Binz.

Master thesis 2024 I Aalborg University

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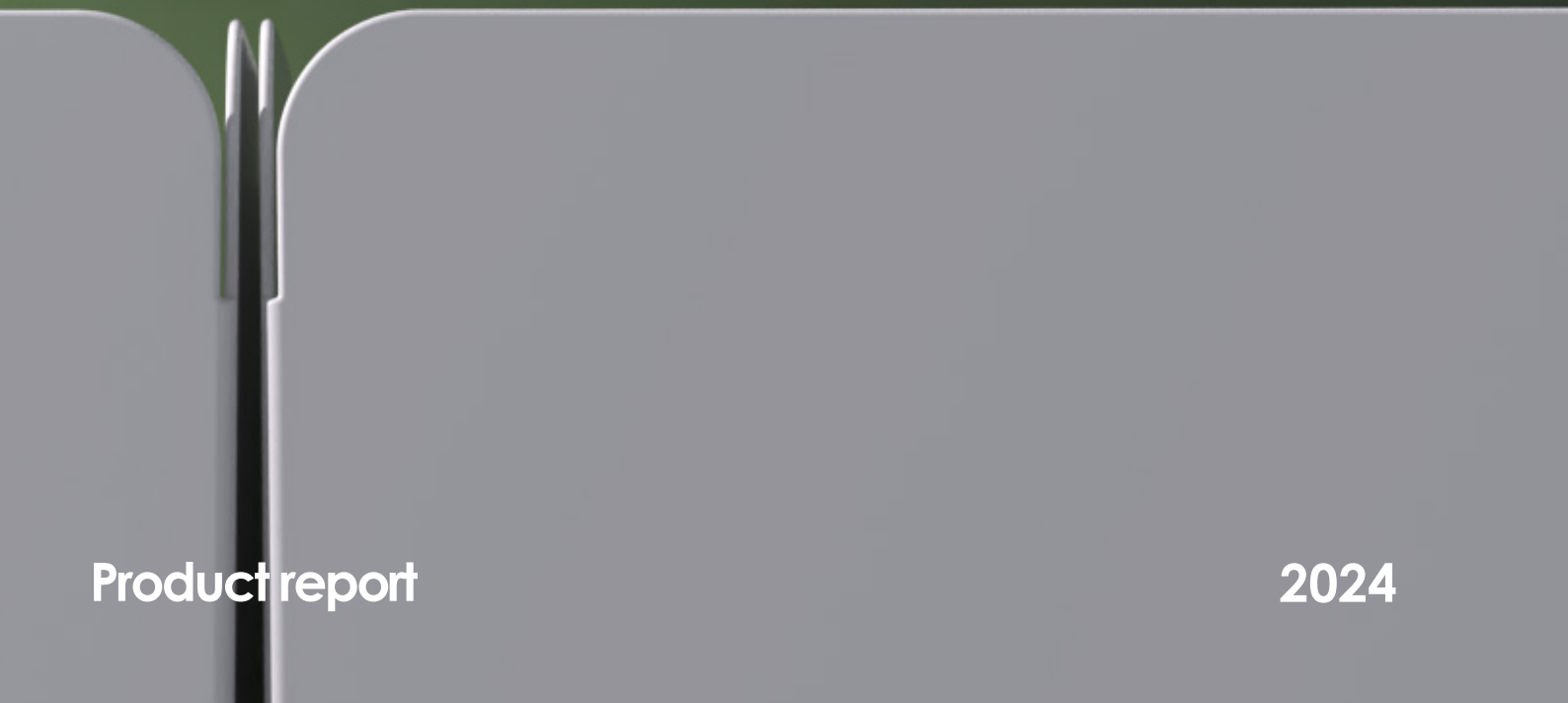
Ma4-ID10



Product report

2024

Title page

Binz

Aalborg University
Master Thesis
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Industrial Design

Product report
1.02.2024 - 30.05.2024

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Pages: 34

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Tobias Andersen

Abstract

The following paper presents Binz, a space optimizing waste sorting solution tailored specifically for smaller apartments. Binz replaces the residual waste bag on the cupboard door under the sink by an open, non-invasive and user-friendly sorting solution adapting to people's existing habits. Binz proposes two fraction sizes that can be combined as needed in up to six fractions, to fit the users' specific kitchens. Targeting primarily housing associations, Binz will start profiting within the first year, allowing reinvestments in variants and add-ons to also fit the consumer market and eventually expanding to other contexts.

“Design is a journey of discovery...

Illu.1

...and you have to get your hands dirty to find the treasure.” - Unknown

Project motivation

Our motivation for designing a waste handling solution as our master thesis emerges among other things from a personal struggle dealing with waste management in our own smaller apartments. We observed that while rules for waste management increase, there is a lack of guidance on how to sort effectively, which leads to confusion, incorrect sorting and thereby overfilled communal bins for residual waste. Existing products on the market did not meet our expectations; they were either too large, unpractical or overly expensive. This gap prompted us to create a solution that is accessible, user-friendly, and space-optimizing tailored for smaller households.

We believe that our waste materials are valuable, misplaced resources. Our goal is to transform the way people perceive and manage their household waste, encouraging them to see the same value in it as we do and start changing their sorting behaviors for the better. By doing so, we aim to contribute to a more sustainable future and take responsibility towards our planet.

Our project aligns with several United Nations Sustainable Development Goals (SDGs). More specifically, it accounts for Goal 11: Sustainable Cities and Communities, by promoting responsible consumption and waste management in the municipalities' and housing associations' local sorting facilities. It also contributes to Goal 12: Responsible Consumption and Production, by creating a long-term waste handling product that has a wide range of utilization and for having a local production using recycled plastic materials from the medicine industry. Furthermore, our solution supports Goal 13: Climate Action, as we strive to lower the production of raw materials through supporting recycling.

Our thesis is a commitment to environmental actions and an attempt to push the boundaries of the society norms, moving towards a greener, more sustainable world. We aspire individuals to make a difference right from their homes, sorting one piece of waste at a time.

Table of content

Project introduction

In the last decades sustainability has been more and more in focus in the general awareness. Cities are filled with new sorting systems and regulations are tighten up, requiring people to sort in more and more fractions - for some Danish regions in 10.

Although the majority of people have taken great initiatives towards better sorting behaviours, 62% of the total household waste still ends up in the residual waste and send to landfills. Research and own surveys although show that some target groups still stand out and impact the statistics. People living in smaller apartments are still struggling with finding the right solutions to integrate in their already very small kitchens, and the economical responsibility often relies on them. With the use of the properties' common outdoor sorting facilities, 'not sorting' is still a possibility with no individual consequences, and too many therefore still chose that option. (Flybjerg et al.,2023)

When asked, people find sorting systems expensive, inconvenient and relate many practical issues like smell, space or lack of information. In addition to the latter boundaries for good sorting behaviours, it is observed how habits and societal norms affect people despite motivation and inner consciousness. Certain standards for how to dispose of garbage have been engraved in the common behaviours and one type still overrules all. The residual waste bag under the sink is seen in far most apartment kitchens and has become a standard element of the kitchens' inventory. Sorting solutions on the market often are built around it, but don't take into consideration how people utilize the rest of the space under the sink, highlighting the importance of compact, space-optimising solutions for smaller households.

In parallel, extensive rules and regulations also affect housing associations, that are struggling with their residents' wrongful handling of household waste. As most of the waste get thrown in the residual waste container, it often overfills and requires extra collection from the communal services. (Himmerland Boligforening, 2024). Equally, when people have a tendency to store huge amounts of sorted waste over longer periods, it can also lead to overfilled containers of e.g. plastic or cardboard, and have economic consequences for the property owners.

Consequently, this project has focused on designing a space-optimising and compact solution, that replaces the residual waste bag with a non-invasive alternative under the sink. It is tailored specifically for smaller kitchens and leaves room for the cleaning agents and other household products that people typically also use the cupboard space for. While removing the habitual solution, Binz feeds into the existing habits by offering an open, easily accessible solution and with removable fractions that can be adapted to the individual needs and regulations of the region, challenging only the number of bags to bring along when emptying the trash anyway.

Illu.6

Binz is a space-optimizing sorting solution under the sink, tailored for smaller households. It is composed by independant and rotatable bucket modules on a common rail system, that can be put as needed.

Illu.7

Illu.8

Big bucket 6L

The large bucket can contain up to 6L household waste and is big enough for the bigger types of the most frequent waste, according to volumes tests with different types of waste. Even though it is perfectly up to the user, the 6L bucket is predefined for fitting **plastic, metal, glass and food and drinks cartons.**

Small bucket 4,5L

The small bucket can hold up to 4,5L of household waste. The size is calibrated to the types of waste that have the smallest volumes, or to store waste that can be folded or compressed. The small size makes it fit to contain waste such as **bio waste, cardboard, paper, and residual waste.**

Illu.9

Adaptable to needs and fractions

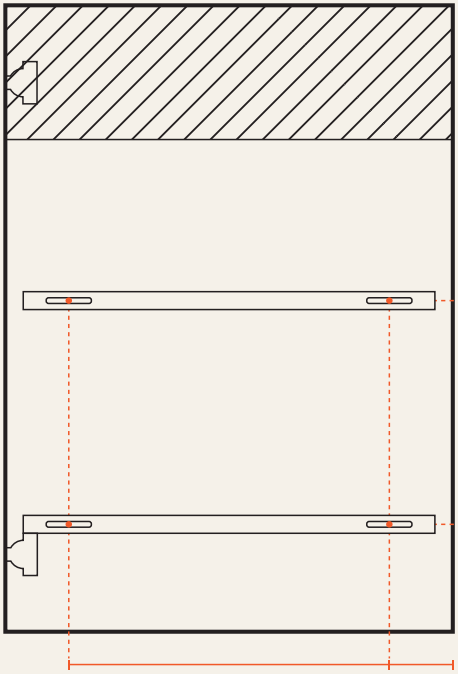
Binz comes in two different sizes that allows the user to customize the fractions accordingly to their needs and the rules of their specific municipality. Combined, Binz offers up to 6 fractions to sort in.

Illu.10

Installing the system

Binz can be installed on all the most common kitchen cabinet doors. The rails come in the three most typical sizes and should be mounted on the door using basic tools such as a drill and a screwdriver. Pre-measure the hight of the sink and follow the measurements below for the rest.

1 Mounting the rail



Illu.15

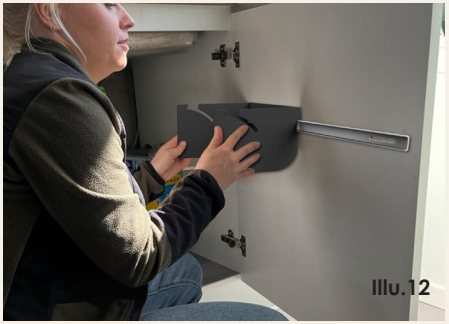
Rail 36:
26cm +/- 2,5 cm
Rail 46:
36 cm +/- 2,5 cm
Rail 56:
46 cm +/- 2,5 cm

