Windesheim Honours College

Circularity and waste management for couches, chairs and armchairs at Kringloop Zwolle, Kringloop Noggus & Noggus and Rova: Final report for WaardeRing

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1. Introduction

This report is the result of a semester of research done by four students of Windesheim Honours College commissioned by Maarten van Dongen of the WaardeRing network for two important stakeholders of the WaardeRing Network: Wilma Voortman of Stichting Kringloop Zwolle and Noggus & Noggus Zwolle (from now on mentioned as Kringloop Zwolle) and Marjolein Mann of ROVA Zwolle.

This report consists of four main parts and is supplemented by a simulator in a separate Excel file and a flowchart as found in Appendix 1. The flowchart can also be accessed online through a separate link. The first part highlights the reason for this report, what the team has done and how to read the report and instructions for using both the flowchart and Excel file. The second part focuses on the numerical side of the research, defines the goals, methodology applied and concludes the results for this part. The third part handles the potential partners and buyers for the different materials and highlights opportunities and challenges associated with each material. The fourth and final part of the report draws a conclusion for potential partners and maps out potential future projects.

1.1 Problem background

Kringloop Zwolle and Rova Zwolle have tasked the team with researching a specific element of their waste stream: couches, chairs, and armchairs. For readability reasons, the team will mention these simply as couches or sofas in the rest of this report, unless specified differently. Kringloop Zwolle receives more couches than there is demand. At the same time, a share of the couches that come in are too old or worn to be interesting for consumers. Almost 90% of couches that come in at Kringloop are eventually disposed of and burned in a waste oven.

The waste processor Rova handles all consumer waste of the municipality of Zwolle. Rova receives both worn couches and such that could still be sold at the Kringloop Zwolle. Yet, due to current regulations, there is no system in place to collect couches at the recycling centre and transport them to the Kringloop stores; thus, all couches end up at the recycling centre of Rova. Because a couch contains so many different materials such as wood, metal, textile, leather and plastics, the couches cannot be easily recycled and thus end up in the general waste destined to be burned in the waste oven. Only chairs that are only made from one material, or predominantly one material (e.g., wood) can be separated into the appropriate material container.

Due to the often large size and heavy weight, couches disproportionately affect the cost of waste disposal for both Kringloop and Rova Zwolle. Based on this situation, the team has, together with the clients, decided on the following goal for this project.

This research aims to develop a business case and plan for the dismantling of discarded couches and the separation of materials into different streams for recycling or upcycling. A secondary goal of the project was to find potential buyers and partners for these different

materials streams. Next to this, the team has added recommendations for future project continuations.

1.2 The materials inside

Most couches and armchairs contain four primary materials: wooden frame, metal springs, foam upholstery and a layer of fabric or leather. Sometimes couches and armchairs can contain pieces of carton. An example of a wooden frame from an armchair with metal strings can be seen in figure 1.

Figure 1. Stripped frame from an armchair.

The material that creates the most volume of general waste is foam. The wood and metal are being recycled, while leather can be repurposed to make new goods on a small scale. Fabrics usually will be wasted too. Figure 2. presents all materials except fabrics and leather that are left over from disassembling one couch and one armchair. Figure 3. shows all textiles that are stripped from one couch and one armchair.

Figure 2. The materials left over after disassembling one couch and one armchair, excluding fabrics and leather.

Figure 3. Textiles from one couch and one armchair.

1.3 The disassembly process

There is no universal system of couch disassembly. Usually, it requires some creative thinking and must be approached pragmatically; after the fabric/leather layer goes off, the disassembling process can take any direction. Most often, after the couch frame has been

stripped, the most realistic way to disassemble a couch is to use a hammer and take the pieces of wood apart using physical strength.

The most common tools for taking couches apart are bread and paper knives, hammer, industrial cutter, etc. Not all these tools, especially electric ones, are suitable to use without dedicated training and cannot be used universally by everyone.

The process of disassembling the couches and armchairs requires hard physical work. The couch disassembling can take around two hours for an expert, while for a first timer, it can take up to four hours to take apart just one unit.

1.4 Produced to be wasted

Unfortunately, one of the primary outcomes of this research is that couches are not produced to be recycled. The materials coming from couches have multiple challenges associated with them – they are most likely low quality, in different sizes and repurposing the materials is a difficult task due to their appearance and unique characteristics.

Further information on materials and the potential usage can be found in chapter “Potential partnerships per material”.

1.5 How to use the product

This chapter provides a short introduction to the content and the structure of the report to guide the reader. Appendix 1. contains instructions about the simulator, which is part of the final product.

Report
After the introduction to the research topic, the structure of this report is in two parts.
The first one is about the following numerical goals.

1. To identify the size of the current waste flow.
2. To identify, qualify, and quantify the different materials collected dismantling sofas and armchairs.
3. To identify the costs associated with the incinerator route and compare them with the financial results related to dismantling the items.

The chapters for each of these numerical goals are divided into the following structure:

- Introduction of the aim;
- Explanation of the methodology adopted to reach the objective;
- Results obtained;
- A conclusion which highlights limits and implications of the results.

While researching, the team developed a flowchart that shows how Rova and Kringloop deal with disposing of the studied items. The final version made and used as support for the research is in Appendix 1.
The first part of the report ends with the conclusion, which summarises the findings of the numerical part and gives recommendations based on four different scenarios. These scenarios vary depending on the costs (per kilogram) to dispose of the other materials and the percentage of items recycled. Starting from these variables, each scenario provides a

forecast about the unit costs, average cost per month, amount of CO2 emitted and the number of work hours necessary for the operation. For each of these scenarios, the team highlighted where collaboration could lead to financial and environmental improvement.

The second part of the report is about the potential partners for materials. For each of the materials available from disassembled sofas, armchairs and chairs, the team made a SWOT analysis. This highlights the strengths, weaknesses, opportunities, and challenges. Besides the analysis, each sub-chapter contains recommendations, collaboration opportunities, and a table containing all potential partners interviewed for the research.
After the materials, there is a subchapter about other opportunities. These are partners or ideas not related to only a single material.
The second part ends with a subchapter about the project continuation and most relevant potential partners.

2. Numerical part

2.1 First numerical goal

The size of the current waste flow

As reported in the project assignment form and confirmed during the first meetings in February, the first goal proposed for this project was to determine the size of the current waste flow. It is necessary to estimate the collected sofas, armchairs and chairs to make disassembly on a large scale possible. These results are a fundamental starting point to quantify the number of raw materials theoretically collectable by each company per month.

Methodology

To obtain these results, the team acted in the following way.

For Kringloop:

The team created a survey in Dutch for the managers of Kringloop. First, to collect data about the goal, there were questions about the number of sofas, armchairs and chairs collected by each shop on average per month. Over that, the managers provide answers related to the numbers of items directly sent to Remondis - the firm that collects industrial waste - and, as a third request, the number of items disassembled in both the shops that dismantle sofas, armchairs, and chairs.

About the first and the third point, it was possible to collect answers for each shop. Because of the lack of internal accountability, these answers are qualitative answers based on the experience and perception of the managers. For this reason, the team decided to apply, as suggested by Jan Tepper, manager of Kringloop in Staphorst, a reduction of 20% on the declared number to create a sureness margin.

For the same reason, it was not possible to quantify the average quantity of items directly sent to Remondis after their not sold permanence in the shop.

The team quantified the average amount of items directly sent to Remondis, multiplying the number of items collected by the “not sold coefficient”. This coefficient is equal to 0.5 because, as reported by Jan Tepper during the first interview on the 10th of February, usually Kringloop sells just half of the accepted items. The others, after two months, are removed from the shop.

For Rova:

To collect information about how Rova manages the items in the recycling centre, the team interviewed Marjolein Mann on the 11th of February. Rova collects the items in two ways: picking them up on appointment or directly at the recycling centre when citizens bring them in. In the first way, everything is dumped into the general waste container. In contrast, with the second, each item is checked and oriented in the proper container. Sofas and armchairs, because of their complex composition of materials, are always collected in the general waste container, while chairs can be recycled in the wood or metal container.

To collect the number associated with this flow, the team interviewed Jan Pruis, a worker in Zwolle recycled centre. As for Kringloop, the lack of specific internal accountability prevents accurate quantification. Jan answered about the number of sofas, armchairs and chairs collected on average per month and provided a percentage of chairs recycled in the wood and metal container.

To collect more specific data, the team provides him with a check sheet to fill. The aim is to quantify the flow of items and compare the sample with the declared data.

Results

In the following table are summarised numerical results obtained for Kringloop.

	Quantity collected on average per month	Quantity not sold on average per month	Percentage dismantled on average per month	Quantity directly sent to Remondis on average per month
Sofas	126	63	10%	60
Armchairs	63	32	9%	30
Chairs	357	178	9%	172

Table 1. Flow of items in Kringloop.

In the following table are reported the number of items collected for each shop (Ommen1 does not collect sofas, armchairs, and chairs)

	Collected			Dismantled			Sent to Remondis		
	sofa	armchair	chair	sofa	armchair	chair	sofa	armchair	chair
Dalfsen	25	11	61	0	1,5	7	12	5	27
Staphorst	15	7	42	6	1,2	6	5	3	18
Hasselt	2	1	7				1	1	3
Ommen2	4	7	39				2	3	19
Zwolle1	34	15	84				17	7	42
Zwolle2	46	22	124				23	11	62
TOTAL	126	63	357	6	2,7	13	60	30	172

Table 2. Flow of items for each Kringloop's shop.

The following table collects the numerical results for Rova; each represents the average amount per month.

In the following table, the data regarding the items collected at Rova can be found.

	Collected/month	Recycled in wood/month	Recycled in metal/month
Sofa	20	-	-
Armchair	6	-	-
Chair	34	26	5

Table 3. Flow of items in Rova.

Conclusion

For both the companies, the internal accountability lacks details about the specific items. This reason, plus the short horizon of the project and the alteration in the system caused by the pandemic, leads the team to choose to collect numbers based on the perception that the workers and managers have. This qualitative representation generates results that could be sensibly different from the quantitative reality. These limits also approximate the phenomena as static without seasonality influences. This, for example, overlooks the effect of spring cleaning. Despite that, the numbers obtained can offer an efficient indicative display of the waste flow for both companies. A future and more accurate collecting of data could lead to more precise results and define even the seasonal influence on numbers. For a future project, having this information can help better predict future data and create a clearer image of the current scenario.

Besides these limits, from the results, it can be observed that the number of items that Kringloop has to dispose of is higher than the number of items that the recycling point of Rova in Zwolle receives. Considering all the shops, Kringloop, on average per month, has to deal with three times the number of sofas and five times the number of armchairs and chairs. This result highlights how for Kringloop, the studied items represent a more significant issue. At the same time, it shows that disassembling a significant percentage of the number of sofas, armchairs and chairs collected by both firms could lead to an opportunity to make more hours of social work available.

Based on the data collected for the second numerical goal, for Kringloop, moving from the actual 10% of sofas and 9% of armchair disassembled to 90% for both could increase the hours of social work from 21 hours per month to 210 hours per month. More details about the implication of this result are in the conclusive part of this chapter.

2.2 Second numerical goal

Identifying, qualifying, and quantifying the different material flows that are released when sofas and armchairs are dismantled.

As reported in the project assignment form and confirmed during the first meetings in February, the second numerical goal for the project was to identify, qualify, and quantify the different material flows released when sofas and armchairs are dismantled. Reaching this result allows the team to forecast what will come out from disassembling the items and the quantity for each material on average. These results, combined with the numerical goal number one, permits the forecasting of the number of raw materials that are theoretically collectable in a month/year from both firms. These results can be used for the implementation of a large-scale disassembling plan.

Methodology
The identification of materials started from the first steps of the project. In the first meeting with clients and during the first interview with Wilma Voortman, Jan Tepper and Maarten Van Dongen in Staphorst, the team received a brief description of the process of disassembling and the list of the materials collected. On the 26th of February, the team went to Staphorst to work with some of the items. The team members obtained a clear vision of the process and collected information about the materials and their qualification. From the meeting with Marjolein Man on the 11th of February, the team understood that the tag for the wood collected from the items is "type B" wood. This information was confirmed then by Hugo Kins, a researcher for Rova, on the 14th of April.

To obtain a numerical distribution of materials among the items, the team provided a check sheet to fill to Jarno Compagner, a worker in the "Noggus & Noggus" in Staphorst that manages the disassembling part. The document asked to provide, for each item disassembled, the time used to work on it, the amount of wood, foam, fabric, leather, and metal collected, over eventual notes. Thanks to the collected data sample, using excel as a support software, the team can estimate the average amount of materials on each item. A report sent by Maarten Van Dongen provided information about materials that usually compose sofas. Here information is provided by aggregated quantities. A comparison between that information and the one collected through the check sheet showed that the results are coherent.

Results
Here follows a table summarising the main results obtained through the interviews and the data collected via check sheet. The average relative composition for sofas and armchairs is comparable to the number of materials collected considering a large sample.

The chairs are usually composed of a single material. Those results show the probability to have a chair made with a specific material. So, the relative expected amount of each material collectable disassembles a large number of chairs. For example, disassembling a single random chair, the probability that this one is made of wood is 75%. Disassembling 100 random chairs, the amount of wood collected should be around 75% of the total mass. The results are expressed in kilograms.

Item	Average weight	Average quantity of wood	Average quantity of foam	Average quantity of fabric	Average quantity of leather	Average quantity of metal
Sofa	60	42,89	11,57	1,93	2,41	1,20
Armchair	30	22,81	2,99	0,27	3,12	0,81
Chair	8	6,00	-	0,80	-	1,20

Table 4. The average quantity of materials for each item.

