this literature review we reviewed only the three journals which all give information on e-waste and process mapping. Unfortunately, there were no more relevant journals found.

Nr.	Criteria	Reason for exclusion
1	Pre 1980-articles	Before 1980 there was no process of e-waste recycling, because electronica was not hugely present yet in households
2	"waste" not mentioned in abstract	Without mention of "waste" in the abstract, the paper will not be topic related for this research
3	"recycling" not mentioned in abstract	Without mention of "recycling" in the abstract, the paper will not be topic related for this research
4	Not related to electronic waste	The paper can be informative on process mapping in overall waste, but for this research we only have a need for papers related to electronic waste and not any other

Figure 1.2: Exclusion and inclusion criteria

Journal	Authors (year)	Title	Methodology	Key findings on process mapping of waste	Key findings on E-waste
Journal of Cleaner Production	Rybicka, Tiwari, Alvarez Del Campo & Howarth (2014)	Capturing composites manufacturing waste flows through process mapping	Workshops with structured and semi-structured interviews with 5 organizations	"Process mapping tools have been used to identify waste that is 'most suitable for transformation' by *(Burmeister et al., 2010)*. That suggests that process mapping is concentrating on waste where potential of maximisation of value from transforming waste is possible." "The tools that have been used for process mapping with intent to outline waste are: value stream mapping, Sankey diagrams, material flow analysis, IDEF0, MEW andflow chats *(Fawaz and Rajgopal, 2007; Rahani et al., 2012; Kahlat and Willims, 2012)*."	N/A
The Canadian Geographer	Lepawsky & Mcnabb (2010)	Mapping international flows of electronic waste	Review study of International flows of E-waste	N/A	"According to studies by the United Nations, anywhere between 20 and 50 million tonnes of e-waste are generated globally, an amount growing at a rate nearly three times faster than the overall municipal solid waste stream (Arensman 2000; see also Schwarzner et al. 2005)."
Research Journal Of Chemistry And Environment	Parthasarathy, Keshav & Anantha Murthy (2008)	E-waste Recycling-Best Option for Resource Recovery and Sustainable Environment	Report on stages of recycling of E-waste at Bangelore, India	"Demanufacturing process, essentially manual dismantling of E-waste equipments and its assemblies and subassembling involves, shredding and chiseling of electronic components followed by segregation/separation of materials into metals and non metals. This is being practiced at different stages of processing." "The hazard parts of E-waste are collected separately during the initial stage of dismantling itself."	"Developed countries like USA, Europe and Japan have adopted fully automated, high cost technology for E-waste recycling. E-waste is crushed, shredded in total, followed by separation of metals and non-metals by adopting unit operations/metallurgical principles."

Figure 1.3: Literature review matrix

II SUMMARY OF INTERVIEW WITH WECYCLE

Verwerkingsproces e-waste Wecycle (04-01-17) Door Laura Ooms

Onder witgoed valt alles wat niet onder koelvries valt. Binnen e-waste zijn er een aantal fracties en die fracties worden gesplitst omdat daar een bepaalde verwerkingsmethodiek achter zit. Die verwerkingsmethodiek wordt ingegeven vanuit de Europese regelgeving, de WEEELABEX-standaarden. Op de site van de WEEELABEX kun je zoeken naar de treatment standards van large householdappliances (lhh) (=groot witgoed in het Engels). Hier is precies te vinden hoe de verwerking van groot witgoed moet plaatsvinden als het gaat over de uitkomst. Hierin staat niet zozeer hoe het gebeurt, maar wat het resultaat daarvan moet zijn. De treatment standards is een wettelijke verplichting in Nederland, dus elk bedrijf dat elektronica verwerkt in Nederland moet gecertificeerd zijn volgens de WEEELABEX-standaarden.

De verschillende fracties zijn er, omdat er verschillende verwerkingsmethodieken zijn die weer wettelijk voorgeschreven staan. Sommige verwerkers richten zich op groot witgoed, anderen op klein huishoudelijke, weer anderen op koelvries enzovoorts. Dat heeft allemaal te maken met de soort verwerking die daarna moet worden gedaan.