Distance:
7cm +/- 2,5 cm

2 Placing the bucklets on the dovetail rail


Illu.11

3 Sliding in place


Illu.12

4 Placing the bucket on the rod


Illu.13

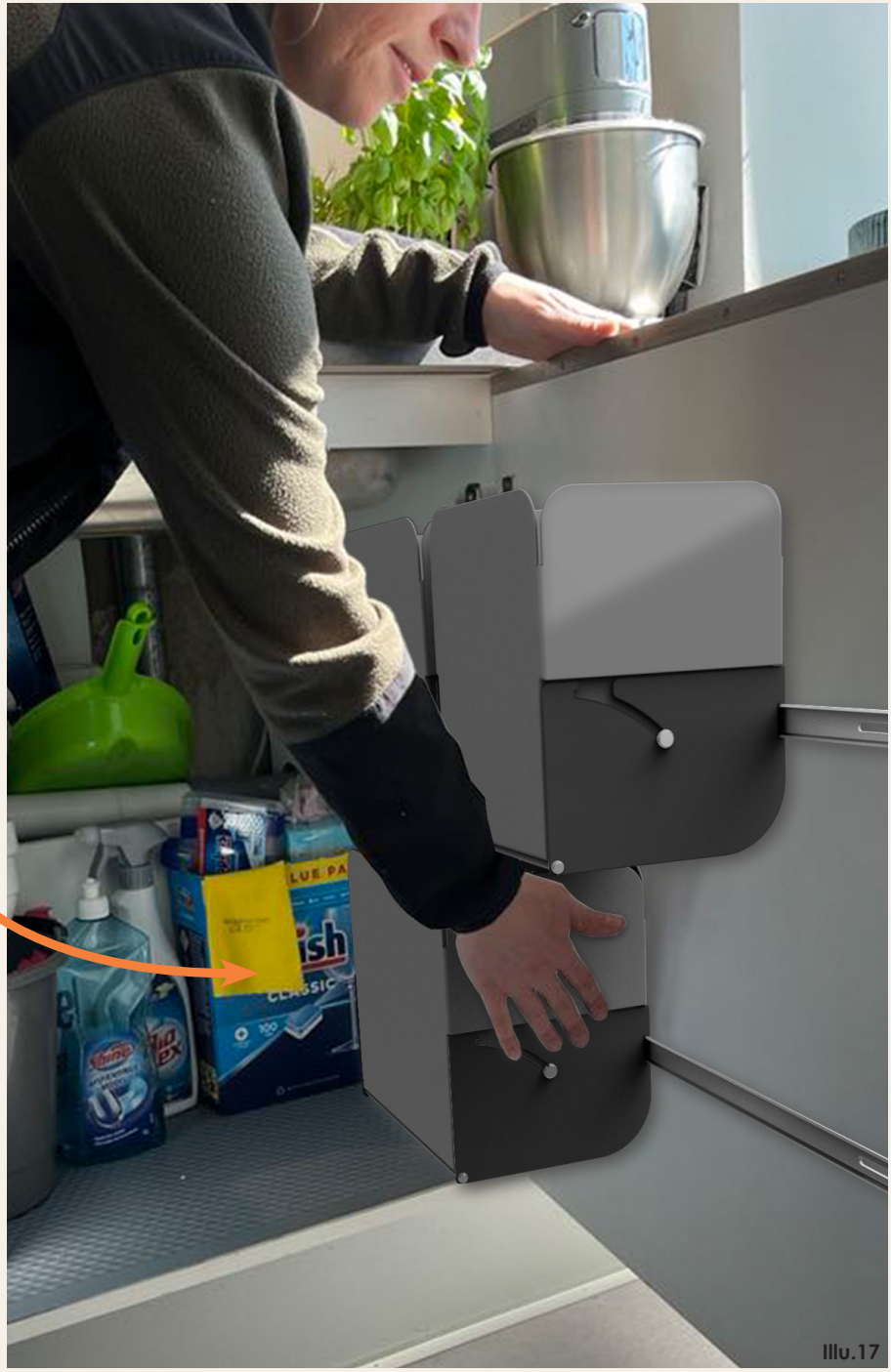
5 Tilting it in position


Illu.14

Illu.16

Slide to fit cleaning products and pipes

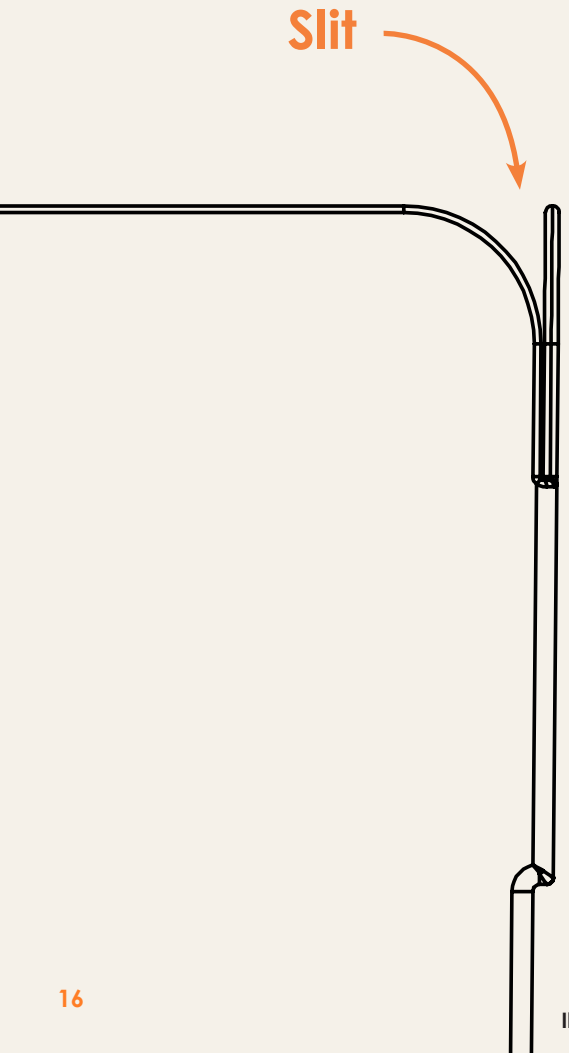
As the buckets are only 15cm deep, they leave room for cleaning agents or other household products to be stored as usual. Should the buckets bump into pipes, they can be positioned by the user as needed on the rail or by removing one of the buckets for other use.



Illu.17

Pre-use

An integrated slit in all four corners of the buckets allows to hold and tighten plastics bags without any additional product parts that might put extra weight on the system. The rounded corners prevent ripping the bags when inserting them or pushing down waste. With minimal interaction the bag can be placed in the bucket by pulling it out and folding the bag over the left and right edges.



Illu.20

Illu.18

Pull out the bucket

Illu.19

Inserting the bag

Illu.21

Feeding into the habits

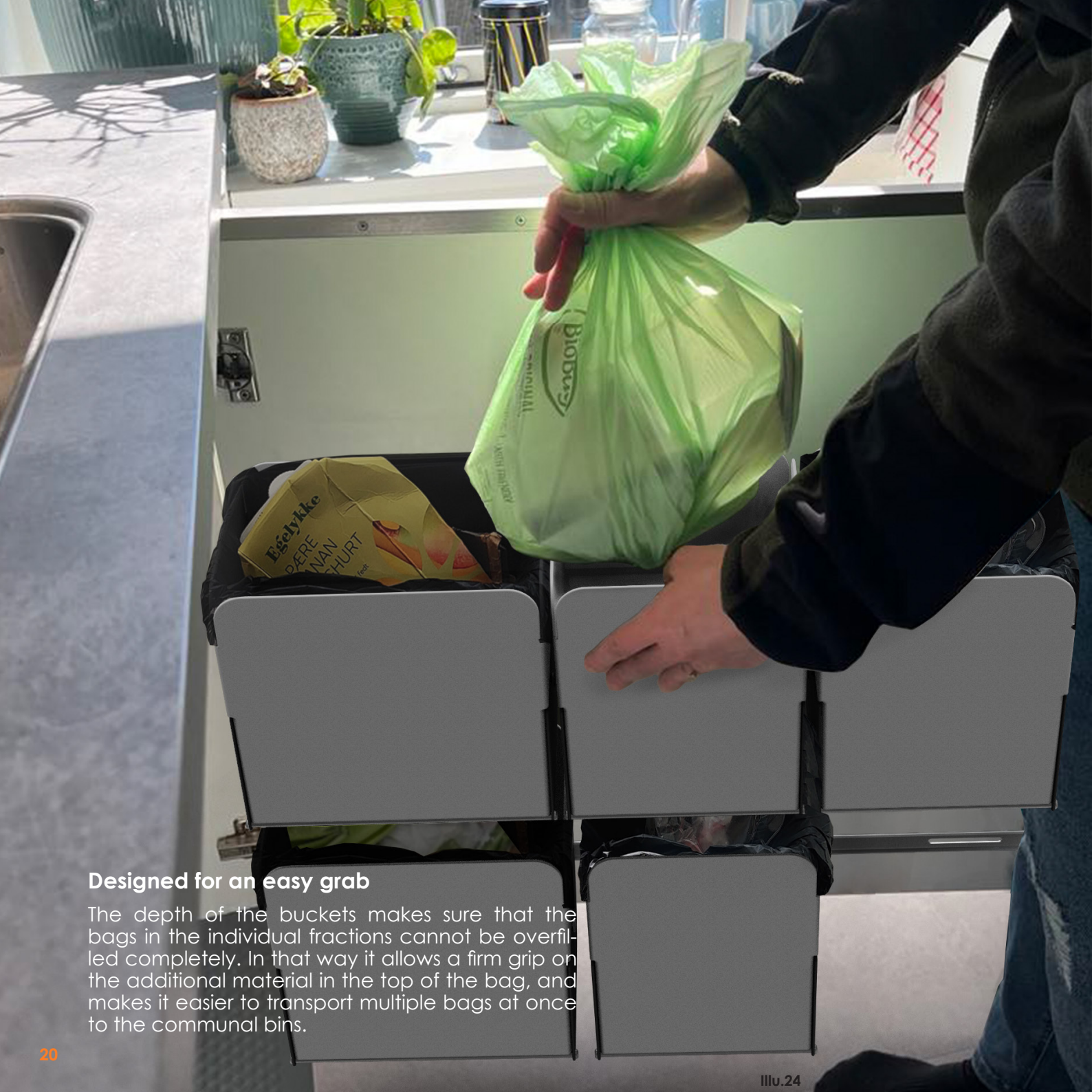
By placing the solution on the cupboard door, it only replaces the habitual residual waste bag that people are used to, but offers open fractions, just as easy to use. For the top row, the three most commonly needed fractions are used with the exact same number of interactions than the usual bag (e.g. residual waste, biowaste and plastic), and the lower row (e.g. glas, carton or metal) is accessible by one additional rotating movement, allowing to keep the volumes optimized. As Binz' placement and easy single-movement use feed directly into existing habits, it only requires knowledge of how to divide the waste in the specific region.

Illu.22

Better integration in everyday chores

As biowaste becomes separated from residual waste in most municipals, its function and use should be considered. Binz' removable bucket allows the user to bring the biowaste fraction onto the workstation while e.g. cooking, which eases the chore and prevents multiple interactions of opening and closing the cupboard door.

Illu.23



Designed for an easy grab

The depth of the buckets makes sure that the bags in the individual fractions cannot be overfilled completely. In that way it allows a firm grip on the additional material in the top of the bag, and makes it easier to transport multiple bags at once to the communal bins.

Illu.24

Emptying process

Smaller volumes, higher frequencies

Even though the existing amount of waste technically is only distributed in rightful fractions, the emptying flow will most likely increase and become more ‘on the go’. Which makes it even more important to transport several bags at a time to the communal bins.

Illu.25

Illu.26

Easy cleaning

The plastic buckets are waterproof and the PP material makes them perfectly resistant to all household chemicals potentially used to cleaning. The inside of the bucket contains no crevasses and the small radius all around the edges prevent dirt and water to get stuck and stagnate.

Housing associations

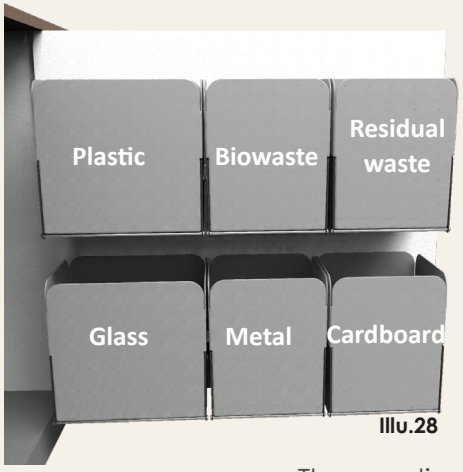
To have the biggest environmental impact and to implement the sorting systems in many Danish homes, seeking to twist their habits towards waste handling, the primary buyer of the products are housing associations. Some recommended combinations can be seen next and should be chosen according to the apartment and kitchen sizes.

Illu.27

Recommendations

The following shows recommended combinations for three types of kitchen sizes. Essentially it is up to the customer to choose what sizes are relevant (due to e.g. local rules), but the illustrations show their applications for typical tenants and their needs.

6L bucket and holder 70.- DKK
4,5L bucket and holder 60.- DKK



Illu.28

The small family (60cm cabinet)

A 60cm cabinet door could typically be found in a home of a small family. The needs for biowaste, residual waste and plastic, from e.g. diapers and toys packaging, would be high. The door space can therefore be optimised with two big and four small buckets, providing fractions for the most frequent and essential types of waste.

price for system: 500.- DKK
incl. rails

The couple (50cm cabinet)

The medium sized cabinet door would typically be found in smaller apartments of e.g. either single or couples. The need for residual waste might be bigger, and on the lower row, the 'dry' types of waste could be combined (such as cardboard and glass).

price for system: 360.- DKK
incl. rails

Illu.29

Illu.30

The student (40cm cabinet)

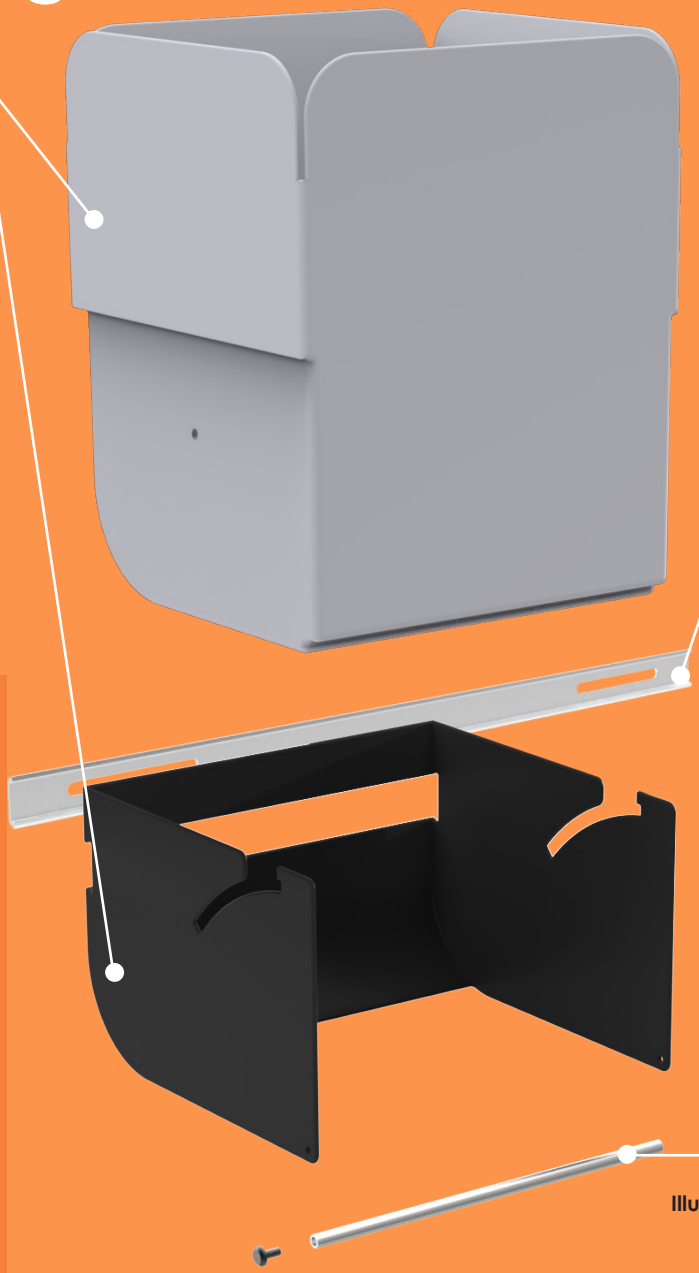
An apartment with a cabinet door under the sink that only measures 40 cm in width might most likely be found in very small kitchens, adapted to singles or e.g. students. A system of either three (two small, one big) or four (four small) buckets as shown on the illustration might fit the essentials needs of the single user. Even though it doesn't cover all fractions, it can still contain plastic, which is one of the most problematic.

price for system: 270.- DKK
incl. rails

Manufacturing

Injection moulding

The bucket and the holder are going to be manufactured through injection moulded as it leverages the advantages of the cost, properties and the processing of the PP plastic (Melito, 2023). By chosing injection moulding for the manufacturing, a set of requirements follows for the product to live up to.



Illu.31

PP plastic and origin

The PP material is sourced from Genplast that collects plastic waste from the medicine industry. When reprocessed, the material loses only 0,5% of its durability, making it largely adapted to Binz.

Adapting to injection moulding

- 100% recycled plastic can't be white
- Draft angle at minimum 0.5 degree
- Fillet radius of 25% of the wall thickness

Extrusion

The rails are made through aluminium extruding and can come in the desired lengths. The holes are CNC cut in an elongated shape to allow some horizontal margin of error during installation.

Standard components

Chicago screws

For the tilting function, chicago screws are assembled through the two holes on each side of the inner buckets. They can be tightened with a regular screwdriver.

Illu.32

Fasteners

The two fasteners to hold the rod in place will be a flatheaded screw compatible with an Umbraco tool.