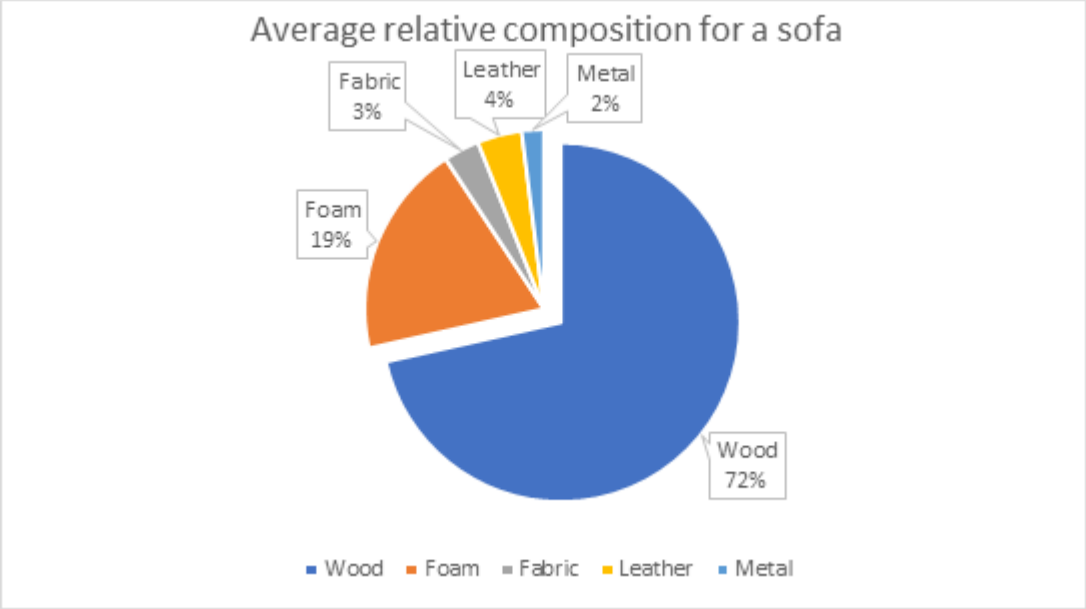


Figure 4. Relative composition of a sofa.

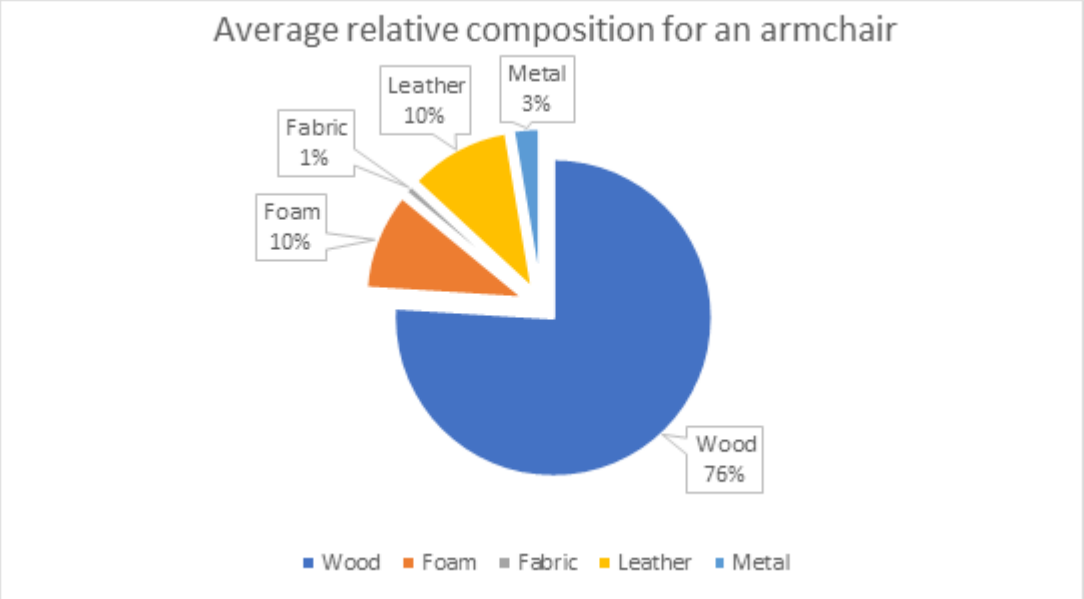


Figure 5. Relative composition of an armchair.

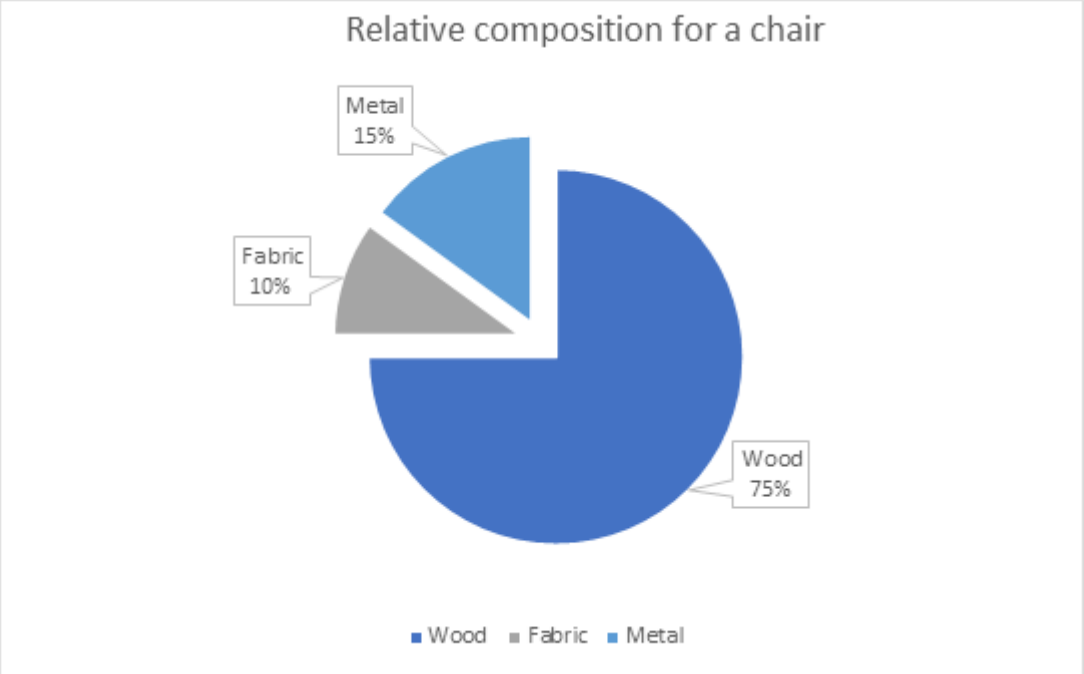


Figure 6. Relative composition of a chair.

Conclusion

The COVID-19 pandemic influenced the data collection negatively. As expected, the lockdown reduced the number of items collected by Kringloop during the study. Consequently, the number of dismantled items dropped drastically. The workers disassembled only two sofas and four armchairs, collecting a small sample for the study. The results collected can be considered indicative of the distribution of materials but not representative of the population of items. Future research based on a larger sample is

necessary for more accurate results and a more precise forecast of the number of materials theoretically collectable. Despite that, the worker responsible for the disassembly point of Kringloop in Staphorst, based on his own experience, confirmed that the data collected are not outliers in the distribution of the materials. It can support the indicative nature of results. Over that, the team created a tolerance interval considering the higher and lower sample. It should provide a more precise overview. More details about this can be found in the excel file attached to the report.

Observing the relative distribution of materials, it is possible to see that all the items are mainly composed of wood. In each case, it is over 70% of the total mass. The second component is the foam that is around 20% in sofas and 10% in armchairs. In chairs, it is not relevant. Over the foam follows the presence of fabric and leather (around 10%) and the metal, 2/3% for sofas, and armchairs. For the chairs, usually mainly made of a single material, the percentage of metal should be around 15% on a large sample. These results combined with those of the first numerical goal allow estimating the number of materials collected per month by both firms. With the actual percentage of items disassembled or recycled, Kringloop and Rova collect, on average per month, around 600 kg of wood, 170 kg of foam, 100 kg of fabrics, 22 kg of leather and 64 kg of metal.

As reported in the first numerical goals, now, Kringloop disassembles only 10% of the items, just six of them collect the studied items. At the same time, Rova does not recycle sofas and couches. If both the firms start to disassemble the 90% of sofas, armchairs and chairs, the number of materials collected per month would be around: 5.200 kg of wood (+863%), 2000 kg of foam (+1140%), 820 kg of fabrics (+787%), 280 kg of leather (+1245%) and 350 kg of metal (+540%). More details about the implication of these results are in the conclusive part of this chapter.

2.3 Third numerical goal

To identify the costs associated with the incinerator route and compare them with the financial results related to dismantling the items.

As reported in the project assignment form and confirmed during the first meetings in February, the third numerical goal proposed for this project was to identify the costs associated with the incinerator route and compare them with the financial results related to dismantling the items.

Initially, as part of the goal, the clients requested to compare the CO2 footprint derived from both flows. Later, when applying the Moscow method, the team and the clients agreed that estimating the CO2 footprint is beyond the project's scope and therefore defined it as a 'Won't have'. Despite that, the team managed to provide an estimation about the C02 thanks to the information provided by Marjolein Mann. On the 10th of February, the client asked to not consider the labour cost.

The team managed to obtain for both the company the average total monthly cost associated with the disposal of the items and the average cost sustained to dispose of a single item.

Methodology

For Kringloop:
To quantify the costs associated with each item and the average cost sustained by the firm, the team collected information about the process, the quantities and the costs associated with disposal.

The reconstruction of the process started from the first meeting on the 2nd of February. Here the team comes out with a first scratch of the flowchart. The information provided on the 10th of February provided a better overview. Here, the team discovered that from the seven Kringloop shops present in the region, just six of them collect the studied items. Only two shops (Dalfsen and Staphorst) have a disassembling point. The items are collected from the citizens directly in the shops and, Jan Tepper, manager of Noggus & Noggus in Staphorst, declared that the shops usually sell just half of the accepted items. After two months of unsold status, those are disposed of. Just a part of them is disassembled and, as confirmed in the meeting of 26th of February, the items are rarely moved between the shops to be disassembled. On the 2nd of February, the team collected information about the cost that Kringloop sustains to dispose of the general waste and the wood with Remondis, a firm that collects industrial waste.

On the 26th of February, the team went to Staphorst to work in the first person on disassembling. Here were collected information about the materials collected, the difficulties related to the work and the time needed to finish.

To quantify the flows associated with each shop, the team created a questionnaire. Thanks to that, it was possible to quantify the numbers of sofas, armchairs and chairs collected and disassembled in each shop. The lack of precise internal countability made it impossible to precisely know the number of items disposed of. This number was estimated using the "not

sold coefficient" declared by Jan Tepper on the 2nd of February. The average weight for each item was collected using the same survey.

This average weight was then compared with the data from the form shared by Maarten. The results were that the numbers were coherent.

To know the average weight of materials that compose the items, the team prepared a check sheet for Jarno Compagner, an employee of the Noggus & Noggus store in Staphorst. Here, for each item disassembled, the total weight of each of the materials was noted down. Thanks to those results, the team could estimate the average quantity of each material contained in the items.

Texting to Jarno was possible to collect information about the costs associated with each material.

Thanks to the data collected and the overview of the process, it was possible to estimate the costs. The specific passages are provided with the attached excel files. There are collected both the passages for the total average monthly cost and the average cost associated with each item.

For Rova:

Similarly to Kringloop, defining the costs was necessary for the team to define: the process, the disposal cost and the quantities.

The process was mainly defined in a meeting with Marjolein Mann on the 11th of February. The team understood that the items could be picked up on appointment by Rova or directly brought to the recycling centre by the citizen. In the first case, all the items are collected in general waste. In the second, they are checked and, in case they were mainly made of a single material, collected in a separate container. Once the general waste container is full, it is sent to a third firm that burns it.

About the costs, on the 18th of February, Marjolein Mann declared that it is not fixed. Counting taxes, it is between €73,15 and €113,15 per ton. The team chose to use the average. For the costs of each material, the team asked both Marjolein Mann and Hugo Kins.

For the quantities, on the 12th of March, the team interviewed Jan Pruis, a worker in the recycling centre of Zwolle. The team collected numbers about the average amount of sofas, armchairs and chairs collected in a month. Over that, was collected the distribution of chairs between general waste, wood, and metal.

Thanks to this information, the team can estimate the total average cost per month related to the items and the average cost of each item. The passages are presented in the Rova sheets in the attached excel file.

About the CO2, the team received data from Marjolein Mann about the amount of CO2 produced by burning general waste. The CO2 coefficient is 1,179 tons of CO2 for each ton of materials. To estimate the CO2 generated, the team applied the following formula:
(Total mass of not disassembled items + total mass of foam collected + total mass of fabric

collected) *CO2 coefficient = Total mass of all materials and items incinerated as general waste* CO2 coefficient = Total amount of CO2 generated (in kg)

Results

In the following tables are summarised the main results. Here it is possible to see the cost associated with each item and sustained from each company both in the case of disassembling and not disassembling. For Rova, the scenario "Rova - Disassembling" is hypothetical because the only item recycled now is the chairs. The third row shows how much is possible to safe disassembling each item. When the results are negative, it means that it is a financial inflow for the company.

	Sofa	Armchair	Chair
Rova - no disassembling	5,89 €	2,94 €	-0,34 €
Rova - disassembling	-0,37 €	- 0,39 €	-0,34 €
Saving by disassembling	106%	113%	0%

Table 5. Unit cost of items for Rova

	Sofa	Armchair	Chair
Kringloop - no disassembling	9,60 €	4,80 €	1,28 €
Kringloop - disassembling	5,61 €	2,05 €	0,43 €
savings by disassembling	42%	57%	67%

Table 6. Unit cost of items for Kringloop.