Bij groot witgoed moeten er wettelijk wat materialen uitgehaald worden en vervolgens moet het restmateriaal wat overblijft zodanig verwerkt worden dat er een bepaalde minimale verwerkingsstandaard wordt gehaald. De materialen die eruit moeten worden gehaald, allemaal te vinden in de WEEELABEX-standaarden, zijn in ieder geval: condensatoren (De reden hiervoor is dat er materialen in kunnen zitten die milieugevaarlijk zijn. Deze moeten eruit gehaald worden en op een speciale manier verwerkt of vernietigd worden.); printplaten; LCD-schermen groter dan 10 bij 10 cm (De reden hiervoor is dat er eventueel kwik in kan zitten).

Het verwijderen van deze stoffen is de belangrijkste activiteit die in ieder geval moet gebeuren en zorgt ervoor dat bij de verwerking van groot witgoed een handmatige verwijdering van de materialen plaatsvindt. Mechanisch is dit niet mogelijk, aangezien dan de materialen kapot worden geslagen die er eigenlijk uitgehaald moeten worden. Het mechanisch of handmatig verwijderen van storestoffen heet depolution.

Het eerste wat er moet gebeuren is dus de verwijdering van gevaarlijke stoffen. Daarna moet het geplaatst worden in een shredder, waarna er vervolgens allerlei sorteerslagen op los worden gelaten om al die stromen van elkaar te scheiden. Er kan ook handmatig verder worden afgedemonteerd, wat betekent dat er zoveel mogelijk schone stoffen uit worden gehaald. Dit omvat vaak glas, beton en eventueel gietijzer.

Als conclusie kan gesteld worden dat er altijd eerst een handmatige activiteit moet plaatsvinden om de milieugevaarlijke stoffen eruit te halen. Daarna kan ofwel mechanisch het restant worden verwerkt ofwel met een kleine handmatige activiteit bepaalde monorstromen er zo goed mogelijk uithalen, waarna alsnog een mechanische activiteit zal plaatsvinden.

Als verwerker is er een bepaalde recyclingwaarde en die verschilt weer per fractie. Bij witgoed staat deze recyclingwaarde ongeveer op 70% wat betekent dat 70% van de inkoopstroom aan gewicht weer als outputstroom moet kunnen worden ingezet in een toepassing die als materiaalrecycling

gekwalificeerd wordt. Vanuit Europese regelgeving zijn hier strenge normen voor. Niet alles mag zomaar tot materiaalrecycling worden gerekend.

Als verwerker ben je dus blootgesteld aan een drietal uitdagingen: Je moet aan de WEEELABAX-certificeringen voldoen en daarmee moet je handmatig een aantal stappen laten zien dat je die processen begrijpt, toepast en daadwerkelijk tot een outputstroom leidt die voldoet aan de voorwaarden daarvoor. Daarvoor moet je een zogenaamde batchtest doen. De grootte van de batch hangt af van de totale verwerkingscapaciteit, aangezien dat in verhouding staat met de totale verwerkingscapaciteit. Vervolgens wordt aan het eind van de lijn gekeken welke stromen eruit komen en welke afzetkanalen daarvoor nodig zijn. Hier wordt gekeken in hoeverre je aan kunt tonen of de materiaal recyclingwaarde wordt gerealiseerd. Deze uitdaging heeft dus te maken met de manier waarop je het verwerkt.

De tweede uitdaging is of je kunt laten zien dat je alle gevaarlijke milieustoffen uit de producten hebt gehaald. Dit laat men zin op een verwerkingslocatie, waar ze het proces kunnen demonstreren en beschrijvingen geven bij het proces. Hier moet men aantonen dat men snapt waar men het over heeft qua kennis- en materiaalniveau.