Illu.33

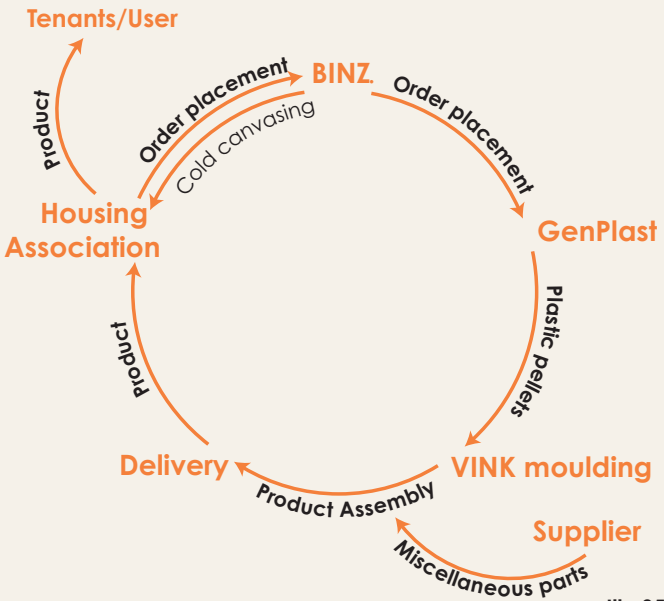
Metal rod

Metal rod with internal threads in both ends.

Illu.34

Supply chain

The main strategy to approach housing associations, will rely mainly on cold canvassing. After order placements, the needed amounts of material will be calculated and an order for GenPlast is placed. From here the PP pellets gets transported to VINK moulding who will manufacture the buckets and holders. The products will afterwards be assembled, where the additional sourced parts are added to the final product before packaging and lastly shipped to the customer where the housing association's handyman can install the product in their apartments.



Illu.35

Business strategy

Target customer and user

Binz is tailored for apartment residents with minimal kitchen storage. The target customers are primarily housing associations to aim for bigger orders and quicker product implementation.

Market

Until the breakeven point the marketing strategies will be kept on cold-canvassing and a made-to-order strategy to keep the investments and affordable losses at a minimum. After the breakeven point, the profit will be reinvested in more marketing such as social media and entering retails shops such as furniture or kitchen stores. Eventually, further reinvestment in product scaling can be made to allocate some of the initial costs in production and marketing and cover more of the market for sorting

Value proposition

The product proposal offers a long-term, intuitive and open sorting system under the sink without adding extra interactions to the user's current behaviour. With two different fraction sizes, the system is customizable after the individuals' needs and local sorting requirements. The inner buckets can easily be removed to e.g use while cooking or for cleaning. A tilting system gives easy access to the lower row, without compromising the storing volumes. Binz brings moreover housing associations an affordable sorting solution for their residents to sort correctly on their buildings' properties and avoid economic consequences.

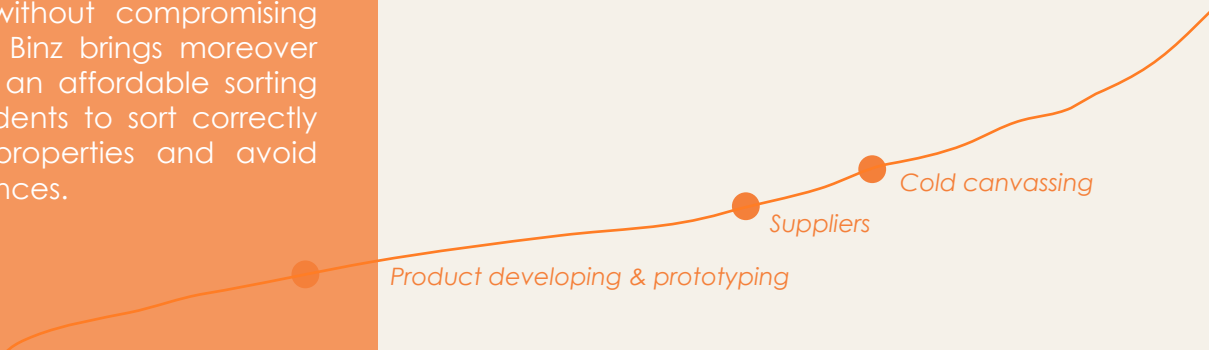
Costs-volume-profit

Potential market			
What	**Value**	**Unit**	**Source**
Apartments in DK	1.434.000	pcs	(Nordicals, nd.)
Apartments run by housing association (HA)	592.959	pcs	
Privately owned apartments	841.041	pcs	
Complexes throughout DK	7.257	pcs	
Housing associations (HA) in DK	511	pcs	
Mean number of apartments per complex	82	pcs	
Mean number of complexes per HA	14	pcs	

Variable cost per unit		
	System (16)	**System (21)**
Bucket	11,11 DKK	11,41 DKK
Holder	10,04DKK	10,10DKK
Rod	9,78 DKK	9,78 DKK
Fasteners (2pcs)	2,08 DKK	2,08 DKK
Chicago screws (2pcs)	0,14DKK	0,14DKK
Total	**33,15 DKK**	**33,51 DKK**
Rail - 38 cm		**23,05 DKK**
Rail - 46 cm		**23,05DKK**
Rail - 56 cm		**27,15 DKK**

Total costs	
Total fixed costs	103.800,00 DKK
Total variable costs	1.225.867,32DKK
Total costs	**1.329.667,32 DKK**

Table 1: CVP with 1-cavity-mould



Contribution margin per unit	
Sales prices per Rail (36) system	362,37 DKK
Total variable costs per Rail (36) system	181,18 DKK
Contribution margin per Rail (36) system	**181,18 DKK**
Sales prices per Rail (46) system	365,25 DKK
Total variable costs per Rail (46) system	182,62 DKK
Contribution margin per Rail (46) system	**182,62 DKK**
Sales prices per Rail (56) system	512,81 DKK
Total variable costs per Rail (56) system	256,40 DKK
Contribution margin per Rail (56) system	**256,40 DKK**
Maximim profit	
Maximum revenue	2.451.734,65 DKK
Maximum profit	**1.122.067,32 DKK**

Table 2: CVP with 1-cavity-mould

Breakeven i housing associations = 1

Breakeven point, systems = 507

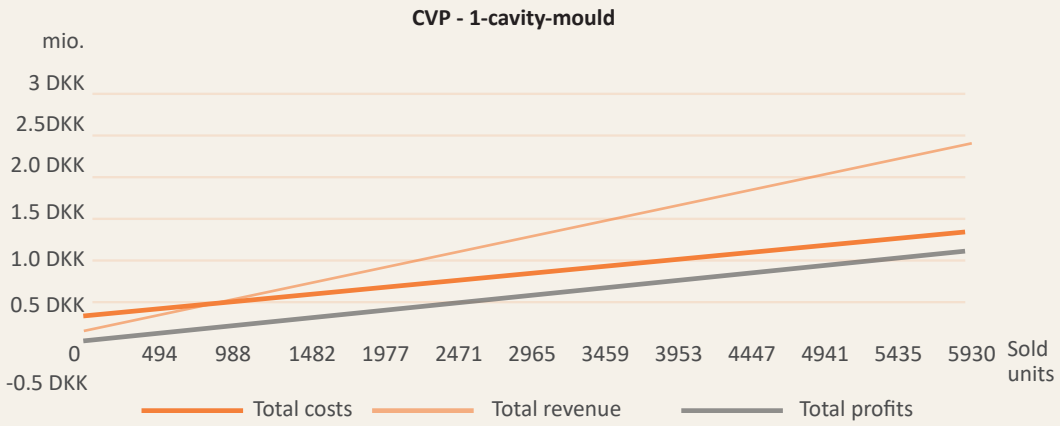
Market expansion to retail market: lid production and development of new products

Marketing investments for private customers (SoMe, Google ads etc.)

Market approval

First costumers

Initial investments



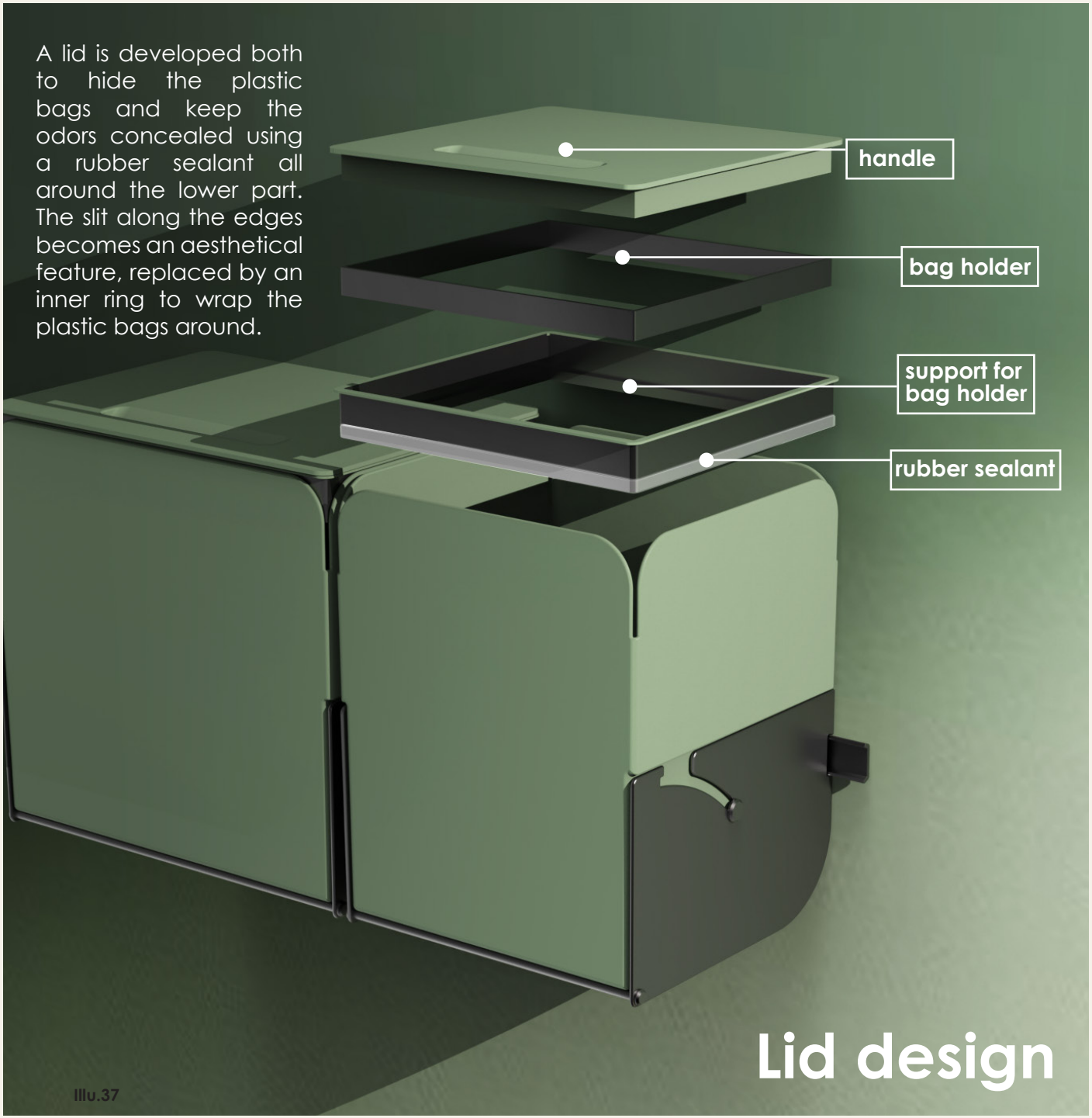
Graph 1: CVP

Future perspectives

Binz offers not only a compact solution under the sink but can easily be transformed into a wall-hanged solution. In a potential expansion of the product to the market for private customers, wide ranges of colours can be possible, turning the very practical sorting system into a simple, elegant piece of kitchen inventory. When not packed away in a kitchen cabinet, there will be some additional practical requirements such as smell and aesthetical wishes to hide away the inner plastic bags.

Illu.36

A lid is developed both to hide the plastic bags and keep the odors concealed using a rubber sealant all around the lower part. The slit along the edges becomes an aesthetical feature, replaced by an inner ring to wrap the plastic bags around.



Lid design

Illu.37

illu.38

Long-term use

As much as Binz offers practical, compact and functional solutions for waste management in smaller households, it also has what it takes to be turned into storage systems for almost every context. Binz can thereby follow the user through a lifetime.

Illu.39

Reflection & conclusion

Binz offers a practical, space-optimising and functional solution for smaller households that covers the basic needs around waste handling. Although, for future product optimisation, there are still some aspects to take into consideration and is worth giving an extra thought.

Firstly, the primary customer has in the business case been housing associations which can to some extent be discussable. The product still requires some installation which consequently means that they have to hire someone to install the system in every apartment. For future development on the product, it could therefore be interesting to look into solutions to mount the rail e.g. without screws, allowing the tenants to install it themselves and remove additional expenses for the housing associations. Another angle could be to target the private customers directly, although there would still need to be some better motivational factors and selling points to justify the system not being for free.

On a product level, it can be uncertain whether the system on the long term will provide nearly enough fractions. As of now, it can provide maximum six of the most common fractions and frequent types of household waste. It can therefore be concluded that Binz does more good than harm, by still pushing the users towards some better waste handling behaviours and eventually apply it outside the household.

List of illustrations

Illu. 34
[skrue-kopskrue-sekskantet-fatning-4-m6x20-rustfrit-stal] n.d. [Image online] Available at: < https://www.skrue-ekspres.dk/skrue-kopskrue-sekskantet-hul-rustfrit-stal-plan-3220/6866-27242-skrue-kopskrue-sekskantet-fatning-4-m6x20-rustfrit-stal-3663072166813.html?SubmitCurrency=1&id_currency=3&utm_campaign=googleads&utm_source=shopping&utm_medium=English&gad_source=1&gclid=Cj0KCQjwxeyxBhC7ARIsAC7dS39baLvl_pmstxmRx07P3sAGNvNktxBL_UfkZLPmYdWr0V-uV6h_kjoaAr5FEALw_wcB > [14-05-2024]

Illu. 35
Self-made

Illu. 36 – Illu. 37
Self-made
[can you make a really realistic picture of a kitchen in green with empty wall space so i can put a rendering photo] 2024. Bing.com [AI generated image] [19-05-2024]

Illu. 38 – Illu. 39
Self-made
[a realistic children's room with toys scattered on the floor, viewed from an angle to emphasize perspective, with an empty orange wall - a realistic kids room with toys on the floor and an empty wall in orange, from perspective] 2024. Bing.com [AI generated image] [19-05-2024]


AALBORG
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Process report

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Title page

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Pages: 97
Appendix: 24

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Abstract

The following paper presents two Industrial Design students' master thesis from Aalborg University. The students have dived into how people's behaviors towards waste handling are influenced by subconscious norms and urban environments, practical habits and psychological aspects. It highlights how house owners have better predispositions towards waste handling, in contrast to apartment residents which directs the project onto designing a non-invasive, space-optimizing waste handling solution specifically for smaller households. The product proposal feeds into the users' existing habits by being placed on the cupboard door under the sink, but challenges behavioral changes by lowering the fraction volume and increasing the emptying frequencies of sorted waste. Targeting primarily housing associations, Binz has a feasible business case that will start profiting within the first year, allowing for expansion to the consumer market. Constructed with recycled PP material and manufactured locally, Binz contributes to a greener future and hopefully pushes people a step closer to changing waste handling norms.