Cost calculation

These results were obtained as follows:

Without disassembling

The average weight of the item in kilogram * Cost per kilogram of general waste = unit cost of not disassembled item

With disassembling

Average quantity of wood per item * price for wood per kilogram +
Average quantity of foam per item * price for foam per kilogram +
Average quantity of fabric per item * price for fabric per kilogram +
Average quantity of leather per item * price for leather per kilogram +
Average quantity of metal per item * price for metal per kilogram = unit cost of a disassembled item

Here the average cost per month of the disposal of the items is summarised.

The first row, "General waste," indicates the costs sustained with the total items directly disposed of, while the second, "disassembled part," refers to disassembled or recycled items. When the results are negative, it means that it is a financial inflow for the company.

	Kringloop	Rova
General waste	892,42 €	134,27 €
Disassembled part	45,75 €	- 10,55 €
TOTAL COST	938,17 €	123,73 €

Table 7. Total average cost for both the firms.

About the CO2 generated, the team estimated the following average quantities in kilograms per month:

	Sofa	Armchair	Chair	Total
Rova	1415 kg	212 kg	32 kg	1659 kg
Kringloop	4329 kg	1076 kg	1626 kg	7031 kg

Table 8. CO2 footprint associated with each item for each firm.

Conclusion

The result for the third numerical goals is a combination of the first and second numerical goals results. Therefore, the bias presents in the data alters the results of the third goal. This bias is present especially for the estimated cost of sofas and armchairs. Considering the minimum and the maximum number of materials present in the items, the minimum expense for a disassembled couch is 23% lower than the average; the maximum is 23% higher. For armchairs, this interval is higher: the minimum is 57% lower and the maximum 135% higher than the average cost. It means that the results are usable for indicative results for a not short period, but a precise prediction of financial results requires more accurate data subjected to less variability. Over the quantities of materials, the total cost of not disassembled items comes from a qualitative estimation of the flow and the not sold coefficient. More details are in the excel files in the sheet "collected data".

Despite that, the results indicate that disassembling the items lead to a significant reduction of disposal costs for both firms. In fact, for Kringloop, disassembling items means a decrease in disposal costs, around 42% for sofas, 57% for armchairs and 67% for chairs. By disassembling items, Kringloop reduces by 5% the average expense per month.
Results are even better for Rova. Thanks to a better agreement about wood, disassembling items for Rova could reduce the costs by 106% for sofas and 113% for armchairs, transforming these costs into a source of income. If Kringloop could have the same agreement for the wood, their expense would change their nature. In this scenario, for Kringloop, disassembling the items would lead to a cost reduction of 100% for sofas, 111% for armchairs and 133% for chairs. It would reduce by 8% the total average cost per month considering the actual situation.

If both the companies cooperate, disassembling 90% of the items and selling the wood, the average cost per month associated with them will decrease by 94% for Kringloop and 106% for Rova. More details about the implication of these results are in the conclusive part of this chapter.

2.4 Scenario Analysis

The numerical results highlight how an increase in disassembling and recycling items can be profitable for both companies. Increasing this activity could lead to a reduction in cost and environmental impact.

The results show that even maintaining the actual costs per kilograms for the dispositions of materials, disassembling the items lead to a drastic reduction in cost per unit. By doing it, Kringloop reduces the cost per unit by 42% for sofas, 57% for armchairs and 67% for chairs. Rova is, at the moment, not disassembling or recycling sofas and armchairs; it does recycle

chairs when they are composed of a single material (wood or metal). The results show that by introducing this policy for sofas and armchairs, the cost per unit associated with them could change its nature and become an income. Rova could reduce by 106% the cost per unit for sofas and by 113% for armchairs by disassembling.

To support the development of a common platform to collect and disassemble the studied items, the team provide the example of four scenarios:

1. 50% recycled - fixed cost.
2. 90% recycled - fixed cost.
3. 50% recycled - best cost.
4. 90% recycled - best cost.

In the first two scenarios, there is no cooperation between the firms. Both internally improve the operation reaching 50% for the first scenario and 90% for the second of items are disassembled. In these scenarios, the cost per kilogram for disposing of the materials remains the same for each firm. Both companies use their workers for the operation.

In the third and fourth scenarios, the companies cooperate on a common platform. In the third scenario, they reach 50% of the total items, and in the last 90% of items are disassembled. Thanks to the cooperation, it is possible to use the lower costs per kilogram for disposing of the collected materials. Over that, the cost of labour can be the cheapest between Rova and Kringloop.

1. 50% recycled - fixed cost.

The lack of cooperation conserves the already existing costs for disposal of the materials collected. The cost for each item does not change. When Rova disposed of the items without disassembling them, it spent 5,89€ for each sofa, 2,94€ for each armchair and gained 0,34€ for each chair. Disassembling the items, all of them became a source of revenue. Each sofa provides an income of 0,37€. Each armchair is 0,39€ while for the chair it remains the same. For Kringloop, the results are less effective but significant. Disassembled, each sofa moved from 9,60€ to 5,61€, each armchair from 4,80€ to 2,05€, each chair from 1,28€ to 0,43€.

In this scenario, the average cost per month associated with the studied items reduces significantly. For Kringloop, improving from an average of 10% of items disassembled to 50% reduces the average cost per month by 20%. From 938 €/month to 737 €/month. For Rova, the results are more significant. Introducing this policy for sofas and armchairs could reduce the average cost per month by 59%. It moves from 123€/month to 51€/month.

By implementing this plan, a large amount of CO2 emission can be saved. 36% for Kringloop (from 6,7 to 4 tons per month) and 40% for Rova (from 1,66 to 0,96 tons per month).

Based on the average hours used in Kringloop to disassemble the items, this improvement could increase the available work hours by 96 per month, the time necessary for this operation in Kringloop and by 31 hours in Rova.

In conclusion, this scenario provides a significant reduction in costs and CO2 emitted for both companies. Despite that, this solution can be financially stable only for Kringloop. Using internal workers for Rova, even if trained to reduce the time necessary to disassemble the items, will lead to a cost of labour that overcomes the savings provided in disposition costs. The same does not happen to Kringloop that leaves this operation to social workers. Punctual considerations about the costs of labour are not a goal for this research.

2. 90% recycled - fixed cost.

The lack of collaboration leads to the same conclusion about the cost per unit of the first scenario, “50% recycled - fixed cost”. The total average cost per month associated with the studied items reduces but not linearly with the percentage of items disassembled. In this scenario, Kringloop reduces the average cost per month by 40% compared to the actual situation. Rova saves 106%.

The CO2 generated in this case is 72% less for both companies. From 6,67 to 1,6 tons for Kringloop and 1,66 to 0,46 ton for Rova.

The monthly average hours of work necessary for this operation is 212 hours for Kringloop and 56 hours for Rova.

In conclusion, this operation could be a chance for Kringloop to save more than 400 €/month and increase the social work hours per month by 190 hours. For Rova, the considerations from the first scenario remain the same: the increase in labour cost could lead to a not profitable operation despite the savings on direct costs.

3. 50% recycled - best cost.

In this scenario, the companies cooperate by disassembling the items in a single place and sharing the most convenient cost for the materials collected. It means that Rova sells the wood and disposes of the general waste while Kringloop disposes of the leather.

This change in costs leads to a reduction in unitary cost for both companies. The cost reduction provided by disassembling the items would be for both the firms by 110% on sofas and 123% on armchairs compared to the actual situation. In this scenario, for Kringloop disassembling items leads to income instead of costs.

The reduction on the average cost per month would be by 71% for Kringloop and 61% for Rova.

The CO2 generated would be the same as the scenario “50% recycled - fixed cost”. it depends only on the percentage of items recycled and not the costs for materials. The same for the total average hours of social work per month.

In conclusion, this scenario leads to the same conclusion as the first one, “50% recycled - fixed cost” about the CO2 generated and the number of working hours necessary per month. Differently from the first scenario, in this case, the cooperation between the companies causes a significant reduction in disposal costs. Over that, allowing Kringloop to manage the

labour workers through the social workers could make the operation financially sustainable even for Rova.

4. 90% recycled - best cost.

It is the ideal scenario where while cooperating, both firms disassemble 90% of their items. The comments about the cost per unit are the same as the previous scenario. The cooperation leads to a drastic reduction in the cost per unit.

In this case, the average cost per month would decrease by 100% for Kringloop and 110% for Rova. It would transform, in both cases, the financial outflow into an inflow.

The CO2 generated would be the same as in the scenario “90% recycled - fixed cost”. These would decrease by 72% for both companies.

The total number of hours necessary for these operations would be around 270 hours per month.

In conclusion, this is the most profitable scenario for both companies. It would transform the costs associated with the items in revenues. It would drastically reduce the emission of CO2 and increase by twelve times the numbers of social work available.

The results and forecast of these scenarios come from the results of the numerical goals. These are subject to bias and limitation explicitly in each numerical goal sub-chapter. Over that, these results come from combinations of the actual situation. Future collaborations with the firms and organisations contacted during this research could lead to better results.

This study does not consider the possibility to reduce the cost per kilogram thanks to the increase in materials. In fact, at the moment, on average, it collects 600 kg of wood, 170 kg of foam, 103 kg of fabric, 22 kg of leather and 65 kg of metal. In the first and third scenarios, these numbers increase to around 3000 kg of wood, 1000 kg of foam, 465 kg of fabric, 157 kg of leather and 210 kg of metal. While in the second and fourth, these numbers reach 5170 kg of wood, 1950 kg of foam, 818 kg of fabric, 283 kg of leather and 347 kg of metal. In addition, at the moment, the foam, the second more frequent component of the study items, is general waste. Future collaboration could transform its nature with an impact from the financial than the environmental point of view. More details about the research on materials can be found in chapter three.

3. Potential partnerships per material

In this chapter, the research and conclusions for all materials by one will be reviewed. Firstly, the characteristics of every material will be described and analysed. Every subchapter will start with a SWOT analysis per material; however, instead of listing *threats* as a traditional SWOT framework suggests, *challenges* associated with the materials will be provided. Then, collaboration opportunities will be presented, as well as recommendations. Every subchapter will finish with a table listing all the potential partners contacted during the research and if a significant outcome was gained.

3.1 Wood

In the current waste flow, wood is being recycled for energy. During the research, multiple alternatives have been discovered and are discussed in this subchapter.

SWOT analysis: Wood

Strengths	**Weaknesses**
· Has some characteristics as raw wood,	· Covered in foam, staples and fabric/leather scraps, · Most of the couches contain low-quality wood,
Opportunities	**Challenges**
· The entire frame can be reused to make new couches, · Can substitute raw wood in some instances, · By standardising the material outcomes (size and quality), scaling is possible,	· The quality of wood differ in different couches, so the stream of wood can be unpredictable, · The quality of wood does not allow for the wood to be reused as a primary material for product design, · Different sizes and shapes of wood make the scaling of the wood stream difficult.

Table 9. SWOT analysis for wood.

Generally, couch frames are produced from low-quality wood. The wood is covered in foam, fabric, and leather scraps, complemented by many staples (see Figure 4.). The wood has some characteristics of raw wood, e. g. weight and durability, and therefore, in some cases, can substitute the raw counterpart. However, wood quality does not allow it to be used as a raw material in product design (e. g., high-end furniture).

Figure 7. Wood from disassembled couches and armchairs.

To scale the streams of wood gained from couches for further distribution, standardisation is essential. For example, to sell the wood for further reuse, the pieces must be of the same size and quality. However, due to the unpredictable quality of wood in the couches, scaling can be challenging.

3.1.1 Repurposing opportunities

Repurposing the wood from couches is a difficult task, and there is no obvious solution. Considering the current market of scrap wood, it is difficult to envision a sustainable solution to reuse individual pieces of wood. However, due to time limitations during this project, no potential designs were explored; and therefore, there is plenty of space for innovation and small-scale design initiatives.

Reusing the couch frame
Considering that the individual pieces of wood are low quality, one of the most realistic solutions to repurpose wood from couches is reusing the frame. No such market exists, and it is difficult to estimate the cost-benefit associated with the resale of frames. However, the scaling of such a solution would be complex due to the difference of frames and, therefore, can become a small-scale entrepreneurship initiative.

This solution provides a significant practical benefit: if the fabric/leather, foam and metal can be removed from the couch to leave the frame intact, fewer hours must be spent in the disassembling process.

Scaling opportunity: Cross-laminated timber
If the pieces of wood can be standardised in size and quality, creating panels of cross-laminated timber (CLT), also known as crosslam, is an option to scale the wood stream. CLT is an innovative wood product composed of several layers of laminas or thin wooden pieces

(see Figure 5.). The end product can almost always substitute the raw counterpart in construction projects (Christiyanto, Purba, & Munandar, 2019).

Figure 8. An example of a cross-laminated timber panel (Lalonde, n.d.).

Creating panels of CLT can access new markets for the scrap wood from couches since no such initiative exists yet. It can be achieved by collaborating with a woodworker with expertise in CLT, e. g. Herso.

3.1.2 Recommendation

While many companies use scrap wood, there is almost no market for leftover wood from couches. Reusing this kind of wood has many challenges, but it can also provide a wide range of possibilities - they just must be found. For further development of this research, we provide three main learnings.

Standardisation
To scale the stream of wood, it is essential to find a way to standardise the individual pieces of wood by size and quality. Without the involvement of external partners, it can be done in a couple of ways. For example, the wood pieces can be cut in a specific size and shape, or the couch frame (or a part of it) can be left intact. With the involvement of external partners, it is possible to produce CLT panels for further sale on a large scale.

Small-scale opportunity
There are endless options to repurpose wood from couches on a small scale. Then, standardisation is not a priority, and there is a more extensive range of wood available. Therefore, establishing a distribution channel for scrap wood dedicated to small initiatives can be beneficial. Selling small-scale can be financially more attractive due to a higher price when not selling in bulk.