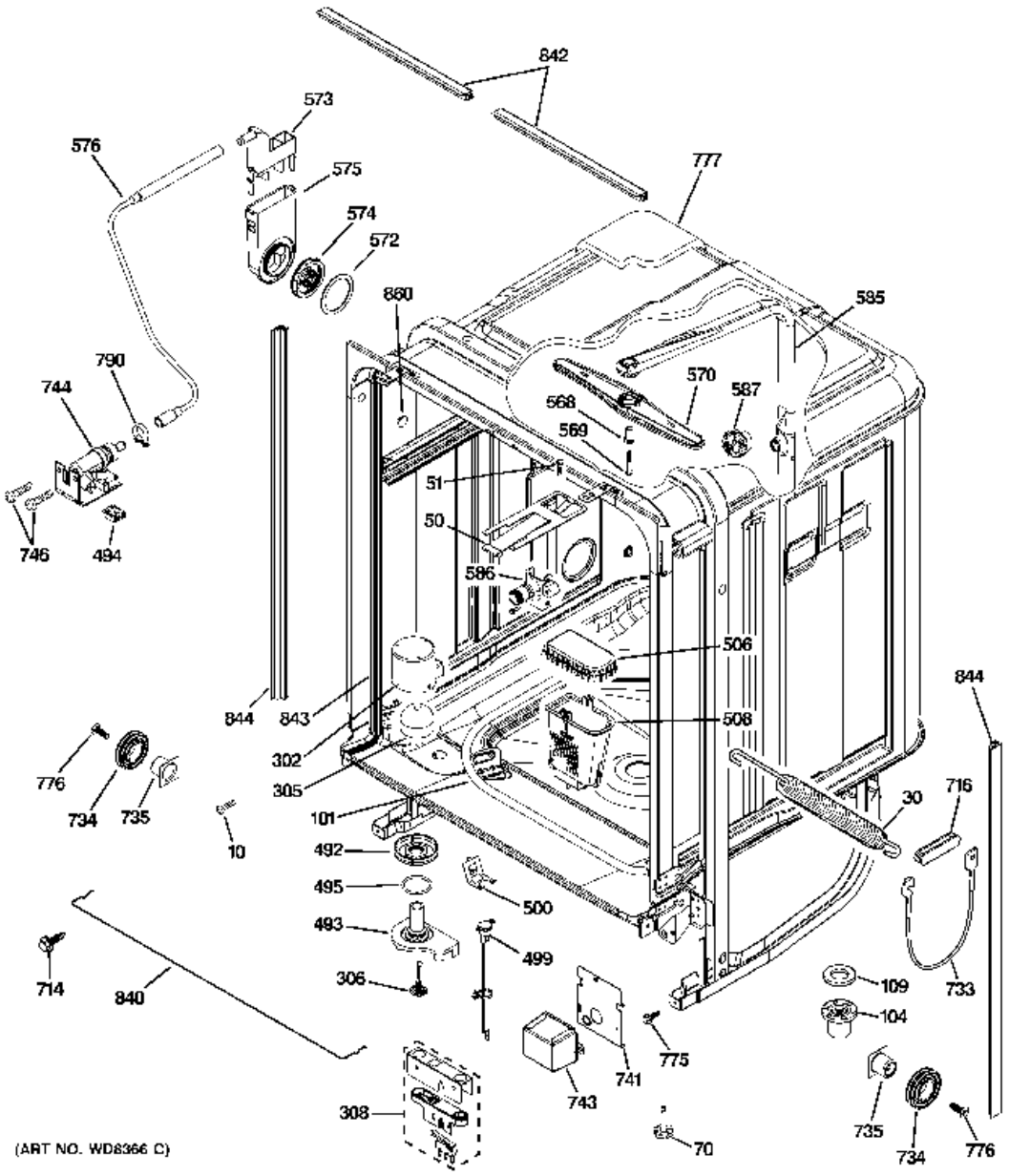
De laatste uitdaging is om de bedrijfsvoering in stand te houden. Hierbij moet ook rekening worden gehouden met alle milieuvergunningen die lokaal gelden, zoals geluidsvergunning.
Bovenstaande zal op elke locatie die groot witgoed verwerkt worden gecontroleerd. Dit kan dus gezien worden als het kader waarbinnen men de operatie uitvoert.