Reading guide

The following project is presented in a product and a process report and should be read in said order. Furthermore, an appendix with additional information including technical drawings of the final product is attached.

Presented on page 92 in this report is a Havard style bibliography alongside with a list of illustrations on page 95 where only illustrations sourced elsewhere will be included.

Quotes will always be presented in italic and orange colour, and throughout the report, information with extra character is marked in bold and/or the same orange colour. When sections are referenced, it will be presented as 'Chapter - section'.

When requirements and wishes emerge it will be presented with a number as shown below. If a requirement or wish is revised it will show the original number as a removed requirement or wish and assign the new one with a new number. Throughout the report the requirements will be collected at the end of a section and be presented again on the design briefs that can be found on the pages 32, 46, 68, and 84.

New requirements #

New wish #

~~**Dismissed requirement**~~ #

~~**Dismissed wish**~~ #

Table of content

0.0 PROLOGUE
Introduction & method

The following chapter introduces the students' motivation behind the topic of this thesis and the initial framing of the project. It will moreover lay out the overall achievement goals and present the angle that this paper will take on designing a waste handling solution. Lastly, the methodological approaches and tools used in the project development will be explained.

“Design is a journey of discovery...

...and you have to get your hands dirty to find the treasure.” - Unknown

Project motivation

Our motivation for designing a waste handling solution as our master thesis emerges among other things from a personal struggle dealing with waste management in our own smaller apartments. We observed that while rules for waste management increase, there is a lack of guidance on how to sort effectively, which leads to confusion, incorrect sorting and thereby overfilled communal bins for residual waste. Existing products on the market did not meet our expectations; they were either too large, unpractical or overly expensive. This gap prompted us to create a solution that is accessible, user-friendly, and space-optimizing tailored for smaller households.

We believe that our waste materials are valuable, misplaced resources. Our goal is to transform the way people perceive and manage their household waste, encouraging them to see the same value in it as we do and start changing their sorting behaviors for the better. By doing so, we aim to contribute to a more sustainable future and take responsibility towards our planet.

Our project aligns with several United Nations Sustainable Development Goals (SDGs). More specifically, it accounts for Goal 11: Sustainable Cities and Communities, by promoting responsible consumption and waste management in the municipalities' and housing associations' local sorting facilities. It also contributes to Goal 12: Responsible Consumption and Production, by creating a long-term waste handling product that has a wide range of utilization and for having a local production using recycled plastic materials from the medicine industry. Furthermore, our solution supports Goal 13: Climate Action, as we strive to lower the production of raw materials through supporting recycling.

Our thesis is a commitment to environmental actions and an attempt to push the boundaries of the society norms, moving towards a greener, more sustainable world. We aspire individuals to make a difference right from their homes, sorting one piece of waste at a time.

Illu.3

Illu.4

Illu.5


PAP
PLAST
BATTERIER
SMÅT ELEKTRONIK
HAVEAFFALD
MADAFFALD
GLAS
PAPIR
SMÅT ELEKTRONIK
ELPÆRER
MAD- & DRIKKE-KARTONER
STORSKRALD
METAL
RESTAFFALD
TEKSTILER
BIOAFFALD
HÅRD PLAST
FARLIGT AFFALD
PAPIR
BLØD PLAST

Illu.6

Project introduction

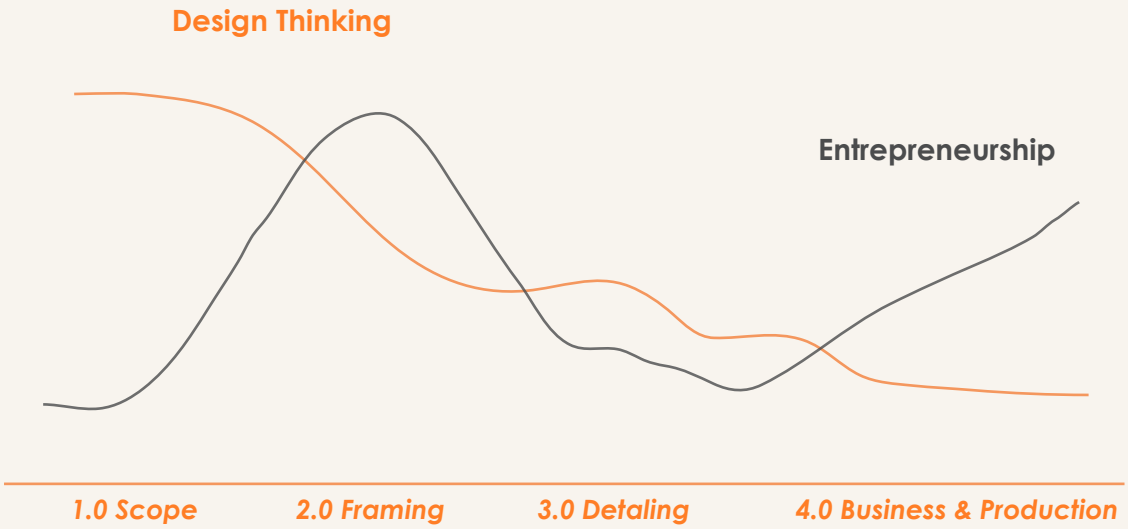
In the past decade, the focus on waste handling has intensified and among other, Denmark is being one of the leading countries creating a growing global consciousness towards sustainability. From July 2023, municipalities will gradually impose inhabitants to sort waste into ten different fractions and as much as it is a significant step towards better environmental care, it does not come without its challenges.(Flybjerg et al.,2023)

Research confirms that far most Danish people make an effort towards integrating new sorting habits, but some specific user groups are far behind. People living in smaller apartments typically lack space, e.g. of integrated kitchen solutions, and are often met with several practical boundaries like smell, volumes or inconvenience, that they have to tackle themselves.(Rambøll, 2022) Although, in contrary to house owners, apartment residents experience no consequences from not complying with the sorting rules and it is very challenging to find actual motivating factors to encourage them to change behaviour. Existing products are typically too big, too small, too inconvenient, too ugly or too expensive. (Flybjerg et al.,2023)

By digging deep into the problem some interesting aspects that affect people's behaviour toward sorting will be highlighted, one of them being subconscious normalities and habits. Those will be the grounding principle of this thesis, that will focus on designing a waste handling solution that feeds into peoples' existing habits and that replaces the current residual waste under the sink, by an open, non-invasive sorting solution tailored specifically for smaller households.

Methodology

Throughout the project development, Design Thinking have been the key approach when exploring the solution space in the ideation phase but as well in the project scope. Some of the tools from this methodology have sat the parameters for the research and tests that have been conducted, together with evaluating the results. Diving into the product development phase, the business aspect and the entrepreneurial approach begins to weigh in the decision making and, to some extent, begin to lead how the tests are conducted. From here the tasks alternate between following design thinking and the entrepreneurial methods to detail a product that can fulfil the users' needs and simultaneously contribute to a viable business. (Hasso Platner Institute of Design, n.d. ; Hartman, n.d.)



Illu.7

Fieldwork techniques for user involvement

Four of the fieldwork techniques are used during the process of designing a solution. Situated interviews and simulated use were the initial approaches to collect data to understand the problem and behavioural patterns towards waste handling. Later in the process, acting out and apprenticeship are introduced in the tests where both the users and the designers take an active part in experiencing the concept and how it affects the flow of habits. (Sperschneider and Bagger, 2003)

Reflection-on-action

When tests were carried out throughout the process, reflection-on-action was used as an evaluation of the results, and the insights from the experiments were used to clarify what needed to be further developed. This is for example seen under the detailing of the product, where several solutions are explored and compared to one another, to make the best decision for the specific function. (Malinin, 2018)

Mapping & clustering

As data was collected, clustering was used together with a final mapping of the problem where patterns towards waste handling are connected to better understand the problem. This can be seen as a part of the initial phase of presenting and evaluating the problem spectrum. (Foli-Awli, 2023)

Build-measure-learn

A build-measure-learn method was applied as a mean to test out hypotheses of the functions that the solution should withhold. This was done by implementing Minimal Viable Products in scale and 3D models in the scale of 1:5 depending on the purpose of the test. (Hartman, n.d.)

Minimal viable product (MVP) and prototyping

During the product development, both an MVP and prototyping have been used to execute the tests, depending on the purpose. The MVP has been used to tests where context, long term use, and behaviour assessment has been necessary to evaluate, along with physical volume. Prototyping through 3D printed models is on the other hand used for the more functional and concrete tests in smaller scales. (Hartman, n.d.)

Leap of faith assumption

During the ideation phase, some concepts will clearly be correlating with the data collected through behavioural research, and despite the feedback of the users, a leap of faith assumptions is made to further detail one specific concept. (Hartman, n.d.)

Pivot

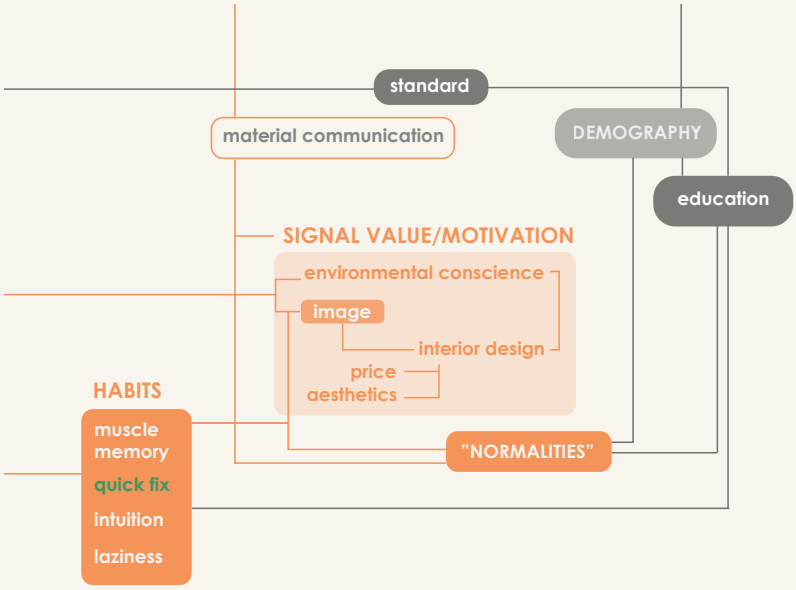
In the first period of the detailing phase, a change of product is made after reassessing the user needs and requirements, along with concerns on future business potential. Within the same frame, some boundary conditions are though changed and will affect the final business case. (Hartman, n.d.)

Finite Element Method (FEM)

Using SolidWorks, a finite element method is used to evaluate the durability, measure stresses for different worst-case scenarios and optimise the final form of the proposal. (Kanade, 2022)

1.0 SCOPE
Waste handling

The next chapter unfolds the core problematics behind waste handling and explores the extent of the problem. Through desktop research, some background knowledge has been acquired to understand how to tackle the problem. A population survey is conducted by the students to acquire their own quantified data about the target users chosen for this project, and to confirm some assumptions from the research. An overview is thereafter created to show how social/urban, practical and psychological aspects all play an important role in steering people's behaviors around waste handling. Each of the three aspects will be further explained in their own section. The chapter will be summed up in an initial first Design Brief.



1.1 Understanding waste handling

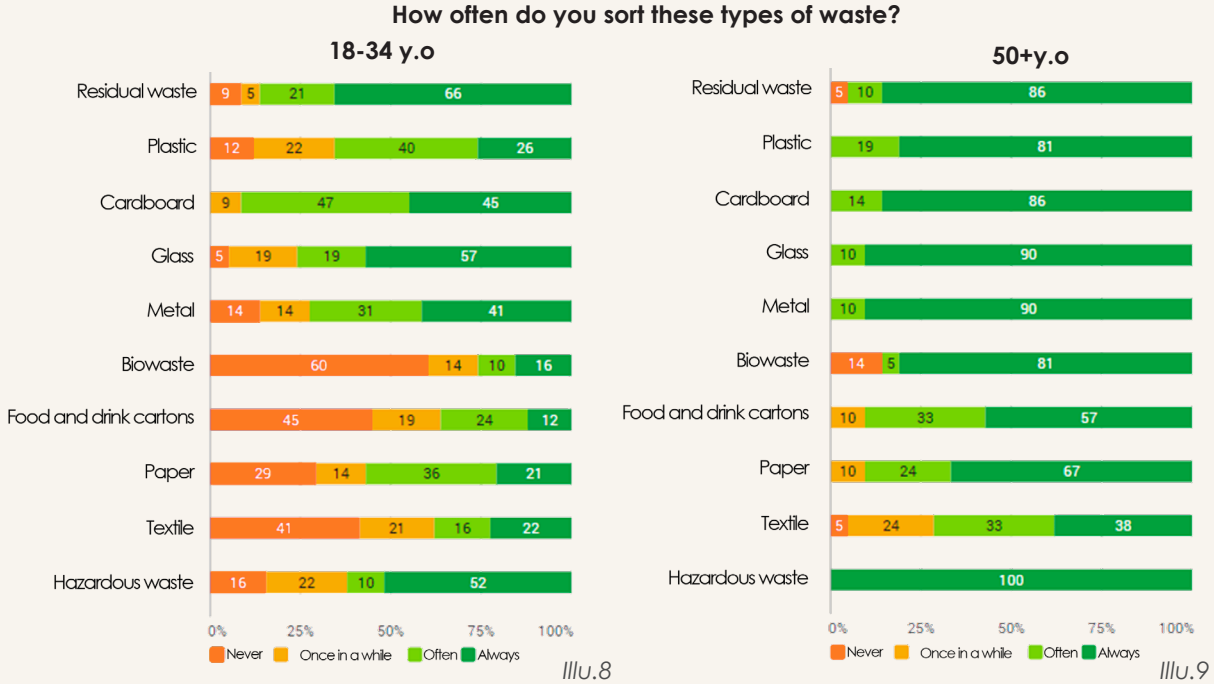
Over the past decade significant attention have been directed on how people handle waste in society. With increasing focus on the reusability of products and household waste, new rules and regulations have been added and changed almost every year and have shaped how the Danish population manage their household waste. Although the municipalities provide more and better communal solutions for the correct disposal, it is still an individual responsibility to find stor and managing solutions to handle the waste within the home.

Waste handling in Denmark

Starting in July 2023, the required sorting categories have been set to ten different types. However, the speed at which this change affects Danish citizens **depends on their specific municipalities**.(Flybjerg et al.,2023) Recent studies indicate that most Danish citizens have shown commitment to waste sorting and that in 2022, approximately 86% of Danes engaged, in some level, in waste sorting, and the numbers are increasing with age. However, less than one third of the population perceive sorting as entirely problem-free. Another study made by DR shows that 62% of the total waste still end up in the buckets for residual waste. The biggest challenges perceived by Danish individuals include lack of space (35%), odor-related issues (29%), and inadequate sorting options near their home (14%). (Flybjerg et al.,2023) Population surveys like the one from Miljøstyrelsen clearly show that age is an important factor and that younger individuals tend to sort a lot less that the older category (Rambøll, 2022).