Product design
Having talked with Freek Groot from Youngmade, the team identified an opportunity for products to be created from wood and potentially also other materials. During an initial meeting, ideas were brainstormed. The recommendation and idea are to organise three couches to be delivered to Youngmade so that a test can be done with the materials. This test will most likely be carried out within two months after the end of this project. Freek has shown much enthusiasm to develop a product design from the materials available. Eventually, couches could be disassembled, and new products created with the help of teenagers at Youngmade.

Additionally, creative study programs such as industrial product design (Dutch: “industrieel product ontwerp”) at Windesheim or other programs from, for example, Cibap or Artez could be involved in creating design ideas for products. Freek used to study industrial product design at Windesheim and hence still has suitable contacts to reach out to for such a possibility. There are plenty of unexplored opportunities regarding scrap wood from couches. By involving product designers, artisans and material experts, the possibilities of innovative product design are limitless. This research can serve as a basis for further development *(see project continuation).*

3.1.3 Potential partners

The table lists companies that provided significant insights and outcomes for the research. A complete contact list can be found in Appendix 2.

Name of the firm	Contact person/position	Description	Insights	Future potential
BySoil	Thijmen Sterken &Teuntje van Leeuwen/ founders	Starting entrepreneurs that make wooden furniture out of tables and chairs	Wooden furniture is difficult to repurpose depending on already existing holes in the wood	They could be interested in the wood they can clean. Such as larger solid pieces.
GoedHoutbaar	Jan-Willem Harwig/ founder	Waardering Partner-entrepreneur that processes reclaimed wood from second-hand stores	Highlighted the need for a standardised product. The idea of collaborating with Tiem. Sees potential in developing two or three products made from the materials.	They are primarily interested in large wooden boards, not in the usually small wooden pieces of couches and chairs.
Atelier van Middendorp	Robert van Middendorp/ founder	Waardering partner and entrepreneur that is working on different sustainable wooden designs	Robert made us aware of the importance of time in the design process of a new product. He suggested that one semester for coming up with a design would be the least amount of time necessary.	Has an idea for a circular couch, could use materials such as wood, textile and leather

Binthout	Cor Wobma/ co-founder	Waardering Partner - local social enterprise and wood workshop in Zwolle working with people with a distance from the labour market and locally sourced wood.	Highlighted need for a homogeneous production process with standardised elements, the smaller the homogenous material, the more time it takes to create something	Only interested in large quantity and large size, homogeneous elements; wooden elements from couches to small and low quality
The Cool Dude	Shasha	Waardering Partner and woodworker in Zwolle who uses old skateboards and tables to create new products.	Helped with brainstorming for design possibilities and highlighted the importance of clean wood.	Interested in clean wood and can potentially create products.
Herso	Rik Ruigrok	Wood processing business that works with scrap wood. Produces furniture for large clients.	Advised about wood and other materials. Suggested that using the couch frame and working small scale are the best options.	Role of an advisor regarding wood and circular economy; Rik was willing to connect to other people in the network.
Phoenix Pallets B.V.	Joost De Boer	Joost reached out to us, offering his craftsman skills to help design something from wood.	Due to a lack of time and different focus of the project, we could not use his help, but we received some insights regarding scrap wood usage in Phoenix Pallets.	In the future, if any products from the materials are to be designed, Joost can be involved.
YoungMade	Freek Groot	Waardering Partner and entrepreneur who together with his colleague Jorn Dijkstra set up Youngmade to help youth (age 15-25) in their development. Young people get to work with their hands and supported in	A workplace with a lot of opportunities to process different materials, including woodworking machines from neighbouring workshops, envisioning	Would like to use three couches for a trial to disassemble and see what can be made from materials. Couches from the Kringloop could be disassembled at

		developing their talents.	potential design for a chair or smaller products.	YoungMade by youth.
Indusigns	Chiel Bodt	Local interior design company in Zwolle making interiors from upcycled materials.	Need for a standardized material, challenging to achieve with couches because most have different measurements	Mostly interested in metal and would only want large quantities of standardized material to create a standardized product line. No immediate collaboration opportunity.

Table 10. Potential partners for wood.

3.2 Foam

SWOT Analysis: Foam

In the current waste flow, foam is disposed of as general waste and incinerated. The research showed several opportunities for more high-quality reuse of foam, the details of which are discussed in this sub-chapter.

Strengths	**Weaknesses**
- The foam makes up the highest volume of all materials contained in couches. This allows for a solution of scale. - Foam from disassembled furniture has similar characteristics as raw foam. Thus it can replace certain new products.	- Quality is not consistent. Some foam is yellow and crumbly after long years of use. - Foam is not fireproof. This is a weakness if it is to be used as insulation material. - The foam takes up a very large space due to its large size to weight ratio, resulting in a storage problem.
Opportunities	**Challenges**
- Foam can be recycled by being cut into small pieces and rearranged for e.g., heat/ sound insulation, floor cushioning, or sports gear (see for example Aslon Refoam) - Foam (if dry and not crumbly) can be chemically recycled into Polyol. From Polyol new foam can be made. To guarantee sufficient quality, polyol from recycled foam must be mixed with “new” polyol.	- Rebond foam (foam made from scrap foam pieces in production processes) is a low-price market competitor for recycled foam. - To be recycled, the foam must have been dry at every stage of its lifecycle. Previously wet foam cannot be recycled, as such proper storage is important. - To know whether foam from furniture can be used for recycling, additional research is needed, this requires a budget.

Table 11. SWOT analysis for foam.

3.2.1 Repurposing opportunities

Both couches and armchairs contain foam. Especially in couches, the volume of foam is higher than that of any other material. Therefore, the sheer quantity presents an opportunity for a scalable solution. Looking at possibilities to recycle foam, one can differentiate between chemical recycling or structurally cutting it into snippets and producing rebond foam from it.


Figure 9 & 10: Example of foam from a disassembled couch

Chemical recycling

There are different kinds of chemical recycling (pyrolyse, chemolyse, and radiolyse). The product of this form of recycling is a form of oil. Companies like DOW in Terneuzen are currently researching manners to make new products from this oil (for more information, see: https://www.cbm.nl/dienstverlening/innovatie/matrasrecycling/). Currently, this kind of recycling is tested out on mattress foam by initiatives like the PRIMA-project (Pyrolyse Recycle Initiatief voor Matrassen). Yet, this is not a very well-established form of recycling, and further research has to be done until chemical recycling can become a large-scale solution for foam recycling.

Rebond foam

Rebond foam can be used for many kinds of products. Theoretically, foam from couches might be suitable to be recycled into rebond foam. As gathered in a conversation with Retourmatras, a Dutch company that specialises in mattress recycling, research would need to be done whether couch foam is just as suitable for this kind of recycling as mattress foam. One of the considerations in this is the density of the foam. Since foam, which is fabricated in couches and armchairs, is usually denser than foam from mattresses, this affects the structure of the rebond foam. To assess whether foam from furniture is suitable for this kind of recycling, detailed research would need to be carried out. Monique Fioole of Retourmatras has shown interest to cooperate on such a study.

One of the challenges of recycling foam into rebond foam is the existing market competition. In the production of products that contain foam, the cut-offs are pressed into rebond foam, this foam is inexpensive and therefore a strong competitor for recycled rebond foam.

Product designs
Another opportunity lies in designing new products from foam that is still intact. During conversations with external stakeholders, several product opportunities have been discussed. These include cow mattresses, judo sports mattresses, punching bags, or packaging material for logistics companies. Further, some larger pieces of foam which are still intact and in suitable shapes could directly be used as new cushions. These ideas present several small-scale business opportunities.

3.2.2 Recommendations

Out of these research results, the following recommendations can be made.

Study with Retourmatras
A conversation with Monique Fioole, Quality Manager at Retourmatras, showed potential to corporate on the recycling of foam from couches and armchairs. Yet, since Retourmatras is specialised in mattress foam, a study would need to be carried out to research the feasibility of recycling furniture foam. This kind of study could lead up to a collaboration between Retourmatras, Kringloop and Rova. One of the main requirements for carrying out a study is a financial budget. Such a budget could be received via the province or initiatives such as the Dutch Circulair Polymer Valley.
The second aspect relevant to future cooperation with Retourmatras is achieving enough foam mass that could be recycled at scale. The research results show that at most, if both Kringloop and Rova were to recycle 90 percent of sofas and armchairs, 1,95 tons of foam could be retrieved per month. For this to become attractive to Retourmatras, a viable cooperation should promise higher quantities of foam.

Cooperating with Ikea
To retrieve bigger masses of foam and support a potential business case with Retourmatras, a cooperation with Ikea has been thought of. Such a cooperation is attractive for three reasons. (1) Currently, the amount of foam retrieved from Kringloop and Rova is not sufficient for a cooperation with Retourmatras. By increasing the amount of foam available, the business case can be strengthened, and the cooperation becomes more attractive to Retourmatras. (2) Ikea could outsource the recycling process of sofas and armchairs and reduce its footprint. (3) Retourmatras and Ikea already cooperate for the recycling of mattresses. Hence this link would not need to be established anew but could be expanded to include foam of couches and armchairs after being disassembled.

Following a conversation with Roelanda Hulzebosch, Dutch Sustainability Business Partner at Ikea, the local branch of Ikea in Zwolle is interested in such a collaboration. Further, the feasibility of such has been consulted with Ikea Zwolle's legal department, which agreed to the possibility of such a cooperation.

During a conversation with Marjolein Mann and Wilma Voortman, this opportunity was welcomed. A suggested way of starting this collaboration between Kringloop and Ikea would be by collecting certain products which cannot be sold by Ikea's standards anymore and selling those at the Kringloop stores.
As soon as a disassembly point has been created at the Rova recycling centre, the cooperation could be expanded towards Kringloop taking over furniture from Ikea and

disassembling this at the recycling centre. The added materials from Ikea allow for scale recycling and hence a stronger business case for the disassembly and recycling of couches.

3.2.3 Potential Partners

The table lists companies that provided significant insights and outcomes for the research. A complete contact list can be found in Appendix 2.

Name of the firm	Contact person/position	Description	Insights	Future potential
Retourmatras	Monique Fioole, co-founder of the family business	A Dutch company that recycles mattresses	Foam from couches is structurally denser than mattress foam. To know whether the couch foam can be used for recycling, a study is needed.	Have offered the opportunity to cooperate with Rova and Kringloop to do a study about couch foam to find out if couch foam is suited for the recycling process
Partners for Innovation	Ingeborg Gort-Duurkoop/ Advisor: Sustainable Innovation, Circular economy	Expert on Polymers/Plastic	Foam can be chemically recycled into polyol and new foam can be produced from this. Rebond foam is a market competitor for recycled foam.	-
Knauf Insulation	-	An international company manufacturing insulation materials	Foam might be reusable as insulation material (yet it's not fireproof. It could be interesting to contact polyurethane insulation companies (e.g. NVPU). Knauf themselves do not work with Polyurethane insulation and can therefore not cooperate on this.	Exploring options of polyurethane insulation.

Spoinq	Bob Valckx	Produces high-end sustainable furniture.	Only exchanged with e-mails; further contact is necessary.	Expressed an interest in foam, but more insight is needed.

Table 12. Potential partners for foam.

3.3 Fabrics and leather

In the current waste flow, fabrics are classified as general waste and are not recycled, while leather is often reused for resale in the store and minor do-it-yourself (DIY) projects with existing partners. In the following chapter, the potential collaboration opportunities for fabric and leather will be discussed.

SWOT analysis: Fabrics and leather

Strengths	**Weaknesses**
• Has similar characteristics as the raw counterparties, • In most cases, the depreciation is low since couch fabrics tend to be highly durable; therefore, the quality of the fabric/leather is rather high,	• Rather small pieces of fabrics and leather are available after disassembling couches • fabrics are often worn a lot after long years of use • The textiles need to be cleaned before reusing for other goods, • Especially for fabrics, the patterns are rather old-fashioned,
Opportunities	**Challenges**
• Due to low depreciation, it can almost always replace the raw counterparty, • Both fabrics and leather can be reused on small-scale projects where small pieces are needed (e. g.), to make accessories like bags); • Both fabrics and leather can be used for new product development (there, the options are naturally limitless),	• Difficult to standardise due to pragmatic approach when disassembling: the pieces can have an unpredictable amount of seams, asymmetric edges etc., • The pieces of fabric are difficult to standardise due to the couches being from different producers with different designs, • The leather can be standardised in colour tones but cannot be 100% of the same kind.

Table 13. SWOT analysis for fabrics and leather.

3.3.1 Collaboration opportunities

Small scale solutions

There are two student start-ups from Windesheim Honours College which expressed their interest in fabrics and/ or leather.

The first is Ragnarøk Clothing, a start-up which just developed their first shirts with the goal to build a sustainable fashion brand. There is a small-scale interest in durable fabrics which could be used as packaging materials for deliveries.

The second start-up is called FloBro and started by producing hammocks from hot air balloons. Equally a small-scale interest, FlowBro is interested in receiving some of the leather in the form of small and light-coloured pieces.

3.3.2 Recommendation

Due to the low scalability potential, the best advice is to focus on small scale solutions. While it is possible to resell fabrics and leather directly (see *Other potential opportunities)*, it is possible to arrange partnerships with small businesses that use fabrics and leather for tailoring different items, e. g. bags, accessories, furniture parts etc.

3.3.3 Potential partners

The table lists companies that provided significant insights and outcomes for the research. A complete contact list can be found in Appendix 2.