Wecycle is een stichting zonder winstoogmerk. In Nederland is de inzameling van e-waste als volgt georganiseerd. Vanuit Europese regelgeving is er een richtlijn afgesproken, de we guideline. Deze richtlijn schrijft voor dat iedere lidstaat een bepaald percentage van het materiaal dat op de markt is gezet terug moet halen en daar een bepaalde recyclingwaarde uit moet halen (= recycling target). Dus iedere Europese lidstaat heeft dezelfde doelstelling en iedere lidstaat is daarin vrij om dat naar eigen inzicht te organiseren. Daarom zie je dat in Europa per lidstaat er verschillende modellen gekozen zijn. In Nederland heeft de overheid ervoor gekozen om daarvoor de zogenaamde producentenverantwoordelijkheid in het leven te roepen. De producenten willen dat best doen, maar wel op 2 voorwaarden: 1. Het vragen van een bepaalde vergoeding van de consument. Dit is de basis van de verwijderingsbijdrage die rond 1999 in het leven is geroepen. Deze bijdrage is inmiddels afgeschaft. 2. Niet individueel organiseren, maar opzetten als collectiviteit. Wecycle is opgericht om invulling te geven aan de collectieve producentenverantwoordelijkheid. De financiering gebeurt door zogenaamde productstichtingen, groepen die bepaalde clusters van producenten vertegenwoordigen die vergelijkbare productsoort op de markt zetten. Dit zijn de opdrachtgevers van Wecycle. Er zijn zes productstichtingen opdrachtgevers, dus er zijn ook zes verschillende clusters van bedrijven. Een bedrijf kan aangesloten zijn bij meerdere productstichtingen. De tarieven die een producent betaald wanneer hij deel wil nemen aan de collectiviteit zijn te vinden op internet. De financiering loopt zodanig dat producenten als collectief betalen en die leggen de rekening, verbouwen dat in hun tarieven die zij uiteindelijk in hun producten neerleggen.

We moeten ons realiseren dat er bepaalde stromen zijn die een positieve opbrengst hebben. Dat hangt af van je materiaal of met name de metaalindices. Op het moment dat de ijzerprijs heel laag is wordt het steeds moeilijker om daar een positieve opbrengst bij te hebben. Die positieve opbrengst is datgene wat je krijgt op het moment dat je iets afgeleverd hebt bij een verwerker. Er is nu geen enkele stroom afgezien van de hoogwaardige ICT-stroom die gezamenlijk met de inzameling en de

sortering een positieve stroom oplevert. Wecycle ziet op dit moment geen businesscase voor het demonteren van e-waste. Wecycle is een stichting en hoeft dus geen winst te maken.
Wecycle is ook druk bezig met social return en als zodanig is hij wel geïnteresseerd om Twente Milieu hierin te ondersteunen en om samen te werken. Het is echter lastig om dit te realiseren. Hiervoor is volume nodig en moet er commitment zijn vanuit de gemeenten. Gemeenten willen wel lokale werkgelegenheid creëren, maar vaak kunnen ze niet garanderen dat ze daadwerkelijk mensen met een afstand tot de arbeidsmarkt kunnen leveren. Er is coaching en begeleiding nodig voor deze social workers. Er is een reden dat deze mensen een afstand tot de arbeidsmarkt hebben. Het zijn vaak geen hooggekwalificeerde, gemotiveerde mensen die je probeert te begeleiden, maar mensen die toch ergens moeilijk sociaal functioneren of het lastig vinden om in standaardprocessen te werken. Doordat ze begeleiding nodig hebben daalt de productiviteit. Uiteindelijk concurreer je wel met partijen die dit wel als industrieel proces hebben ingeregeld. Er moet dus gezocht worden naar activiteiten die waarde toevoegen. Hierbij moet je met name kijken naar de depolution activiteit. Dit moet toch ergens gebeuren en kan dus ook lokaal gebeuren. Om dit te organiseren moet je investeringen doen en heb je volume nodig. Wecycle merkt dat er nog weleens een discrepantie zit in de verwachtingen van de gemeente en wat men uiteindelijk bereid is om erin bij te dragen. Dit is een kanttekening hierbij. Echter, toch is dit wel de toekomst. Het is een model waar we allemaal naartoe moeten werken en vorm moeten geven.

III PARTS DIAGRAM OF A DISHWASHER



(SEARSPARTDIRECT, 2017)