Young people lag behind

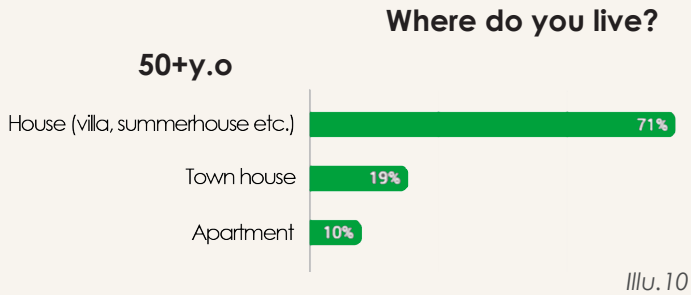
For this project, a new survey was elaborated by the students to acquire own and updated data. The results were similar to the previously mentioned research and showed that the 18–34-year-olds are significantly worse at sorting their garbage correctly than then the 50+ years olds (c.f.illu.8 and 9). (c.f. Appx. 1)



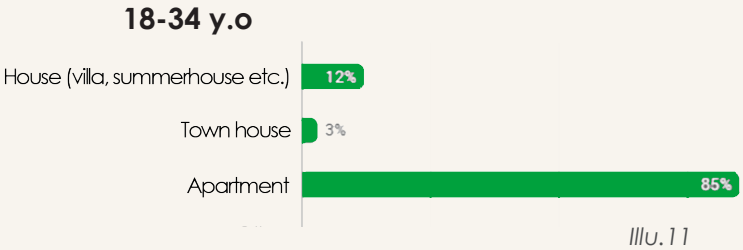
Illu.8 *Illu.9*

Apartment residents/ house owners

The age range was not the only determinant factor but as well whether they lived in apartments our houses. In apartment complexes, residents are expected to use communal outdoor waste disposal systems. However, there are no repercussions for the wrong disposing of waste. On the opposite, homeowners are provided with private outdoor bins and are required to meticulously sort their waste. Wrongful or unsorted garbage disposal will result in fines and may not be collected by local services. (Mellerup, 2022) The consequential parameter that houseowners meet can therefore explain why they might gain more from following the rules.



Illu.10



Illu.11

"Does sorting even matter?"

A visit to the sorting facility in Aalborg was taken to better understand the fraction system and eliminate many current doubts from the users on how much sorted waste actually is reused and whether sorting at home is at all useful. The visit gave a good idea of the bigger picture and explained why and how the fractions are divided as they are. A description of the latter can be found in appendix 2, but the conclusion is **yes, it matters** how we sort our waste.

Verdis sorting facility

Illu.12

Problematic

In a society where waste management regulations are continually evolving and tightened, research indicates that younger people and apartment residents still struggle with proper waste sorting. Consequently, **this project aims to develop an effective garbage disposal solution tailored specifically for smaller households.** In the following sections, the various barriers and factors that contribute to the persistence of this issue will be delved into. By unraveling these complexities, we aim to gain a comprehensive understanding of the broader context.

New requirements

1. ***Must fit in different municipalities***

1.2 Who are the users

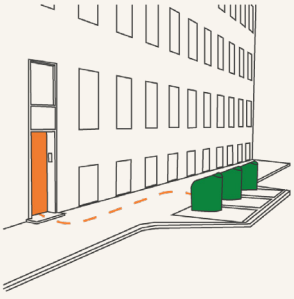
The next section will present the main three users/households that have been used throughout the process. The purpose of the section is to help the reader to better understand insights and feedback that will be mentioned in this report by presenting who they are, what their backgrounds are and what approaches and barriers they currently have towards waste handling. Moreover, as the project is highly concerning behaviour and habits, the goal is to see to what extent the users might change behaviour over time. (c.f. Appx.3)

Illu.13

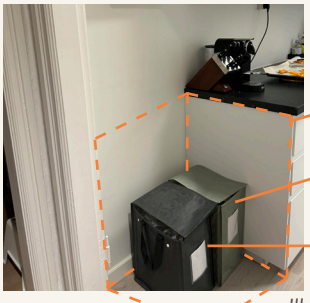
Kathrine and Daniel

Age: 24 and 26 years old,
Home: cooperative apartment Aalborg, 1st floor.
Relation: couple

Kathrine and Daniel reside in an apartment with a **separate kitchen area** where they sort their waste. To make the sorting most manageable they have two large buckets, **one for bottles for recycling** and **one for the sorted household waste**. They put all the household waste in it that is not: Dirty, wet and/or covered in food. So **only clean trash,** that they later on **sort by hand by the bins on the street**. They empty them deliberatly and take residual waste out when they go out anyway.



Illu.14



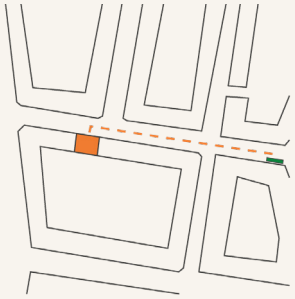
Illu.15

Illu.16

Line and Anders

Age: both 24 years old,
Home: 2 bedroom apartment in Aalborg, ground floor.
Relation: couple

Line and Anders lives in an older apartment with a **separate kitchen area**. They are accustomed to sorting their household waste by utilizing **three buckets beneath the kitchen sink for plastic and metal, cardboard, and glass items**. Additionally, they utilize their windowsill to **temporarily store excess trash** when the buckets are full, as the disposing of the trash is a considerable distance from their home, making them **postpone the task** as much as possible.



Illu.17

Illu.18

Illu.19

Christinna

Age: 25 years old,
Home: 2 bedroom apartment in Aalborg, 1st floor.

Christinna lives alone in a newly build apartment with a **kitchen and living room in one**. She has a small apartment and does not have any space to spare. She currently **doesn't sort her household waste** and puts **everything into the residual waste**. When she has to empty her residual waste, she has **communal bins wherever direction she goes**.

Illu.20

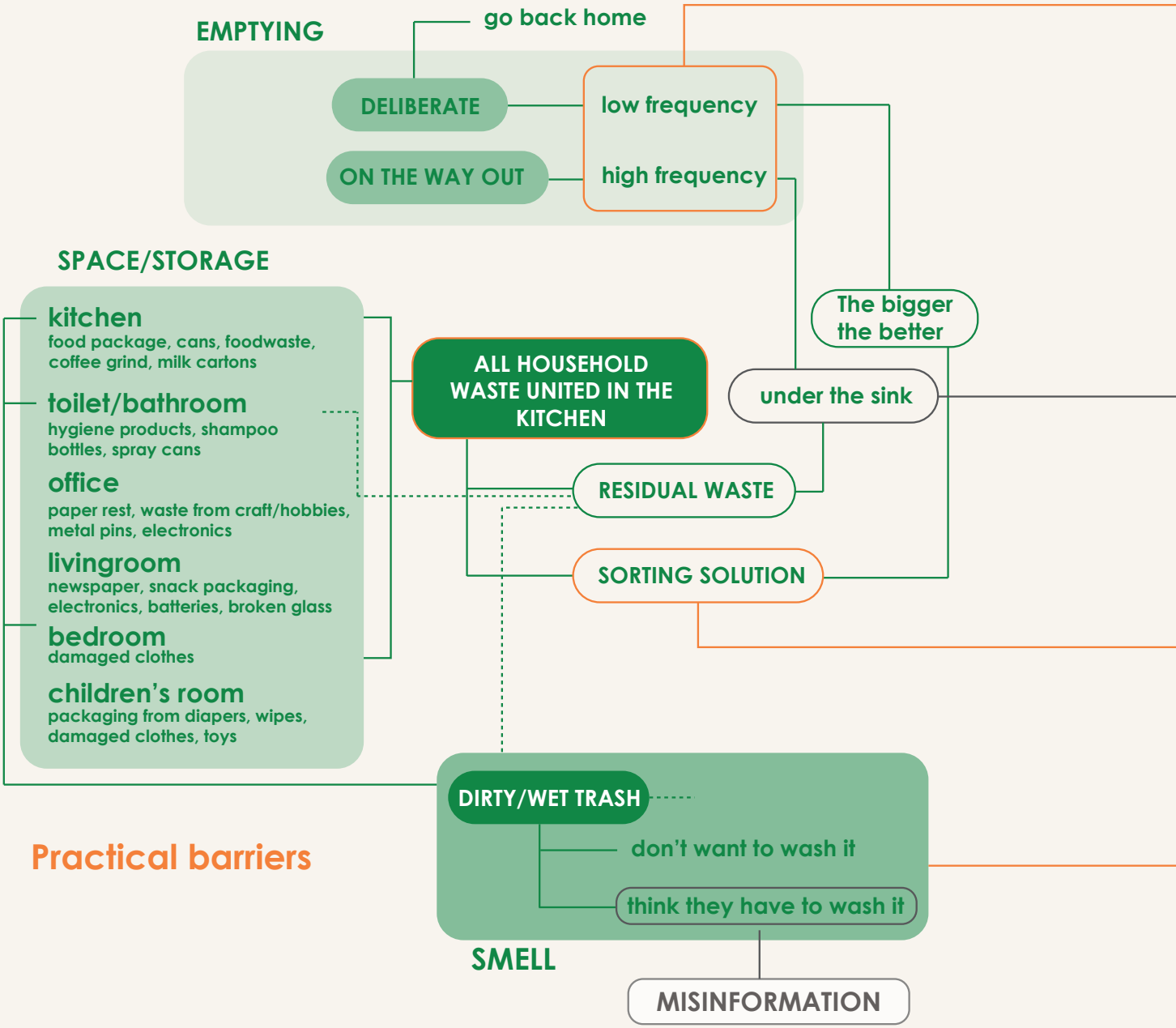
Illu.21

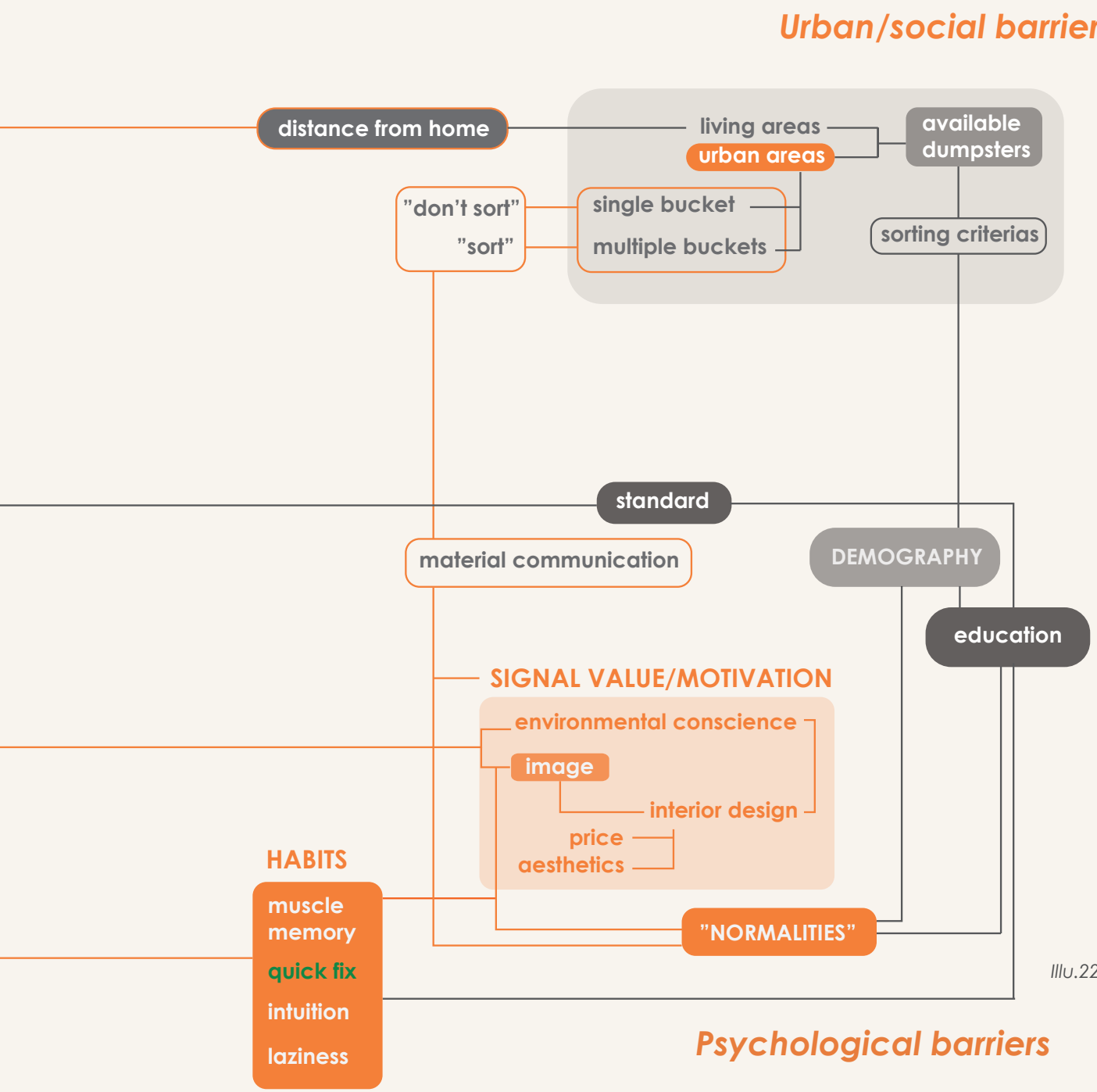
Subconclusion

Based on an initial description of the user's behaviours, different boundaries can be observed, set by different factors. E.g. the distance to the containers dictates how often and how much they want to sort and as well issues like smell, space and convenience. The many factors impacting the behaviour toward waste handling will be delved further into in the next chapter and compared to the observations or interviews with the users.

1.3 Problem mapping

To understand the complexity of the problem and find the unsolved core issue an overview is made to visualise the interdependency of the several aspects and barriers around waste handling. The mindmap has been made based on research and the several user analysis (interviews, collection and analysis of household trash, observations, survey). (c.f. Appx.4) The following illustration will be further explained and elaborated in '1.0 Scope - Urban/social barriers, Practical barriers, Psychological barriers'.





Illu.22

The map shows roughly the main factors and aspects contributing to behavior around waste handling, that were found and explored during the research phase in the problem framing process and their interdependency. The latter could be expanded and detailed even more in further work with waste handling.

Urban/social barriers

When asking citizens to change behaviour towards better consistency in their handling of household waste, social factors and urban environments play a tremendous role. They dictate both the feeling of purpose but also the behavioural challenges that it results in for the individual person.