Name of the firm	Contact person/position	Description	Insights	Future potential
Ragnarøk Clothing	Daniel Cohen Stuart	Windesheim Honours College student start-up producing sustainable t-shirts and building a sustainable fashion brand	-	Small-scale interest might want to use some of the furniture fabric as packaging material
FlowBro	Samuel Wagner	A small start-up that makes hammocks out of hot air balloons.	Even though they are in a relatively early phase, they could be a small buyer of leather.	Potential future buyer of leather.
Lupelo	Lucy Peters	Accessories brand: mostly from upcycled and sustainable materials.	Lucy was ready to prepare a bag prototype for this project to see what the possibilities regarding the leather and fabric are	Possibly interested in leather and fabrics in small quantities

Table 14. Potential partners for fabrics and leather.

3.4 Metal

In couch production, metal is used for details such as springs to ensure comfortable seating (see Figure 6. for visual examples). Metal makes up the least volume of materials in a couch, and in the current waste stream, metal is being recycled. Therefore, during this research, considering the limited time and resources, metal was not considered as a priority.

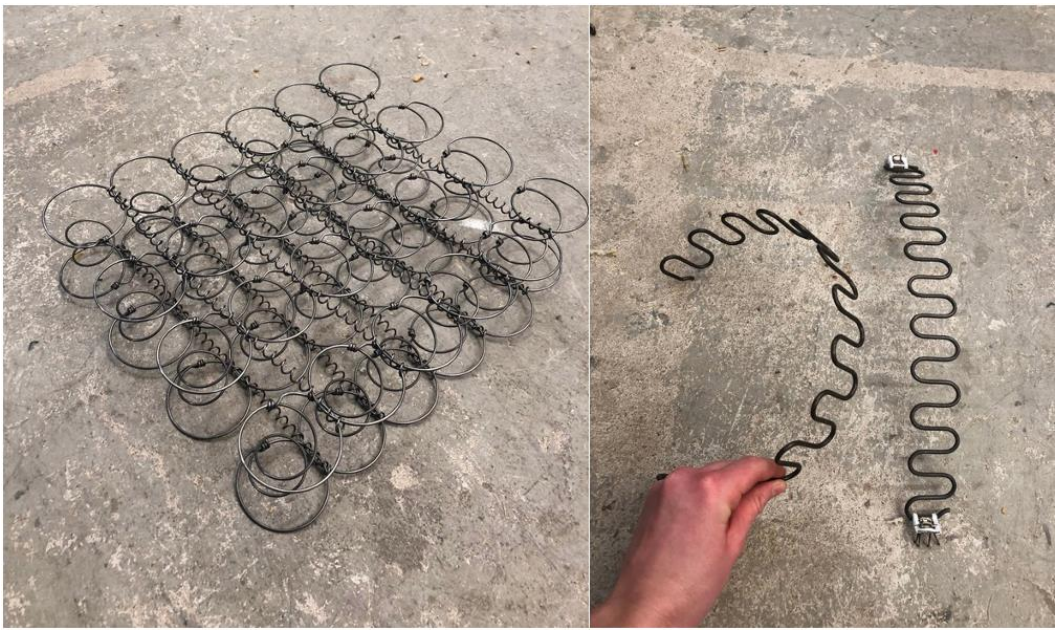


Figure 11. Springs from couch seating.

SWOT analysis: Metal

Strengths	**Weaknesses**
· Has the same characteristics as raw metal,	· Small quantities
Opportunities	**Challenges**
· Due to rather predictable shapes (springs), there is an opportunity to repurpose the metal for new product development,	· Financial viability of the alternative solution to recycling is questionable.

Table 15. SWOT analysis for metal.

3.4.1 Collaboration opportunities

Due to limited time and resources, no realistic alternatives to the existing solution were discovered. This research was concluded with one contact connected to repurposing the metal stream and the contact can be found in the table below.

Name of the firm	Contact person	Description	Insights	Future potential
Project-81	Ed van de Gaar	Produces sustainable furniture on a small scale.	Ed suggested designing a product around the available materials rather than trying to fit it into something that exists.	Possible contact for repurposing metal and designing a product, but a more defined focus is needed.

Table 16. Potential partner for metal.

3.4.2 Recommendation

While the current solution – recycling - for metal streams is reasonable, more research can be conducted to explore the potential of metal. However, in the context of couches and armchairs, the volume of metal that is available is considerably low and thus can be considered as low priority.

3.5 Other potential opportunities

During the research, several different people in the network have been contacted, and potential collaboration possibilities have been discussed. Some of these opportunities do not fall under an individual material and thus are listed under this subchapter.

Collaboration with Excess Materials Exchange (EME)

Excess Materials Exchange (further EME) aims to connect companies with leftover materials for further reuse. While currently, matchmaking happens manually, they are developing an automatic tool to connect companies all over the world. EME can do a paid research to discover what can be done with these materials and possibly further this information to interested parties. A major benefit of this is that it might be possible to sell an entire couch frame instead of focusing on individual materials. If such collaboration is to be established, it is possible to work with large scale quantities. During the research, contact with EME was established, but further contact from the clients is needed.

Dedicated channel for DIY enthusiasts

During the research, many small-scale artists, craftsmen, and designers were encountered. There is considerable interest (see the contact list) in small quantities of leather, fabrics, stuffing, and other materials that come from the couches. Considering that many of these materials are not scalable (e. g., fabrics) due to their appearance and size, it can be beneficial to open a dedicated channel for DIY enthusiasts. In that way, the interested customers can gain used materials for lower prices, thus decreasing waste. This channel could be either online or offline: a landing page on the Kringloop website, a dedicated website for scrap materials, a dedicated corner in one of the stores etc. If the interested parties know that such materials are available, the demand will increase steadily.

Kringloop becomes a boutique

In a second-hand store, sometimes people give away high-quality, expensive items that can lose their value when placed together with cheaper alternatives (due to the consensus of *used goods).* One solution is starting a dedicated boutique where more high-end items are gathered. By setting a theme - high-end goods for reasonable prices - many benefits can be gained. Firstly, it can potentially gather additional public to second-hand shopping (better brands mean higher prices, yet a good deal). Secondly, some items that are currently discarded (e. g. vintage couches) have a new potential to be sold rather than disassembled. This is general advice that was acquired during best practices research and did not apply to couches only.

Name of the firm	Contact person	Description	Insights	Future potential
IKEA Zwolle	Anique Prinzen-Balmaekers	Business Navigation Manager Ikea Zwolle	IKEA Zwolle is interested in doing a scaled test to make their business more sustainable.	Possibility to do a scaled test to find out strengths and weaknesses of disassembling couches on a larger scale by using couches supplied by IKEA.
Aventus & Windesheim Interior design program	Els Esselink	Teacher and entrepreneur	Els is enthusiastic about working together and sees the potential to use the couches for a semester of design and sustainability classes.	Possible collaboration and could supply design ideas.
Alba Concepts, Excess Materials Exchange (EME)	Marie-Sophie Res	EME aims to provide a matchmaking platform for businesses to share excess materials. Alba Concepts is a branch specialised in real estate. Currently, it happens manually, but they are introducing AI to make the processes automatic to connect anyone in the world.	EME can research for clients to see what the material possibilities are and create a match with another company to use those raw materials,	It is possible to create a business partnership with EME to sell the excess materials; clients should contact EME to see the possibilities regarding the available budget.

Table 17. Other potential partners.

4. Project continuation

The question remains of how this project will be continued. Considering the research findings for potential material partners, this chapter highlights the most promising pathways for continuation. Chapter 4.1 addresses which potential partners, based on the research, interviews, and conversations with the clients, are most relevant for continuation. Chapter 4.2 lays out the possibilities for a continuation of the project research, to build a specific business case, or to outsource the design process for products made from couch materials. Next to this an example of a best practices for a recycle/upcycle centre is included.

4.1 Most relevant potential partners

Based on the potential partners for each material, the following matrix (figure 12) was created.
The Interest-axis stands for the voiced interest by each party to participate in the continuation of this project - depending on the partner, this differs between the interest in buying materials, helping to create a design for the materials (e.g., Atelier van Middendorp), designing new products from materials (e.g., Youngmade), or conducting more research about the recycling of certain materials (e.g., Retourmatras). The specifics of the kind of collaboration are described in each material chapter under Potential partners (column: future potential). Reasons for lower interest in the project were that (1) some contacts liked the idea but have different priorities right now; (2) the materials that are offered are not high quality enough; (3) For some contacts, a product design is required upfront to produce products.
The Impact-axis, on the other hand, refers to the estimated impact of a collaboration based on the aim to recycle or reuse as many of the materials of couches, chairs, and armchairs. For instance, FlowBro and Ragnarøk Clothing are small student start-ups that would not be able to use a lot of materials. As opposed to that, a collaboration with Ikea of Retourmatras offers potential for large-scale cooperation.

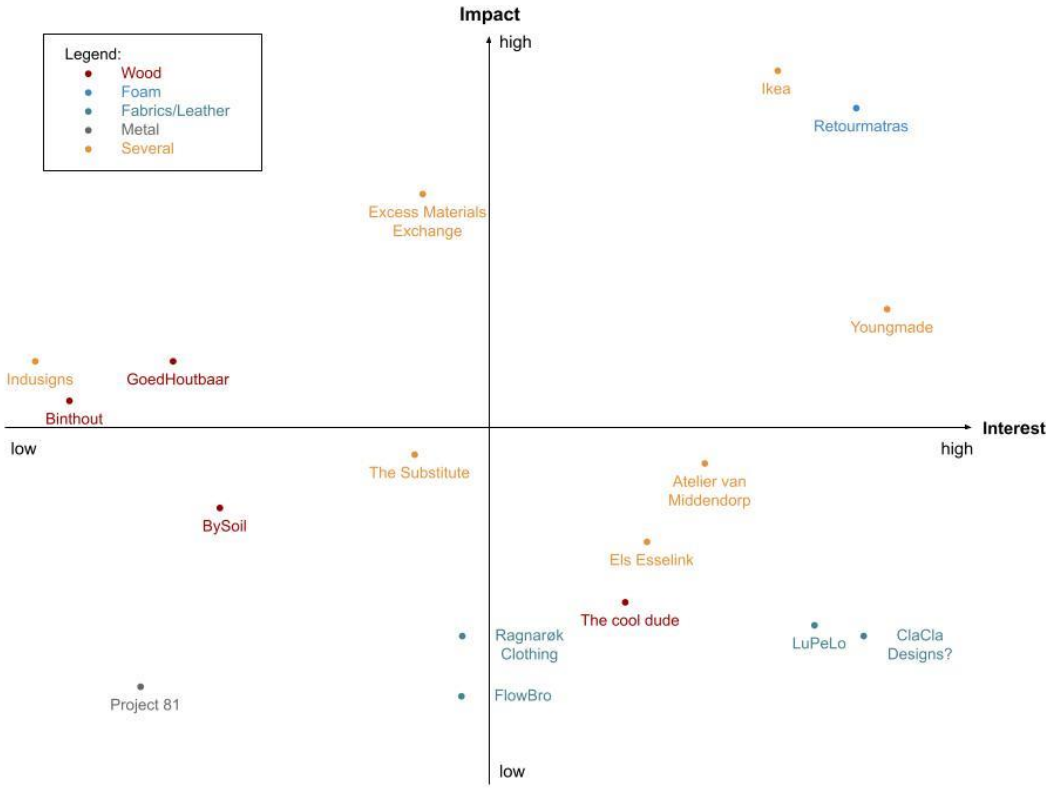


Figure 12: Interest-impact matrix for potential partners

Besides the contacts displayed in the matrix, table 18 lists other advising parties that contributed to the research yet do not serve as potential future partners.

Advising parties:
● Ingeborg Gort-Duurkoop
● Knauf Insulation
● Herso
● De Nederlandse Vereniging van Polyurethaan Hardschuim-fabrikanten (NVPU)
● Upcycle center almere
● Recycle Ann Arbor
● Hugo Kiens
● Phoenix Pallets

Table 18: Other advising parties

4.1.1 Recommendation for Rova and Kringloop

Considering that the priority for both Rova and Kringloop is to build a feasible business case, the large-scale potentials should be considered priority. This is because smaller collaborations would not be able to use large masses of materials and would, therefore, not be able to support a financially sound business case. Thus, both Rova and Kringloop should put focus on the high-interest/high-impact (top right) quadrant. Thus, as seen in the matrix,

Ikea, Retourmatras, and Youngmade are the three potential partners that should be given the most attention.

Collaboration with IKEA Zwolle

The Swedish furniture giant IKEA has a service called ‘’retour- en recycle’’, when customers buy a new couch, IKEA offers to pick up the old couch of the customer for a small fee. Next to this, IKEA has an in-store customer service that takes in couches. A number of these returned couches are offered in the sustainability corner (previously ‘koopjeshoek’) at a discounted price. However, the rest of them are too damaged or old to be used again and are discarded in a general waste container.

This situation offers the opportunity for IKEA Zwolle and Kringloop Zwolle to collaborate and create a win-win situation. IKEA Zwolle would put couches that otherwise would go to the general waste in storage. When IKEA has collected a certain number of couches, they contact Kringloop to pick them. Kringloop then transports the couches to the disassembly hall for recycling and upcycling. IKEA will pay a certain amount of money to the Kringloop for the couches based on weight or size. IKEA wants to be fully circular by the year 2030. Thus, the costs for recycling by Kringlopp are important yet not the highest deciding factor. Currently one of Ikea’s highest priorities is to make their business more sustainable.

To make this collaboration a reality, the following steps (table 19) would need to be taken:

Kringloop	Rova
1. Establish contact with Roelanda Hulzebosch (National sustainability business partner Ikea) & Anique Prinzen-Balmaekers* (Business Navigation Manager Ikea Zwolle) to discuss the first possibilities of bringing products which are currently disposed of in waste containers but still of sufficient quality from Ikea to the Kringloop stores. 2. Develop the collaboration so that, as soon as the Kringloop disassembly point at the Rova recycling centre is realized, Ikea couches can be brought to the recycling centre and disassembled at the location.	1. Establish contact with Roelanda Hulzebosch (National sustainability business partner Ikea) & Anique Prinzen-Balmaekers (Business Navigation Manager Ikea Zwolle) to discuss the details of bringing couches from Ikea to the Rova recycling centre as soon as a disassembly point has been created.
1. Continue to work towards the implementation of a Kringloop disassembly point at the Rova recycling centre. 2. Carry out a test phase with Ikea to either bring the couches to Kringloop or the recycling centre for disassembly. Based on this the three parties could agree on a business proposal.	