Urban barriers

In public spaces trashcans are strategically placed to prevent littering. However, these trashcans do not all invite for sorting. Taking Aalborg city as an example, there are some places where trashcans provide sorting options but often only for residual waste and plastic/metal. Those are often placed apart from each other. Most other spaces and green areas only provide unmarked, single cans for mixed waste. Research although shows that if a cluster of marked trashcans is placed in the urban area, their material language appeals to sorting and expresses: "Here we are sorting the waste" as opposed to the single standing trashcans saying: "Here we are not sorting the waste" that affect the unconscious decision in the individual's behaviour toward waste in the urban area. (Katan, 2021) Moreover, the demography also is an important factor, as different rules may apply in different regions as well as different solutions.

2

Sorting in Aalborg

no clear difference between residual waste and plastic/metal

classic single standing city bin

Illu.23

Sorting in Copenhagen

one unit, three colourful divisions

clear difference between the fractions

Illu.24

3

The ways people behave towards sorting in urban areas also affect the importance they give it in their own daily life. If individuals are met with consistency in sorting solutions in their urban and social circles, research also shows that they will be more prone to implement those behaviours in their own everyday life as it becomes a norm.(Lou, Zhao and Zhang, 2020)

As previously mentioned in '1.0 Scope - Understanding waste handling', houseowners have better conditions towards sorting, and the fines that incorrect sorting results in, is motivation enough to do it right. For apartment residents there are no consequences from doing it wrong. Buried containers are installed by the municipality around the city in clusters with the required fractions for everyone to use.

Communal containers *Private containers*

Illu.25

Illu.26

However, a long distance from home to the containers can be an obstacle just as it is for Line and Anders. Instead of going out with the waste more frequently and/or on the way out, they store sorted waste for longer time and empty it deliberately occasionally. (c.f. Appx.3)

Social barriers

Since the 2012 passed ordinance on proper waste handling rules have been constantly changing, requiring individuals and sorting solutions to adapt (Affaldsbekendtgørelse,2012). According to Galán, 2022 one should be reminded constantly how to sort and why it is important to do so, to engrave the new behaviour (Galán, 2022).
Sociologist Lina Katan states that it is important to make waste sorting seem less dutiful as it is a new task that have been imposed on people and therefore something that takes a lot of effort to comprehend. It has to become as much a part of the everyday chores as e.g. doing the laundry or the dishes. (Galán, 2022)
Christinna e.g. sees waste sorting like a task she knows she should be doing but refuses to do so because they are no good solutions for her. She doesn't really feel bad about it.. (c.f. Appx.3)

*"My **life is too short for waste sorting**" Christinna.*

However, when she visits her mother, she makes an effort to sort the waste correctly

*"I am sorting when I am visiting my mom because **she says that I have to**." Christinna*

There is a tendency to respond to authority, where Christinna is afraid of getting scolded by her mother, but her mother is also trying to avoid the consequences of not sorting correctly. Moreover, a lot of doubt is still seen from the users on why it actually is important to sort. Many think it all gets burnt anyway while others overdo it because they misinterpret the rules (c.f. Appx.3):

*"**I don't actually know** how much more we are supposed to sort or **whether or not we are supposed to wash it**" Daniel* (1)

*"Somewhere I hear that **in some regions we have to wash the waste and in others not. It's confusing**." Line*

The visit to Verdis although showed that it is quite important that people sort correctly, but the washing is not required at all. With some types of waste, it might even be dangerous for the workers at the station if done incorrectly. (c.f. Appx.2)

*"**It can end up very bad if it is not sorted correctly** [...] If a battery lands on the conveyor belt, then I would stop the process and send all my employees out to ensure that nothing happens." Danny*

New requirements

2. ***Must be divided into several fractions***
3. ***The fractions should be visually divided***

New wishes

(1) ***There mustn't be doubt on where to put specific waste***

Practical barriers

Through several initial user visits and interviews with different households and analysis of collected household trash, some interesting observations were made that explain the practical boundaries people have toward waste handling in smaller households. The latter have led to some initial criteria that will be summed up in Design Brief 1.0.

Space

The most common practical barrier not only to be observed but mentionned in most of the research is the lack of space (Zeuthen,2021). It typically correlates with the smaller kitchens and spaces in apartments where solutions have not been integrated during construction of e.g the kitchen, but is something the residents have to solve themselves. (c.f. Appx.3)

Kathrine & Daniel

no space? *Illu.27*

*"For me, it **could be integrated in the kitchen**" Daniel* (2)

*"I wish we could have **big buckets for every type of waste**, but we **don't have the space**" Daniel*

(3) *"If we could, we'd have the Ikea solution, but **we can't because of the pipes**" Kathrine*

Line & Anders

Illu.28

*"The **more space you give it, the better** you are at sorting" Anders*

*"The **all time best solution would be if it was integrated**, but it's **not an option, because of the pipes under the sink.** We only have space for the **bag on the door**" Line* (2)

Christinna

Illu.29

*"I don't have space under the sink, **only for the residual waste on the cupboard door"** Christinna*

*"I could have the ikea buckets under the sink, but **then I would have to remove the one on the door and that doesn't make sense**" Christinna*

Subconclusion

All three households struggle to make sorting solutions fit their household. One common opinion is though, that if it were possible, an integrated solution under the sink would be optimal.

New requirements

(4) ***Should be space optimizing***

New wishes

(2) ***Should be integrated in the kitchen***

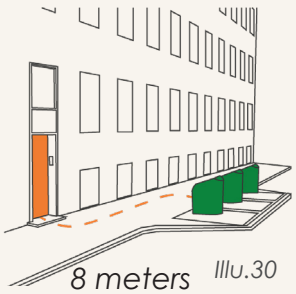
(3) ***Should store big waste volumes***

Emptying frequency

Some clear differences is seen in the frequency in which the users empty their garbage. Typically the residual waste is emptied on the way out, whereas sorting solutions are for some, emptied deliberatly. Although the frequency also is dependt on how close the communal solutions are placed. (c.f. Appx.3)

5

Kathrine & Daniel



8 meters Illu.30

*"We have no problem with going down and **sort the waste directly in the bins. It takes 30 seconds**."Kathrine*

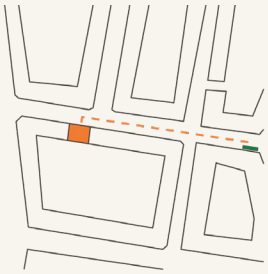
6

*"The solution **can also be too little.** Then we have to **go down too many times**" Daniel*

4

*"We usually **take out the residual waste when we go out anyway**" Kathrine*

Line & Anders

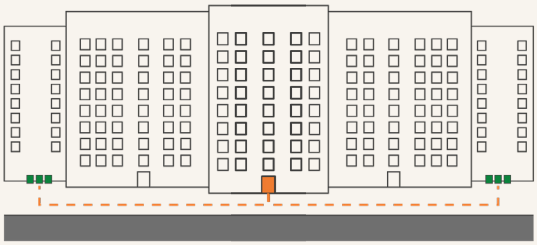


100 meters Illu.31

*"We only do it **once every second, third week** or when we have guests, because **we have to go back with the buckets** so **we can't just do it on our way to school**" Line*

7 4 11

Christinna



71 meters Illu.32

*"If I remove the trashbag from the under the sink **I go down with it immediately. Whether it's on the way out or I have go back in**. I don't want it to stand there and wait" Christinna*

4

Subconclusion

Higher storing volume seem to correlate with a lower emptying frequency. The more they go out with the trash, the less space it can take in the apartment and opposite. They are though more prone to go out with it if it can be done on the way out and not deliberately, except for Christinna who wants it out of the way immediately.

New requirements

5 ***Should be transportable***

6 ***Can be sorted by the bins***

7 ***Should be disposable***

New wishes

4 ***Can be emptied on the way out***

Smell

Another common barrier relating to sorting is often smell coming from dirty trash. The users have expressed feeling disgusted around trash and react quickly to the idea of having waste stored over a period of time that is not clean. (c.f. Appx.3)

8

Illu.33

9

*"All **garbage that has food** on goes in **residual waste**. "*
Kathrine

10

*"**As long as I don't have to touch the dirty trash after I have thrown it out**, it doesn't bother me to sort my waste. But the **process of washing it it too complicated**" Kathrine*

*"Sometimes we are a **bit too lazy to wash it,** and dirty jars of jam e.g. **might end up in the residual waste**" Line*

Subconclusion

Smell from dirty trash can easily be related to longer periods of waste storage and lower emptying frequency. Moreover, clear misinformation is observed on whether the waste should be washed, which is not a requirement. Although, washing the dirty waste also benefits the user, as they want to prevent it from smelling in the kitchen.

New requirements

8 ***Odors from dirty waste must be contained***

9 ***Dirty waste must not be touched after throwing it out the first time***

10 ***Dirty waste shouldn't need washing.***

Analysis of household waste

11 To understand the differences in the types of waste different households might create, and the volumes each type of waste fill, one week of (sorted) household waste is gathered from three households. (c.f. Appx.4)
To map out which types of waste seems most recurrent, the waste will be marked with the following colored boxes. The divisions are based on what each fraction in the city containers should include.

plastic/metal/cartons	cardboard	glas	atypical
1 fraction	*1 fraction*	*1 fraction*	

Household 1

volumes

10 L

3L

>1L

12

would typically be taken out apart

not from kitchen

Illu.34

not from kitchen

cans without pant

Very little sorted waste. How much of it has gone in the residual waste ?

Household 2

volumes

17 L

5L

>1L

12

Folded

Not folded

not from kitchen

not from kitchen

Illu.35

Different opinions withing the same household on how to handle waste?

Subconclusion

From the analysis, it can be concluded that the waste comes from different rooms in the household. For some reasons, it all ends up in the kitchen garbage. Moreover some clear differences in volumes can be seen, as plastic and metal fill much more than the rest. There was suprisingly less glass, which was a concern prior to the test, but indicates that it is not the main issue.

New requirements

11 ***Should store one week of waste***

12 ***Plastic should have more space than other compartments.***

Psychological barriers

Both literature and user observations show that a big aspect that influences peoples' behaviours toward waste handling are psychological barriers. Motivational factors, education and information, habits and materiality have a big impact on how waste sorting is approached in the household.

Self-interest

According to Griskevicius, Tybur, and Bergh, 2010 there are two ways to motivate individuals to better sort their household waste. For some people, appealing to their self-interest by promoting waste handling as beneficial in their personal life, either in form of rewards or better image through social acceptance, is the way to catch their motivation. E.g during an interview, Kathrine mentioned that she wanted a new, wall hanged solution that costs 5 times the price of their current solution, is way smaller and less practical, but more "design". (c.f. Appx 3).

Illu.36

6 *"If it looks nice, **I could give 1000DKK** for it"*

Kathrine

The furniture-like product would bring a lot of aesthetical value in their home, which is higher prioritised in her case than sorting for environmental purposes, but most likely will contribute to more incorrect waste handling due to smaller compartments and less practicality.

In the contrary some also value the products relating to waste sorting as very low despite the aesthetical value but need it to do more to justify the cost.

5 *"I think it was appropriate that **we could get two buckets for 60DKK in Ikea**."*

"There are a lot of things I would upgrade before upgrading my garbage system"

*"I would **pay more** if it could also **optimize the space** and do something **more than just being a bin**"*

Daniel

Altruism

For others, an altruist approach is more motivating and appeals to their environment conscience without personally gaining anything from it. (Griskevicius, Tybur, and Bergh, 2010) For Line and Anders, a messy kitchen is not bothering them, if it means that they can sort their waste. They genuinely feel bad when they occasionally throw out dirty jars but separate the cardboard and plastic from e.g. yogurt packaging without even being aware of it. Wrong sorting of the waste is mostly not intentional but due to **unconscious habits** and misinformation. (c.f. Appx 3)

13

Tonglet, Phillips, and Bates, 2004 also suggests that there can be different motivational factors for different people, but aspects like time, space and convenience still have big impacts on most individuals.

Distancing the problem

A lot of misinformation is seen from the users. Whether or not the waste should be washed before thrown out and where each type of waste should fit in the different containers (c.f. Appx 3). But one common aspect that also influences the personal feeling of responsibility towards the environment is the distance created between individual and the positive effects of waste handling. Indeed, as there is no immediate effect of sorting it can be difficult to see the purpose of it. Moreover, some people still believe that the several fractions are useless and that most of the waste (e.g. plastic) gets burnt anyway. Research also shows that information and good sorting habit also correlate with education and what habits have been taught in the childhood (Nielsen and Engedal, 2021). Other research also currently focus on how to incorporate waste handling early on in school to break society's norms early (Kristiansen, 2015).

Habits and normalities

Based on the information gained through the user observations and interviews, people are clearly driven by their habits and what is expected from them in public and urban spaces. As mentioned earlier, what is required from individuals outside the home, will most likely also affect how they tackle waste handling inside the home and become habits and normalities. According to Katan, 2021 not sorting shouldn't still be socially acceptable but should instead not be negotiable. Currently, sorting is still seen as optional whereas sociologist Lina Katan means that it should be as normal as going grocery shopping or picking up the kids from school and become a new habit. Although, it is also clear that emotions like laziness and inconvenience still play a tremendous part in the motivation to break the habits. (Katan, 2021)

13

Subconclusion

The psychological aspects affect how people tackle waste handling whether it is driven by habits and normalities or due to different motivation drivers. For the purpose of this project, it is therefore important that those factors are seen as boundaries for futures design proposals and that further tests should be made as tangible and measurables as possible despite the latter being difficult to measure.

New requirements

13 ***Should feed into existing habits***

Wishes

5 ***Should be multifunctional***

6 ***Should have an aesthetical value***

1.4 Market analysis

The next section will present and comment on a selection of existing solutions to better understand what their boundaries are and why people don't use them as intended. Pictures of the products have been taken out to the users to get an understanding of their priorities (c.f. Appx 3).

Integrated solutions

requires installation

15

Illu.37

Illu.38

takes space from storage unit

14

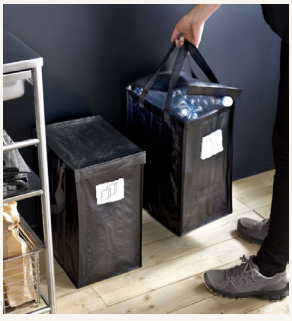
*"The **wishful solution** would be if it was **integrated into the kitchen**, but that is **not a possibility for us**." Line*

*"I do not have the space for an integrated solution in my kitchen. I **only have room for the hanger on the cupboard door** underneath the sink." Christinna*

*"I wish that we could have this solution, but we do not have the space as there are **too many pipes beneath the sink**." Kathrine*

Free standing solutions

takes up lot of floor space



Illu.39

Illu.40

too many interactions

*"I would **love to have** the system where I would have the **big buckets for every fraction** of trash, **but we do simply not have the space for it**." Daniel*

*"The solution we have here is just **a container for everything** and then **we just sort it by the bins outdoo**r." Kathrine*

16 *"**I hate lids on trashcans** and that you have to open it to throw something out." Anders*

Wall hanging solutions

requires wall space in the kitchen

Illu.41

*"I think it **can be too tiny**. Cardboard can take a lot of space and then you have to take it down on its own anyway."*

(3) *Daniel*

*"(...)there are a **lot of other things I would upgrade before** I would update **my waste sorting solution**."*

(6) *Daniel*

Subconclusion

The market offers a variety of products with different benefits. Integrated solutions are highly sought after, but the users targeted in this project live in small apartments without pre-installed systems. Tenants often can't install these systems themselves and therefore don't want to invest in garbage disposal solutions. However, some sorting products adds value through design, storage, or extra functions like workstations, which makes them more appealing to customers. Yet, the common view is that sorting solutions are either too small, too bulky, or too costly. Additionally, there's a psychological factor at play. The effort required by current products to sort items can be a deterrent, making users less prone to engage with sorting solutions, even if they understand the benefits.

New requirements

14 ***Shouldn't take space from other storage units***

15 ***Should be easy to implement***

16 ***Should need minimal interactions***

DESIGN BRIEF 1.0

Vision statement

We want to aspire people to see a greater value and potential in waste materials and make them feel that their small actions make a big difference for the environment.

Mission statement

We want to integrate waste handling in everyday routines by providing better storage for smaller homes.

Problem statement

How can we design a piece of furniture that optimizes and utilizes the space in smaller apartments and provides efficient sorting solutions?

Requirements

1. *Must fit in different municipalities*
2. *Must be divided into several fractions*
3. *The fractions should be visually divided*
4. *Should be space optimizing*
5. *Should be transportable*
6. *Should be disposable*
7. *Can be sorted by the bins*
8. *Odors from dirty waste must be contained*
9. *Dirty waste must not be touched after throwing it out the first time*
10. *Dirty waste shouldn't need washing.*
11. *Should store one week of waste*
12. *Plastic should have more space than other compartments.*
13. *Should feed into existing habits*
14. *Shouldn't take space from other storage units*
15. *Should be easy to implement*
16. *Should need minimal interactions*

Target customers & user

The product is aimed at younger people living in apartments which are also the target customer.

Value proposition

The product should offer an efficient and user-friendly sorting system that optimizes the storage space at home. The product integrates waste handling in the interior design of the home and adds aesthetical value for the user.

Market & business

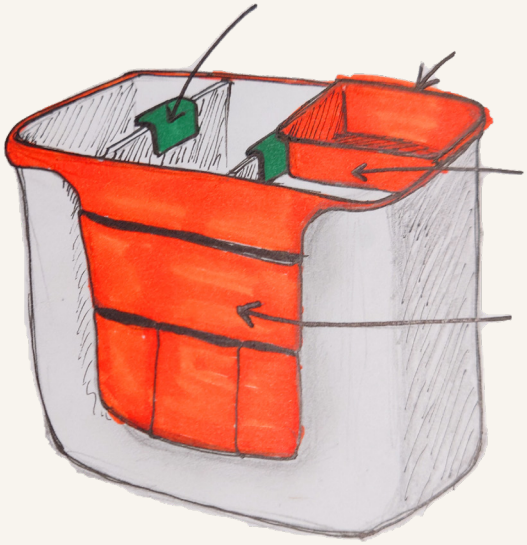
The sorting solution will compete with many existing products in the red-ocean market but should stand out by its efficiency and Scandinavian value, that makes the product become more than just a garbage product. It should be sold through the retail market like interior design shops.

Wishes

1. ***There mustn't be doubt on where to put specific waste***
2. ***Should be integrated in the kitchen***
3. ***Should store big waste volumes***
4. ***Can be emptied on the way out***
5. ***Should be multifunctional***
6. ***Should have an aesthetical value***

2.0 FRAMING
Break the habit

Based on the previous research and data collection on user behaviors toward waste handling, initial ideas and abstract principles are created and presented to the users. Some interesting paradoxes will emerge, and some working principles will be taken further to a detailing process in a Leap-of-Faith approach into a concrete concept. Simple mock-ups are then constructed and tested with the users that will confirm the core principles of the product. An entrepreneurial take on the project will then adjust the project direction by evaluating the potential of both B2B and B2C markets. The chapter will be outlined in the second Design Brief.

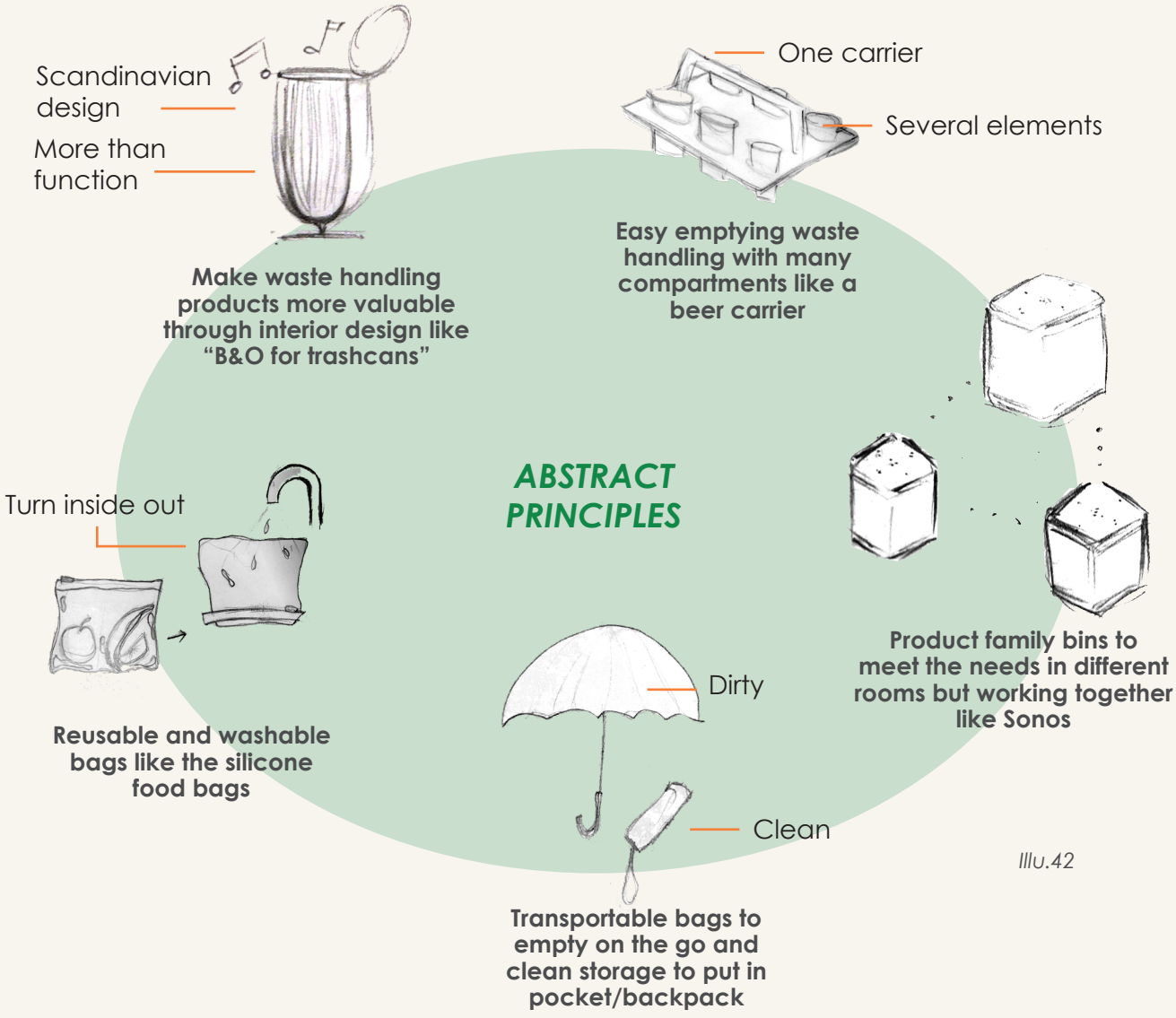


2.1 Ideation & concept development

The next section presents the initial thoughts and ideas that have kickstarted the product development process. Both very abstract and concrete visualization of possible concepts will be elaborated and assessed based on user feedback and observations. (c.f. Appx 3; Appx.5)

Abstract principles and values from other products

Following the initial conversions and observations with the users, some initial ideas and principles from existing products were interesting and taken inspiration from, to meet the requirements mentioned during the interviews.



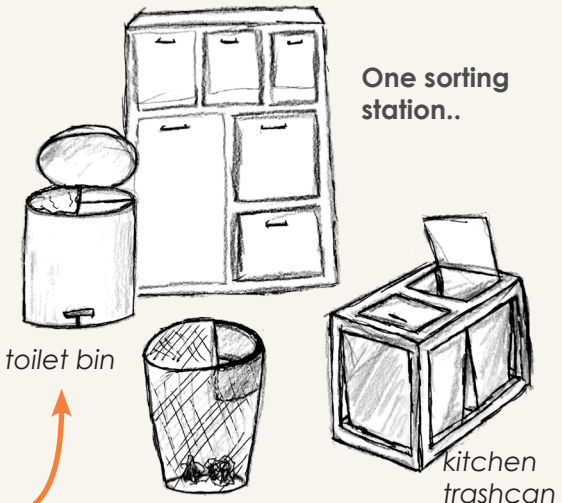
Illu.42

Initial concept & value proposals

The initial principles which laid the ground for the idea generations were a set of different functions and values presented to the users in different combinations. On the one hand a free-standing space optimizing furniture, that focuses on bringing the required functions for waste handling but also aims at the aesthetical value that customers can be attracted to. On the other hand, principles that focus on easing interactions like emptying and transportation of waste, cleaning properties and/or integrated solutions that also challenge the user's existing behaviour.

Modular solution (furniture)

- Different needs in different rooms
- One main station(furniture) and several modules around the house that fit the specific needs
- Toilet bin, office bin, kitchen bin
- Move trash away from the kitchen



..solutions to sort in every room

Illu.43

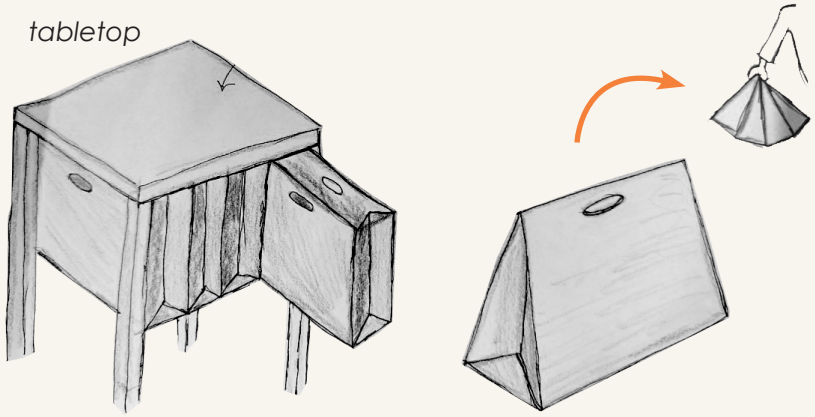
*"Everything from the bathroom goes in the toilet-bin. **Bigger things like soap bottles or spray cans** that don't fit **go in the kitchen waste**"*

Anders

17

*"**No one** really **sorts the toilet bin**. "*

Christinna



Illu.44

Transportable system (integrated)

- Separate and movable compartments
- Transportable, foldable bags (emptying on the go)
- Extra function to the kitchen (table top, work station)
- Easy clean material
- Worth more with more functions?

*"If it becomes furniture, it **demands that I spend some money** on it, and **it's just trash after all**"*

Anders

*"I can see the point of integrating it in furniture. I **could use the extra space.** But I just **can't see where it could fit.**"*

Christinna

*"I think it could be brilliant if the **sizes could be changed**, so I can **make it fit my needs.**"*

Line

7

Replace the black bag, keep the hanger

Illu.45

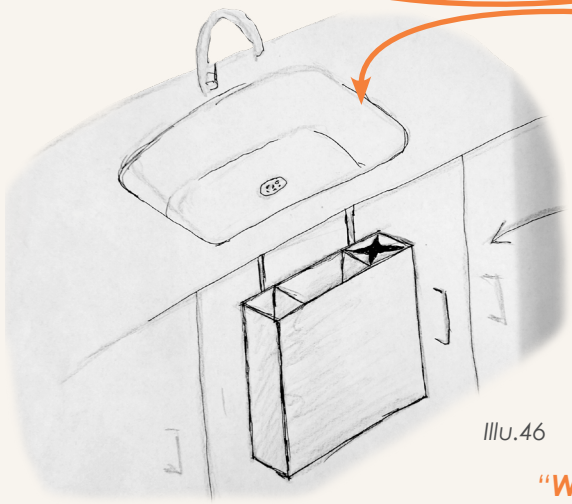
Compressed solution under the sink

- Transportable, foldable bags (emptying on the go)
- Use the existing hanger under the sink
- Feed into the existing habit
- Integrated solution
- Spread the existing amount of waste from the residual waste into smaller compartments

*"I don't have room under the sink, **only for the bag on the cupboard door**"* Christinna

13 18 *"I think it's very smart if it's **the same place that i am used to**. In that way I think **I actually might do it**."* Christinna

FEED INTO THE HABIT: SAME PLACE, SAME VOLUME, SAME FREQUENCY, MORE BAGS. EMPTY ON THE GO.



Illu.46

Compressed solution on the cupboard door

- Easy accessible like the one under the sink
- Smaller compartments and higher emptying frequency (on the way out)

*"There should be a **lid if the trash is visible**"* Anders

19

*"**When it's inside a cupboard it doesn't need a lid**, but if it's outside we don't want to see our trash"* Line

Subconclusion

The user feedback was quite unclear and sometimes contradictory. Although they still expressed concern about the small sizes, the lack of space and other inconveniences, the solutions farthest from what they already do and know seem to be the ones with the least potential.

New requirements

17 ***Should consider the waste from the whole household***

18 ***Must replace the residual waste in the hanger***

19 ***Must have a lid if the trash is visible***

Furniture solutions → Takes too much space / not recessary for people in apartments
Integrated solutions → Too small compartments but meet more requirements

2.2 Leap of faith

Based on the previously mentioned interviews and feedback, one concept direction is chosen to be elaborated and tested with the users despite unclear feedback.

It's all about behavior !

When taking the solution too far from what the user's already know, or being too invasive by proposing furniture that takes up space and costs money, the users have even more requirements. Although the users have not expressed a direct interest in the specific concept, it is clear that the integrated solution is the least invasive and has most potential to fit into the existing habits which is the essence of the problem. Therefore, the project is framed around creating a simple solution that **doesn't require changes in behaviour in the moment of throwing out,** but **challenges elements like volume, emptying frequency** and related **behaviour**.