Table 19: Recommended next steps Ikea

* Anique’s contact details have already been forwarded to both Wilma Voortman and Marjolein Mann.

Collaboration with Retourmatras

Since the foam is the highest volume material within couches, researching applications for this material should be placed among the highest priorities. Out of all opportunities for foam, a research study with Retourmatras which aims to identify whether couch foam can be recycled with the same techniques as mattress foam appears as the most large-scale and promising pathway.
This is not only based on the research results but also on the conversations with Wilma Voortman and Marjolein Mann, who have expressed their interest to initiate such a study. Monique Fioole, quality manager of Retourmatras has shown willingness to cooperate with both Rova and Stichting Kringloop, assuming that an adequate budget is available. In conversation with the clients, likely financing possibilities have been thought of. Further, Monique Fioole has already gotten in contact with Marjolein Mann to discuss possibilities. With interest from both parties, the results of a study could not only be beneficial to develop processes for couch foam recycling but could, in the long run, lead to a collaboration with Retourmatras as a buyer of foam.

To make this collaboration a reality, the following steps (table 20) would need to be taken:

Kringloop	Rova
1. Together with using the existing contact with Monique Fioole to agree on a research study with the goal to find out whether couch foam can be recycled (chemically and/or mechanically). 2. Assuming that the results of the study show that couch foam recycling is possible, building a collaboration with Retourmatras to buy foam from disassembled couches. This is only possible at scale (in quantities larger than one ton per month) and considering that there is a disassembly point in place at Rova. A collaboration with Ikea could provide the required amount of foam for collaboration with Retourmatras.	

Table 20: Recommended next steps Retourmatras

Collaboration with YoungMade

Youngmade, being a social enterprise that is already part of the Waardering network, carries an intrinsic interest to contribute to the WaardeRing initiatives. The current plan is that in the upcoming weeks or months, a trial will be done at the Youngmade workshop with three couches from Stichting Kringloop Zwolle. With the couches being at the workshop, Freek Groot and Jorn Dijkstra will disassemble the couches, test possible applications, and conceptualize designs for products. The test phase would be successful if Youngmade can find applications for (some of) the materials and develop one or several product ideas from those.
In that case, the strengths of a collaboration with Youngmade would be (1) that it is located close to one of the Stichting Kringloop Zwolle stores, (2) that Youngmade works with youth (age 15-25) who are capable of the physical activity of taking apart couches and might favour such physical work and learn about the process of recycling and upcycling. (3) Youngmade is financially not solely dependent on the sale of the products made from the materials since it is financed by a third party, for the social work that Youngmade does with

youth. Hence, the profits and financial strength of the business case would be of less importance than the social and educational aspects of the project.

Equally for this scenario, the team has been in conversation with both Freek Groot (Youngmade) and the clients, and both sides look forward to running a test phase. The constraint, which avoided the test phase to be earlier, is that Youngmade recently expanded its workshop and was busy with the renovation process. Currently, the agreement is that Freek Groot will get in contact with Jan Pruis to arrange for the test couches to be brought to the workshop of Youngmade.

To make this collaboration a reality, the following steps (table 21) would need to be taken:

Kringloop	Rova
1. Enable three couches from one of the Kringloop Zwolle Stores to be delivered to the Youngmade workshop. 2. If the test phase is successful (Freek Groot from Youngmade can offer some product opportunities), setting up a regular process for couches to be transported from Kringloop to the Youngmade workshop. Couches can be disassembled by youth and products made at the workshop. R 3. Remaining disassembled materials that cannot be used in the product would need to be discarded by either Kringloop or through another party.	-

Table 21: Recommended next steps Youngmade

Looking at the recommended next steps, the one most important step for potential collaborations with Ikea and Retourmatras is for continued efforts to implement a Kringloop disassembly point at the Rova recycling centre. Only with a collection point in place will it be possible to process and mass-disassemble couches. For example, scenarios of this, please refer to chapter 2.4 (Conclusion Numerical part).

4.2 Outsourcing further research and design process

Depending on the chosen pathway, several opportunities for research continuation might become relevant. In the suggestions below, each continuation suggestion is accompanied by ‘steps to be taken’ by the three clients if a specific continuation of the project is wished for. Any contact information for suggested continuations can be found in the contact list in Appendix 2.

Windesheim Honours College Follow-Up Project

If there is an interest to build a specific business case based on this project's research, another student team from the same study program (Global Project and Change Management) could be employed. In preparation for this, a proposal document outlining this possibility has been compiled and sent to the university. Yet, the decision for this continuation scenario is still up to the clients and will be determined after the closure of the current project.

Steps to be taken:

- Discuss with all clients if a follow-up project is wanted
- Communicate with Windesheim Honours College lecturers for a project to be continued in next semester

Design outsourcing

Another pathway lies in unexplored design opportunities. As mentioned in the material chapters, there are various opportunities for products to be designed from the available materials. Yet, assuming from a conversation with designer Robert van Middendorp, it can be expected that a design process would take at least one semester with no certain outcome guaranteed. Alternatively, the team had the idea of organising a hackathon event or competition for different people to contribute their design ideas.

Hackathon and Competition

One of the pathways which were also considered as a final product for this project is to organize a hackathon. The current COVID-19 regulations and the uncertainty caused by the pandemic is one of the reasons why this idea was not pursued as a final product. The second reason was that Marjolein Mann favoured the idea of a continuation through a student project over that of a hackathon due to having had bad experiences with the outcome of hackathons. Still, if COVID-19 regulations lessen, and events can be organised again, this could be one way to involve a lot of people with the idea in a short time. Alternatively, one could also organise a competition to be stretched out over a longer time. The strength of this, again, would be that many people could be involved and that the project would gain attention within Zwolle. It would, however, be a challenge to involve professionals, therefore a competition would probably be done with lay people or students participating.

Steps to be taken:

- Find someone within WaardeRing or a student team who could organise a competition or hackathon.

Art and Design Study Programs in Zwolle

One of the study programs which could be asked for cooperation on design ideas is Industrial product design (industrieel product ontwerp) at Windesheim. Freek Groot from Youngmade used to study this program and offered that he could, with the help of the clients, reach out to the specific contact persons. The team was not able to establish contact with the responsible coordinator. The possibility could be discussed to start a one-semester student project on designing a product from the materials available.
Two other schools that come to attention are Cibap and Artez, which are both located in Zwolle. The team equally reached out to contacts from both schools. For Artez, we were in contact with designer and lecturer Robert van Middendorp. From his judgement, a collaboration with Artez would take in-advance planning and a clear project proposal, seeing it more likely a possibility with Cibap than with Artez. For Cibap, the team was not able to establish contact with the responsible coordinator. Yet, altogether, continuing the design process through a student team appeared to be a welcomed idea by the clients and a possibility to be explored.

Steps to be taken:

- For Industrial Product Design: Reach out to Jeroen Thoolen and, if needed ask Freek Groot for previous contacts of his
- For Artez: Reach out to Robert van Middendorp
- For Cibap: Reach out to Ellen Bosman

4.3 Best practices - Upcycle Centre Almere

The Upcycle Centre Almere is a centre that is housed in a unique building that has been made with modularity and circularity in mind. The upcycle centre houses three entrepreneurs who each have their own workshop on the premise, next to this the upcycle centre deals with the household waste of around 100.000 inhabitants every year. An experience centre has been built on the premise entirely of reclaimed materials. The experience centre is used as an educational and meeting space. The building was designed by Modulo, a company that focuses on modular building design, as such this is an interesting company to contact when planning to build a disassembly hall.

The three entrepreneurs at the upcycle centre are switched out every year and a half for new entrepreneurs. These entrepreneurs take their materials directly from the waste that comes in at the centre. These entrepreneurs are given financial aid and exposure to secure the future of their business. In the centre the textile and leather are cut from couches to be used, the rest is discarded as it is too labour intensive to fully disassemble.

The upcycle centre is for a large part funded by the municipality of Almere and a part comes from the Fonds of Verstedelijking Almere. The centre was in the perfect situation to receive funding as Almere is a relatively young city. This enabled them to make circularity a focus of the city of Almere and created the opportunity to receive funding.

Challenges of Upcycle Centre Almere

- Red tape is hindering the prospect of collaborations with Kringloop stores in Almere. Waste that comes from the Kringloop stores are considered business waste and as such cannot be brought to the upcycle centre in Almere.
- It is important to have enough space available in the case of growth and expansion. The centre is now facing the challenge of finding affordable spaces to use for expansion.

5. Conclusion and acknowledgements

Five months of research have led to a multitude of possibilities to reuse materials and reduce waste from discarded couches, chairs, and armchairs. Although, as the outcomes of this research have shown, most couches are still produced to be wasted, and materials are often low quality, hence challenging to apply in new products, there are opportunities that allow imagining a feasible circular business case. With the findings from this research, the team hopes to have laid the groundwork for further explorations and efforts to be taken to transform the waste management of couches, chairs and armchairs and support the transition towards a circular economy in this niche.

Lastly, the team would like to thank all parties and individuals who contributed to this research.

References

Christiyanto, A., Purba, R. H., & Munandar, W. A. (2019). Exploratory study on the utilization of recycled wood as raw material for cross laminated timber. *IOP Conference Series: Materials Science and Engineering.*IOP Publishing. doi:10.1088/1757-899X/669/1/012011

Lalonde, C. (n.d.). Cross-Laminated-Timber Cottage [Image]. Photolux Studio. Retrieved from https://www.archdaily.com/893442/cross-laminated-timber-clt-what-it-is-and-how-to-use-it

Waardering. (n.d). Waarom. Retrieved June 2, 2021, from https://waardering.nl/waarom/

Appendices

Appendix 1: Simulator explanation

Included with the professional product is it possible to find an excel file called "Simulator". This file contains all the data collected, the calculus and techniques applied to obtain the numerical results. On top of this, it presents a simulator that allows forecasting the impact of price and percentage of items recycled on unit cost, total average cost, CO2 emissions, the number of materials collected and work hours necessary per month.
What follows is an explanation of the content of the four sheets that compose the file:

1. Main results and simulator
2. Collected data
3. ROVA
4. Kringloop

1. Main results and simulator

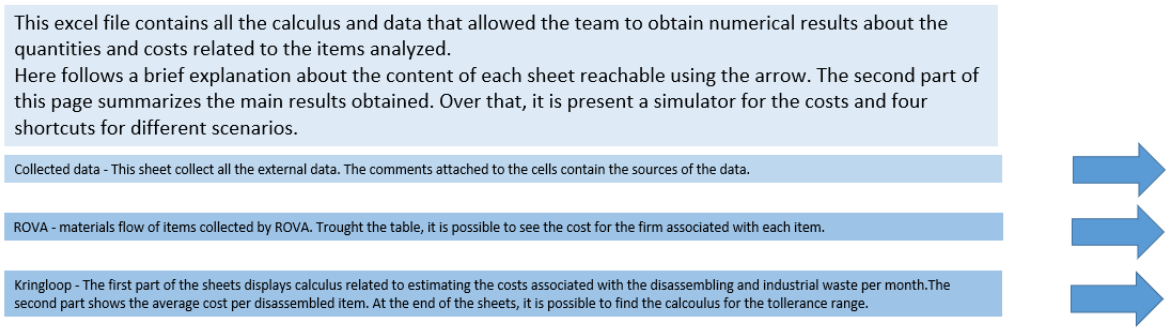


Figure 17. Introduction of the simulator

The sheet starts by introducing the file's content, including shortcuts represented by arrows, as shown in figure 17.

Below that it summarises the main results in six tables, these results represent the current situation based on the data collected during the research (figure 18).

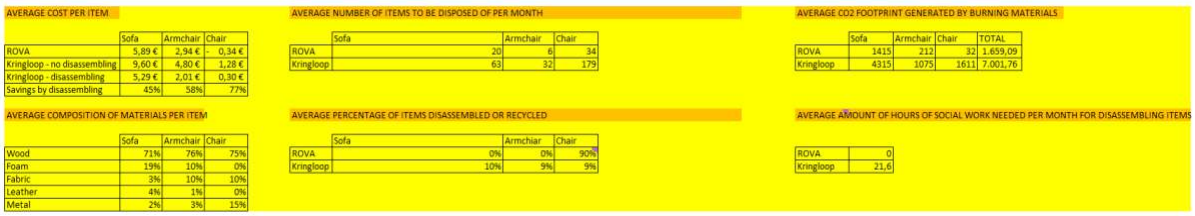


Figure 18. Table showing the current situation

The sheet ends with the simulator (figure 19).
By modifying the white cells related to the costs of materials and the percentage of items disassembled per month, it is possible to forecast the unit cost, total average cost, CO2 emissions, the number of materials collected and work hours necessary per month, for both

companies. The column "variation respect to the actual situation" shows the percentual variation based on the unit costs compared to the current unit cost.

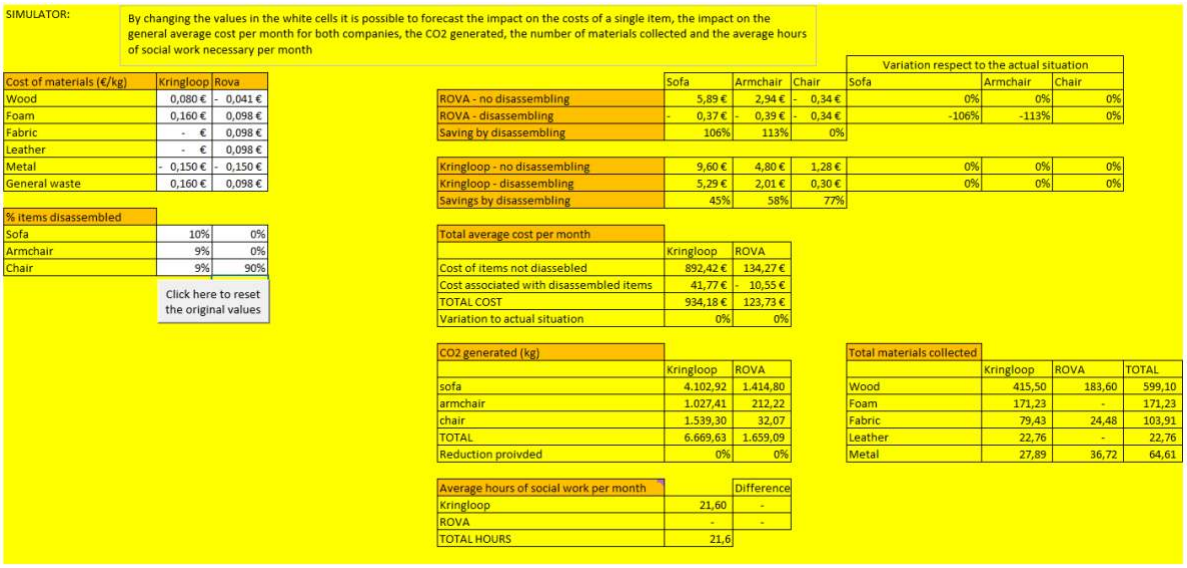


Figure 19. Screenshot of the simulator

Next to the simulator, there are four shortcuts for the scenarios, as discussed in the numerical conclusion of the report (figure 20).

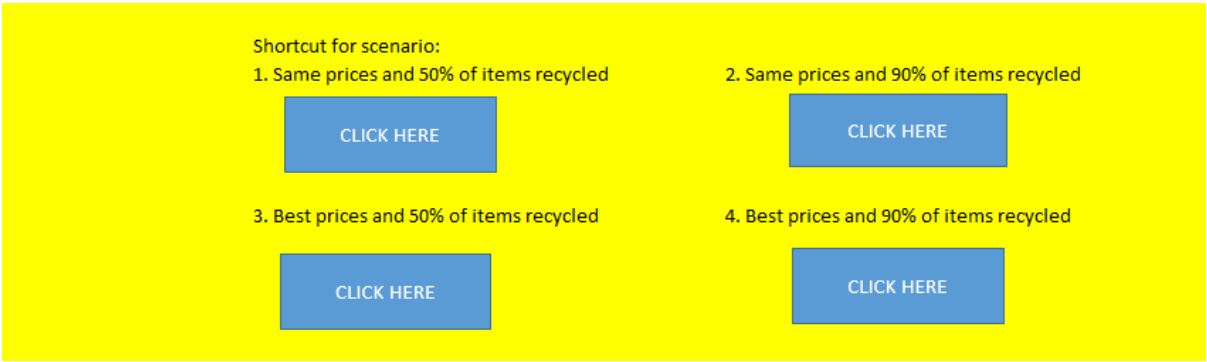


Figure 20. screenshot of the shortcuts for scenarios.

2.Collected data

This sheet contains all the data collected during the research. Comments, as seen in figure 21, explain the source of the data. It is written just in the first cell when it is the same for all the columns, as shown in figure 21.

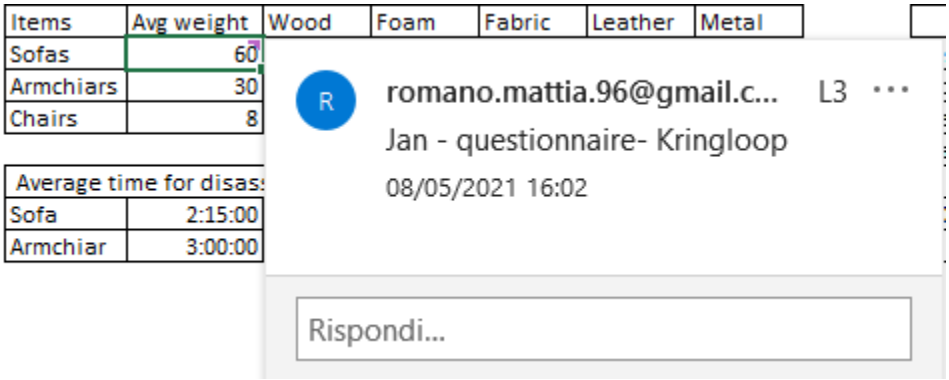
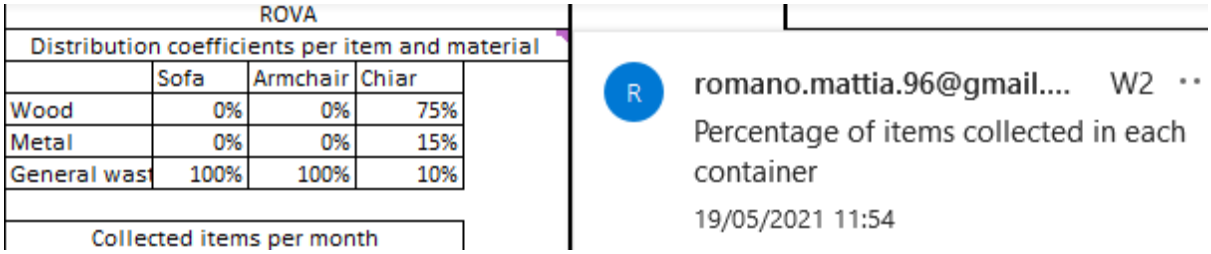


Figure 21. Example of comment with source.

For some data, the comment contains a short explanation, as shown in figure 22.



ROVA

Distribution coefficients per item and material

	Sofa	Armchair	Chiar
Wood	0%	0%	75%
Metal	0%	0%	15%
General wast	100%	100%	10%

Collected items per month

R romano.mattia.96@gmail.... W2 ··

Percentage of items collected in each container

19/05/2021 11:54

Figure 22. Example of explanatory comment.

3. ROVA

This sheet contains a single table that displays the calculation done to obtain the numerical results for Rova (figure 23). This way, the team collected the unit costs and the total average cost per month.

	sofa	armchair	chair	
Number	20	6	34	
Avg weight (kg)	60	30	8	
Total weight (kg)	1200	180	272	
Collected as wood (kg)	0	0	204	
Collected as metal (kg)	0	0	40,8	
Collected as general waste (kg)	1200	180	27,2	
Cost/kg wood	-0,04055	-0,04055	-0,04055	
Cost/kg metal	-0,15	-0,15	-0,15	
Cost/kg general waste	0,09815	0,09815	0,09815	avg total cost per month
Total cost per item	117,78 €	17,67 €	- 11,72 €	123,72 €
Cost per single item	5,89 €	2,94 €	- 0,34 €	

The number in euro represents costs so, the negative numbers are earns.

Figure 23. Table showing the calculation made for Rova.

4.Kringloop

In the first part, this sheet shows a table used to obtain the total average cost per month associated with not disassembled items. In comparison, the table which is pointed at with the arrow displays the average cost per month associated with the disassembled items (figure 24).

	Declared data			Corrected data			Dismantled			Sent to Remondis			Total weight per item (kg)			
	Sofa	Armchair	Chair	Sofa	Armchair	Chair	Sofa	Armchair	Chair	Sofa	Armchair	Chair	Sofa	Armchair	Chair	Total cost per location per month
Dalfsen	31	14	77	25	11	61	0	1,5	8,5	12	5	26	744	139,5	210,8	175,09 €
Staphorst	19	9	53	15	7	42	6	1,2	6,8	5	3	18	276	93,6	141,44	81,77 €
Hasselt	2	2	9	2	1	7				1	1	3	48	18	27,2	14,91 €
Ommen2	5	9	48	4	7	39				2	3	19	120	102,6	155,04	60,42 €
Zwolle1	42	19	105	34	15	84				17	7	42	1008	223,2	337,28	250,96 €
Zwolle2	58	27	155	46	22	124				23	11	62	1392	327,6	495,04	354,34 €
TOTAL	157	79	446	126	63	357	6	2,7	15,3	60	30	171	3588	905	1367	937,49 €

Click on the arrow to come back to the main page

Material collected monthly (kg)				Total	Cost/kg	Total cost per material
Wood	267,00	56,70	91,80	415,50	0,08	33,24 €
Foam	72,00	7,43	0,00	79,43	0,16	12,71 €
Fabric	12,00	0,68	12,24	24,92	0	- €
Leather	15,00	7,76	0,00	22,76	0	- €
Metal	7,50	2,03	18,36	27,89	-0,15	- 4,18 €
					MONTLY AVG TID	41,77 €

Figure 24. Table showing the calculation made for the total average cost of Kringloop.

The second part of the sheet contains three tables used to obtain the unit cost per disassembled item (figure 25).

Sofa			
Material	Quantity	€/kg	€
Wood	44,5	0,08	3,56 €
Foam	12	0,16	1,92 €
Fabric	2	0,00	- €
Leather	2,5	0,00	- €
Metal	1,25	-0,15	- 0,19 €
Average cost per sofa			5,29 €
Average cost without dissassembling			9,60 €
%saved			45%

Armchair			
Material	Quantity	€/kg	€
Wood	21	0,08	1,68 €
Foam	2,75	0,16	0,44 €
Fabric	0,25	0,00	- €
Leather	2,875	0,00	- €
Metal	0,75	-0,15	- 0,11 €
Average cost per armchiar			2,01 €
			4,80 €
			58%

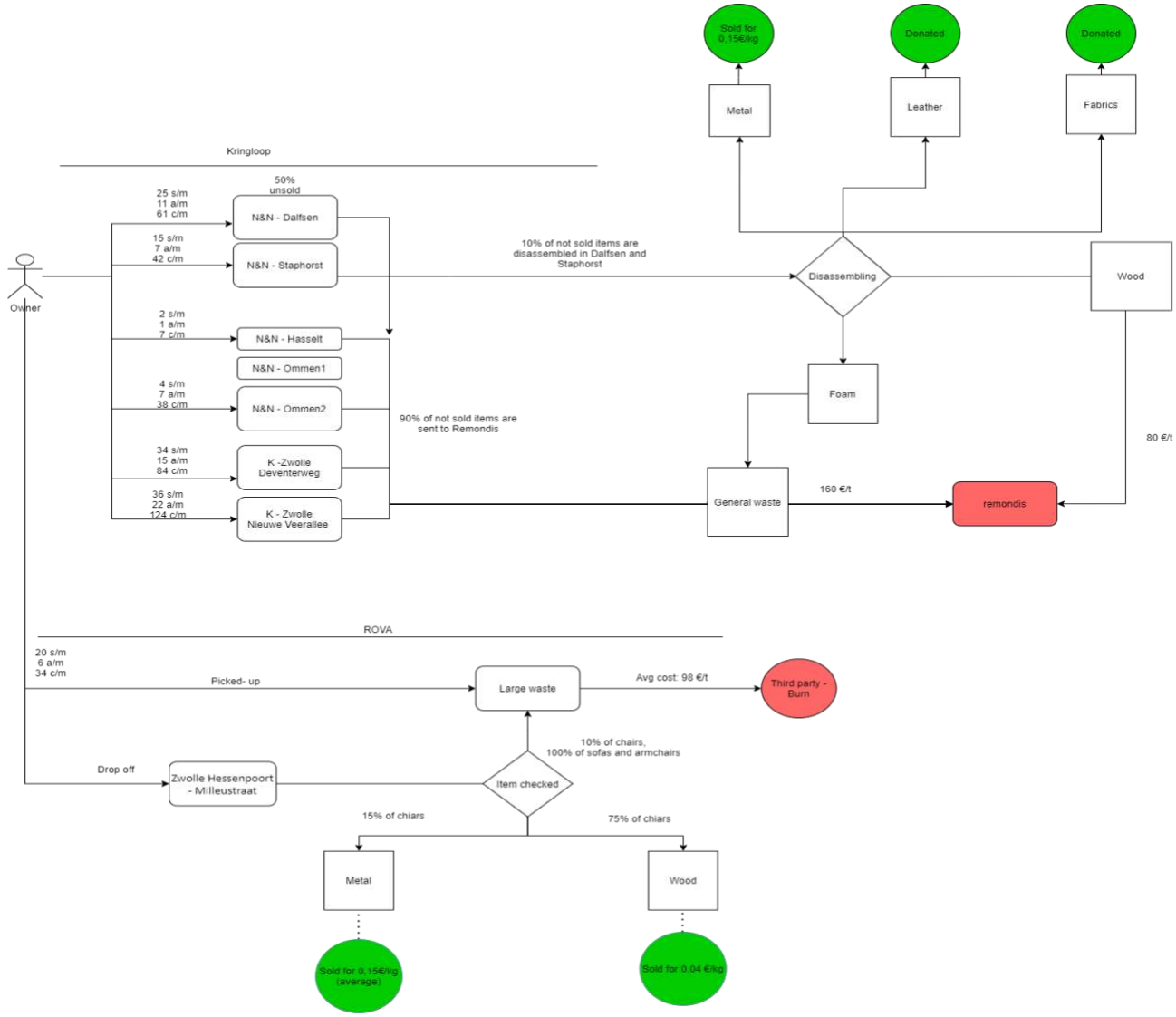
Chair			
Material	Quantity	€/kg	€
Wood	6	0,08	0,48 €
Foam	0	0,16	- €
Fabric	0,8	0,00	- €
Leather	0	0,00	- €
Metal	1,2	-0,15	- 0,18 €
Average cost per chair			0,30 €
			1,28 €
			77%

Figure 25. Table showing the calculation for the unit cost of items.

The last part contains the calculus done to estimate the tolerance range in the unit costs (figure 26). It compares the unit cost of the smallest and largest sample recorded with the average.

	min	avg	max
sofa	4,41 €	5,69 €	6,98 €
armchair	0,88 €	2,47 €	4,82 €
	Difference respect to average		
sofa	23%	0%	-23%
armchair	64%	0%	-95%

Figure 26. Screenshot of the tolerance range in the unit costs.



The complete flowchart can be accessed at
https://drive.google.com/file/d/1TB6mJz99TFxdgt4lHB8VXvSSC_Oezqmf/view?usp=sharing

Appendix 2: Contact List

The full excel sheet can be accessed here

Waardering - Contact List

For contacts without contact information (e-mail adresses) classified as 'client contacts', contact information can be received via Maarten van Dongen.

Interviewed individuals/organizations

Name	Material	Description	Type	Contact Person	Email	Website
Binthout	Wood	Local woodworking company with value for sustainability/lo	Waardering partner	Cor Wobma	info@binthout.nl	https://binthout.nl/
BySoil	Wood	Startup of MBO-students from Cibap, making furniture fron	Waardering partner	Thijmen &Teuntje	mail@by-Soil.com	https://www.by-soil.com/
De Nederlandse Vereniging	Foam	Dutch association of rigid-foam polyurethane manufacturer	Other	André Meester	andre.meester@nvpu.nl	https://www.nvpu.nl/
Frankenhuis	Textiles	Textile recycling company	Client Contact	Werner Pasop	-	https://www.frankenhuisbv.nl/
Atelier Middendorp/Artez co	Several/General	Designer working with used materials and teacher at Artez	Waardering partner	Robert van Middendorp	info@ateliervanmiddendorp.con	https://www.ateliervanmiddendorp.com/
GoedHoutbaar	Wood	Designer making furniture from recliamed wood	Waardering partner	Jan-Willem Harwig	hello@artilleryfurniture.nl 06 51	https://www.goedhoutbaar.nl
Ikea	Several/General	World's largest, multinational furniture retailer	Other	Roelanda Hulzebosch & Anique	Contact info shared with clients	
Indusigns	Several/General	Upcycling interior design office in Zwolle	Other	Chiel Bodt	info@indusigns.nl	https://www.indusigns.nl/inspiratie/
Ingeborg Gort-Duurkoop	Foam	Expert in foam and circular possibilities	Client Contact	Ingeborg Gort-Duurkoop	i.gort@partnersforinnovation.co	https://partnersforinnovation.com/en/team/ingeborg-gort-duurkoop/
Ragnarøk Clothing	Textiles	Student start-up building a sustainable fashion brand	Student contact	Daniel Cohen-Stuart	Contact via Website	https://ragnarok-clothing.com/
Retourmatras	Foam	Company that specialises in recycling matresses	Other	Monique Fioole (Qualitymanage	info@retourmatras.nl	https://www.retourmatras.nl/
Herso	Wood	Produces cross-laminated timber from scrap wood	Other	Rik Ruigrok	rik@herso.nl	https://herso.nl/
The Substitute	Several/General	Community for sustainable interior design brands	Other	Marieke Kamphuis	marieke@thesubstitute.nl	https://thesubstitute.nl/
LuPeLo	Leather	Bags designer	Other	Lucy Peters	lupelo.tassen@gmail.com	https://www.lupelo.nl/
Excess Materials Exchange	Several/General	EME works with matchmaking for companies to share exce	Other	Marie-Sophie Res	marie-sophie@albaconcepts.nl	https://excessmaterialsexchange.com/nl/
Phoenix Pallets	Wood	Produces pallets, were contacted for best practices	Other	Joost de Boer	joostdeboer50@hotmail.com	-
The Cool Dude	Wood	Makes wood furniture and kitchen related products from we	Waardering partner	Shasa Boogaard	s.b.boogaard@gmail.com	https://thecooldudesupply.com/
Youngmade	Several/General	Organisation helping youth to integrate and develop thorug	Waardering partner	Freek Groot	freek_groot-1995@live.nl	https://youngmade.nl/contact/
FlowBro	Leather	Student start-up creating making hammocks from left-over	Student contact	Samuel Wagner	flowbro.hammocks@gmail.com	https://m.facebook.com/FlowBro.hammocks/
Els Esselink	Several/General	Entrepreneur and teacher at Aventus & Windesheim Interic	Other	Els Esselink	Contact through linkedIn	https://www.linkedin.com/in/els-esselink-7344a8129/
Hugo Kiens	Wood	Intern at Rova, researching appliances for A and B quality	Client Contact	Hugo Kiens	hkiens@rova.nl	-
ClaCa design	Leather	Small company that makes bags and other accesoires of le	Other	Claudia Casagrande	info@claca.design	www.claca.nl
Upcycle center almere	Several/General	Centre in Almere that houses 4 upcycle initiatives/entreper	Circular best practice	Hede Razoky	upcyclecentrum@almere.nl	https://www.almere.nl/wonen/afval/upcyclecentrum

Contacted Organisations - Email responses/no interview

Knauf Insulation	Foam	Insulation company	Other	-	knaufInsulationNLCustomerSer	https://www.knaufinsulation.nl/producten-van-knauf-insulation
Recycle Ann Arbor	Several/General	Second-hand chain in Michigan, US, works with furniture	Circular best practice	-	info@recycleannarbor.org	https://www.recycleannarbor.org/
Kierrätyskeskus	Several/General	Second hand chain in Finland, works with furniture	Circular best practice	-	koulutus@kierratyskeskus.fi (en	https://www.kierratyskeskus.fi/
The Crazy Smile	Several/General	Creative designer working with reused materials	Other	Jim van der Wardt	info@thecrazysmile.com	https://thecrazysmile.com/
EigenDraads	Textiles	Works with circular clothing design	Other	Hilde van Duijn	hilde@eigendraads.com	https://eigendraads.com/
Handwerk Cafe Zwolle	Several/General	Once a week meet-up for lay people to craft together	Other	Carola Bruinink	handwerkcafezwolle@hotmail.n	https://handwerkcafezwolle.blogspot.com/
Productatelier Mija	Textiles	Designer	Other	Mia Stik	info@mija.nl	https://www.mija.nl/
The Bin	Wood	Circular product design start-up	Other	Martijn ten Kate	Martijn@thebin.nl	https://www.thebin.nl/
Ferna Jalink	Several/General	Lecturer at WHC with many business contacts	Student contact	Ferna Jalink	fg.jalink@windesheim.nl	-
Spoinq	Metal	Designer, works with circular furniture focused on metal	Other	Bob Valckx	info@spoinq.nl	https://spoinq.nl
ReTuna	Several/General	Sustainable shopping mall in Sweden	Other	-	konferens@retuna.se	https://www.retuna.se/english/
Precious Plastic	Foam	Local firm about reduction of plastic waste	Local organization	-	hello@preciousplastic.com	https://preciousplastic.com/

Contacted organizations - no response

Cibap	Several/General	Mbo level school in Zwolle with design focus	Waardering partner	Ellen Bosman	e.bosman@cibap.nl	https://www.cibap.nl/
Gispen	Several/General	Circular Furniture Design (Utrecht region)	Circular best practice	-	-	https://www.gispen.com/nl/
Raw Materials	Wood	Produces interior goods and furniture from upcycled wood	Circular best practice	-	via website	https://rawmaterials.eu
GreenPac ILab	Foam	Center focussing on polymer appliances in Zwolle	Client Contact	Mireille Kinket and G. Boschmai	m.Kinket@polymersciencepark.	https://www.greenpac.eu/nl/ilab/
Thorbecke School	Several/General	School offering practical education	Waardering partner	Wilco Wezenberg	-	https://www.thorbecke-zwolle.nl/
Buurman	Several/General	National organization with crafting workshops for individual	Other	-	info@buurman.in	https://www.buurman.in/

Additional organizations to be contacted in case of follow-up project

Prima Project	Foam	Recycle foam into oil	Other	-	-	https://www.cbm.nl/dienstverlening/innovatie/matrasrecycling/
Sidijk	Foam	Rebond foam upcycling	Other	-	-	https://www.sidijk.com/
JPI Polymer	Textiles	Reuse pvc from artivifical leather for new things	Other	-	-	https://www.jpi-polymers.nl/
Van Werven	Foam	Company which recycles hard plastics from recycling cente	Other	-	-	https://www.recyclingplastics.nl/
Europur	Foam	European organisation for polyurethane soft-foam	Other	Patrick de Kort	info@europur.org, p.dekort@eu	https://www.europur.org/
Covestro	Foam	Rawmaterial manufactuerer of polyurethane that delivers t	Other	Pascale Sagaert	pascale.sagaert@covestro.com	https://www.covestro.com/

PUReSmart	Foam	Project seeking to transition from the current linear lifecycl	Other	-	haelterman.bart@recticel.com	https://www.puresmart.eu/			
Tiem	Several/General	Social workshop (previously called Wezo) located close to	Other	-	-	https://www.tiem.nl/			
Atelier Hip (Kas van Kaart)	Several/General	Creative crafting workshop working with reused material ar	Other	-	-	https://www.facebook.com/Hipindekasvankaat/			
Research Cowmatresses/ju	Foam	Companies that produce cowmatresses and sports judo m	Other	-	-				
Planq	Textiles	Furniture design companies that works with recycled mate	Other	-	-				
Sofa for Life	Several/General	Modular, sustainable Sofa UK	Other	-	-	https://www.sofaforlife.co.uk/			
Circular Economy Sofa	Several/General	Modular sofa design NZ	Other	-	-	https://bestawards.co.nz/product/student-product/steven-almond/circular-economy-sofa-system/			
Lensveld	Several/General	Circular furniture producer amsterdam	Other	-	-	https://www.lensvelt.nl/about-lensvelt/our-mission			
ModuPlus	Several/General	Circular couch NL	Other	-	-	https://moduplus.nl/circulaire-bank/			
Green Furniture Cirlce	Several/General	Make circular furniture and want to help and promote a circ	Other	-	-	https://www.greenfurniturecircle.nl/#animatie			
Triboo	Several/General	Development of circular furniture (Rotterdam)	Other	-	-	https://www.triboo.nl/circulaire-meubels-en-inrichting-van-afval			
Royal Ahrend	Several/General	Office furniture producer in Amsterdam, into circular econo	Other	Dionne Ewen, Manager Circular	communications@ahrend.com	https://www.ahrend.com; https://cradletocradlecafe.com/ahrend/			

Appendix 3. Final product visual deliverable

01

ELKE MAAND WORDT ER VOOR ELKE 10 BANKEN* DIE WORDEN WEGGEDAAN MAAR 1 GERECYCLED.

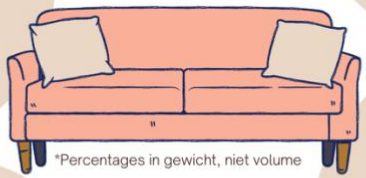
*in Kringloop Zwolle, Kringloop Noggus & Noggus and Rova milieustraat in Zwolle

WAT ZIT ER IN EEN BANK*?

19% foam

Grote hoeveelheden foam van inconsistente kwaliteit en niet vuurbestendig.

Het is mogelijk om te hergebruiken voor isolatie, sportartikelen en vloerkussens. Ook kan het chemisch worden gerecycled.



*Percentages in gewicht, niet volume

3-4% stoffen en leer

Lappen stof van verschillende omvang in verschillende kleuren en patronen. Lastig om op te schalen en moet voor hergebruik schoon gemaakt worden.

Kan worden gebruikt voor kleinschalige projecten zoals tassen en accessoires.

72% hout

Laag kwaliteit hout, bedekt in foam, nietjes, stoffen en lijm.

Nieuwe banken kunnen gemaakt worden met de oude frames. Standaardiseren bij afmeting en kwaliteit maakt dit mogelijk.

2% metalen

Kleine hoeveelheden die al worden gerecycled.

Is potentie voor een nieuw product ontwikkeling.

02

WAT ALS 9 UIT DE 10 BANKEN WORDEN GEDEMONTEERD EN GERECYCLED*?

250 uur werk kost het om de extra banken te demonteren

105% een vermindering van 105% in afval gerelateerde kosten

72% een vermindering van 72% in CO_2 uitstoot

5 ton hout gewonnen uit de banken

2 ton foam gewonnen uit de banken

1 ton stoffen en leer gewonnen uit de banken

,3 ton metalen gewonnen uit de banken

*voor details, zie report.

03

04

POTENTIEEL PARTNERS

De ontwerp opties van materialen uit banken zijn bijna grenzeloos en moeten nog worden ontdekt door ontwerp professionals. Dit onderzoek focuste op de numeriek kant van het project en het ontdekken van mogelijke samenwerkingen.

IKEA

Samenwerking tussen IKEA en Stichting Kringloop,

Een test uitvoeren om te ontdekken of IKEA genoeg banken kan verzamelen om te laten demonteren of verkopen in Kringloopwinkels in Zwolle,

De test kan aantonen of een samenwerking op grote schaal in de toekomst mogelijk is.

RETOURMATRAS

De mogelijkheid om een onderzoekssamenwerking te doen tussen Retourmatras, Rova en Stichting Kringloop,

In overleg kan er een onderzoek worden gedaan om de recycle mogelijkheden van foam te onderzoeken,

Dit onderzoek kan leiden tot een mogelijke samenwerking op grotere schaal.

KLEINE ZELFSTANDIGE BEDRIJVEN

Een aantal kleine bedrijven hebben interesse getoond in het kopen van overtollige materialen van banken, bijvoorbeeld leer.

Om deze kansen te benutten moet er een toegewijd communicatiekanaal worden opgezet, bijvoorbeeld een aparte webpagina of de website van Kringloop.