Feed into the quick fix: acting in the throwing out moment

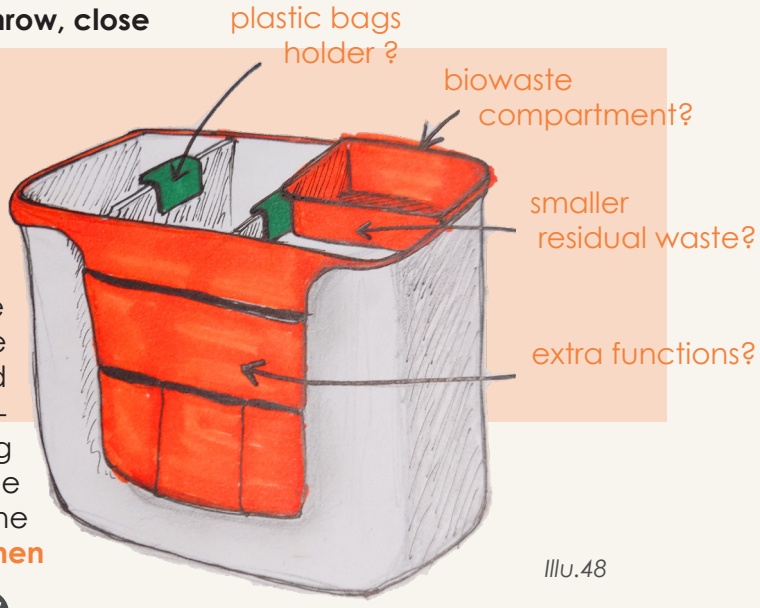
kitchen bathroom office

Illu.47

Open, think, throw, close

Challenge the residual waste under the sink

The concept is a plastic bag solution under the sink that doesn't require changes in behaviour in the decisive moment of garbage disposal. Instead of adding a product to the existing context, the concept focuses on replacing and updating the existing solution in the hanger under the sink. Moreover the concept **focuses on waste in the kitchen as it will have the biggest impact.**



Illu.48

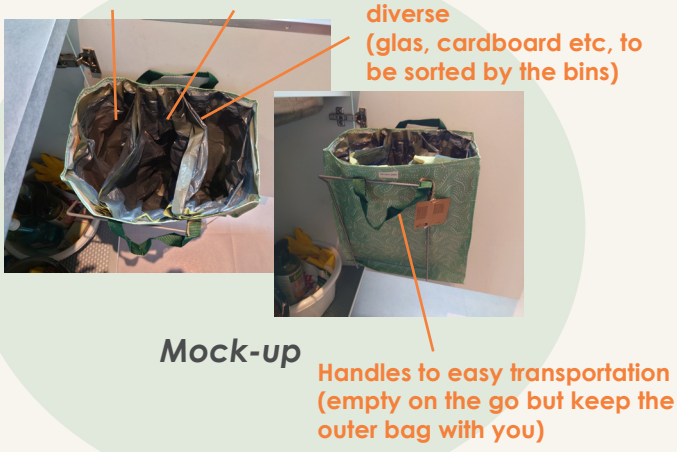
17

2.3 Initial tests and proof of concept

The next chapter presents the initial tests and models that have been made to confirm the concept of replacing the bag under the sink but keeping the metal hanger. It focuses on testing how the users can adapt to the small compartments with the assumption that when sorting the waste correctly, the solution doesn't change the volume of the waste, as it will be distributed between the compartments.

1st test: bag in the existing metal hanger

The test focus on assessing the potential of the smaller containers but **the same placement under the sink** as they are used to. Moreover, the users have been asked to empty their waste by removing the inner plastic bags but testing the concept of the reusable outer bag to easy transportation. Focus will also be on the **higher emptying frequency** that the model requires by its small size. (c.f. Appx 6)



Mock-up

Illu.49

mock-up 1: in use (Line & Anders)

20

Results

21

mock-up 2: in use (Kathrine & Daniel)

Illu.50

- Residual waste used as usual. **Closed bag with knot.**
- Plastic and metal together (wet and dirty included) and thrown together in the plastic bag at the molochs (c.f. worksheet x rules in aalborg). **Opened bag.**
- Carton, glas etc sorted by hand by the bins. **Opened bag thrown seperately.**

FEEDBACK

Line & Anders

The model was **not tested as intended** and was just **placed in the windowsill**.
It became a temporary spot or some sort of container for the household waste that ends up in the temporary spot and therefore did not reach the indented value for the user.

Kathrine & Daniel

When filling the black bags, the **weight from the waste pulled them down** and the clips that held them broke. It resulted in the **waste spreading across the hole textile bag** and the **users quickly getting upset** and throwing the hole system out. 22

(c.f. Appx 6)

What went wrong?

While the purpose of the tests was only to validate some simple functions, two very simple and primitive models were made to be the most effective and time optimizing. In retrospect, the very primitive models were confusing and malfunctioning to the purposes of the tests. Line and Anders misunderstood the prototype and Kathrine and Daniel's broke after only one day. The quality of the models is therefore to some extent important and will be higher in further tests. Although the tests in general failed, they still highlighted some interesting problematics and created new requirements.

2nd test: revised model

Illu.51

(To avoid making the mock-up too complicated and risking wrongful user feedback, the users were asked to use the residual waste for food rests. It will be taken into account later in the process) (c.f. Appx 7)

FEEDBACK

Line & Anders

"It actually **works quite well.** It's easier to sort e.g. the bread and the plastic around the bread correctly because **it doesn't change anything to put it in the bag right beside it.**"

"They have just removed the residual waste in the back alley, so **we have to go to the molochs anyway**, so we also sort at the same time, **it doesn't change anything**" 11

"Right now, we **mostly used the residual waste and the plastic/metal**, so it could be nice if the **compartments could be adaptable**"

Christinna

"I have been using the waste sorting system for about a week and not yet been out with the bags to the molochs. It was therefore fairly **easy to adapt to the system even though I have given it a bit more thought than usual.** "

"Overall, I would say that **it worked very well** and with a system like that I would almost say that life is not too short for waste sorting. "

"It **works fine with just having more plastic bags**, as **I don't need to go back** but just empty them on the way" 5 6

(c.f. Appx. 7)

Additional insights from tests

Besides focusing on the proof of concept, some additional and interesting aspect to take into considerations emerged, leading to requirements. (c.f. Appx 7)

Scraping food waste

Too close to the kitchen top makes it difficult to shovel the food down

Shovelling the food down parallel to the kitchen is difficult with small compartments, especially with a big plate 23

24

Placing it on the front makes it easier to access

Illu.52

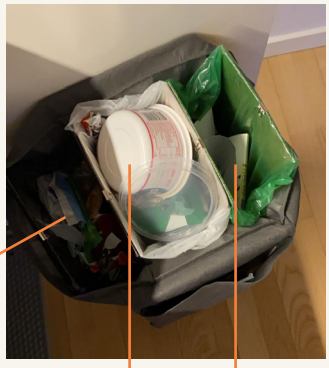
Volume

The users were asked to use the mock-up for approximately a week, and to take pictures throughout the week. After only a couple of days, it can be seen that the plastic compartments are filling up way quicker than the residual waste and diverse. Moreover, it can be seen that most of what is in the residual waste, meaning that it possibly could be even smaller once a solution for biowaste is added.

24

2 days into the test week

Christinna test



Acting out: own house

Illu.53

Proof of concept

As the tests worked as intended, it can be concluded that the concept has potential. As mentioned in the feedback, the users saw the system as tangible, easy and intuitive to use, as there was absolutely no difference whether they threw the waste in residual waste or the one right beside it. The open solution in the same place as they are used to have only one residual waste, forces them to consider sorting as they are throwing something out. The solution although doesn't require them to interact more with another product than with the residual waste (e.g having to pull a drawer and open a lid). Moreover, they have in the test period been adapting their emptying habits and frequencies, as they have emptied all wastes types on the way out like they used to do only with residual waste. It can therefore be concluded that an open solution on the cupboard door that can replace the existing residual waste with a simple, tangible solution, is functioning.

3 5 6

New requirements

20 ***Must have clear, solid dividers***

21 ***Fractions must not take space from each other***

22 ***Inner bags must be held in place***

23 ***Easy accessible while scraping off foodwaste***

24 ***Plastic/metal fraction should fill more than residual waste***

Two business cases: strategic approach

Initially, the product was intended to the B2C market as the solution was seen as a consumer product. Although, the B2B market might be interesting in order to eliminate some of the many requirements from the users. To measure and evaluate the potential of both scenarios, two business cases are set-up against each other.

B2B market

Buyer
Housing associations (e.g. Himmerland, DEAS, Alabubolig)

User
Apartment residents

Impact
Reaching one customer would result in many residents sorting having to use the product. The more users the bigger environmental impact

Benefits for buyer
Better environmental reports. Less fines from residents sorting incorrectly and having to damage control. Cleaner properties from overfilled containers. Easier handling of the communal bins as there would be the same amount of waste per bag if every resident is given the same sorting solution. In contrary to people storing their waste and sort once every 3 weeks.

Benefits for the user
Solution is given by the associations. No money spent. Delivered to the door. No need to find a solution on their own.

Barriers
Price. Implementation: there might be required to also deliver different kinds of plastic bags. Residents can take it with them when they move

Market
Many sold units per costumer and low price units. Less marketing costs to get one customer (mail promotion, cold canvas). Bigger orders, lower production price

Feedback and insights from housing associations

Sorting solutions are often being compromised due to high costs and installation requirements. During the interviews with DEAS and Plus Bolig, there was some enthusiasm about the residents being able to pick the bag op at the janitors and install it themselves in the existing hanger. Moreover, they confirmed incorrect sorting having economic consequences for the properties, as typically the fractions would be overfilled, and extra costs are required to get the waste picked up additionally. More insights are presented in appendix 8.

B2C market

Buyer
Apartment residents

User
Apartment residents

Impact
Reaching one customer would result in one household using the product.
Low environmental impact

Benefits for buyer/user
Feel better about themselves
No actual benefit, as sorting is becoming a requirement.

Barriers
Need to target their individual motivation to get private users to buy the products. It needs to be worth the money and respond to all their individual requirements, and the standards will be high as soon as it costs money.

Market
Retail shops gets profit shares meaning the unit price is higher. It takes more to convince one customer. More marketing is necessary through e.g. SoMe, adds, promotion in physical stores and adds expenses to the unit price. Order to stock production and need to estimate an order volume. Therefore there are higher start investments and thereby high affordable loss.

Subconclusion

When looking at both business cases, it is clear that aiming at housing associations could be the approach with the most potential. By selling to housing associations, the product will be implemented in the users' homes without having to convince them. This means that the motivational factor that is otherwise necessary to attract them, can be eliminated and that for further product development, the requirements should be more generalised to target the majority and make sorting as tangible as possible.

DESIGN BRIEF 2.0

Vision statement

We want to aspire people to see a greater value in waste materials by making waste handling an unconscious part of the everyday life and change the behavioural norms towards waste handling.

Problem statement

How can we design a solution that replaces the current residual waste bag with a compact, open sorting solution that utilizes the existing space and inventory in apartment kitchens?

Value for buyer

Cheap sorting solutions that don't require handyman to install it. The product can be flat packed and picked at the janitors. Can help reduce extra expenses due to incorrect sorting on the apartment properties.

Mission statement

We want to eliminate the use of single residual waste solutions and replace it with correct, non-invasive sorting systems for kitchens in smaller apartments and make it the new standard for kitchen inventory.

Customer

Housing associations are the primary target customers.

User

The product is designed for apartment residents that are limited in kitchen space.

Value for user

Single interaction solution equal to their current bag on the hanger. Set up by hand on the existing hanger and using three compartments for plastic/metal (dirty and wet waste), dry waste that can be sorted by the bins and other waste, all to be disposed on the move. No additional space is used under the sink.

Requirements

1. ***Must fit in different municipalities***
2. ***Must be divided into several fractions***
3. ***The fractions should be visually divided***
4. ***Should be space optimizing***
5. ~~***Should be transportable***~~
6. ***Should be disposable***
7. ***Can be sorted by the bins***
8. ***Odors from dirty waste must be contained***
9. ***Dirty waste must not be touched after throwing it out the first time***
10. ***Dirty waste shouldn't need washing.***
11. ~~***Should store one week of waste***~~
12. ***Plastic should have more space than other compartments.***
13. ~~***Should feed into existing habits***~~
14. ***Shouldn't take space from other storage units***
15. ***Should be easy to implement***
16. ***Should need minimal interactions***
17. ~~***Should consider the waste from the whole household***~~
18. ***Must replace the residual waste in the hanger***
19. ***Must have a lid if the trash is visible***
20. ***Must have clear, solid dividers***

Market & business

A blue-ocean market is entered, as there are no equal solutions on the market that utilizes the existing hanger and without requiring extensive installation. To reach the B2B market, a cold-canvas approach should be adapted, and no intermediary physical platforms are required. The model will be an order to manufacturing approach and not order to stock, as one customer will imply many ordered products.

Illu.54

Current concept: Replacing the residual waste under the

21 ***Fractions must not take space from each other***

22 ***Inner bags must be held in place***

23 ***Easy accessible while scraping off foodwaste***

24 ***Plastic/metal fraction should fill more than residual waste***

Wishes

1 ***There mustn't be doubt on where to put specific waste***

2 ***Should be integrated in the kitchen***

3 ~~***Should store big waste volumes***~~

4 ***Can be emptied on the way out***

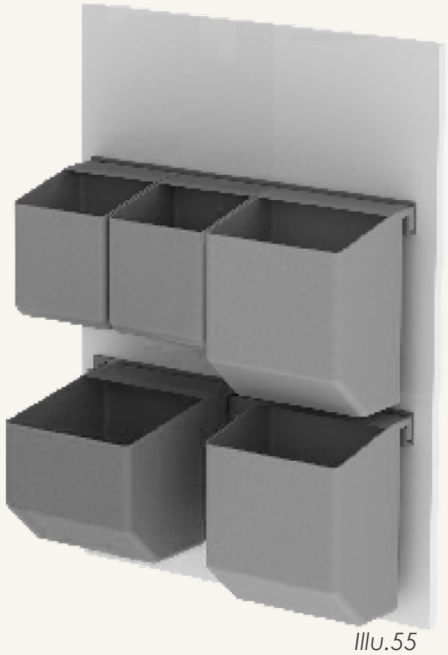
5 ~~***Should be multifunctional***~~

6 ~~***Should have an aesthetical value***~~

7 ***Should have adaptable fractions***

3.0 DETAILING
Loosing the hanger

In the next chapter the project direction will change due to a pivoting of the product proposal. Changes to the business case and challenges to the initial project framing will occur. Following, the sections will tackle forming, dimensioning and detailing the system of the final product, based on several tests using both FEM analysis but as well the data collected through 'Apprenticeship' methods and analysis of household waste. Moreover, every step in the use scenario will be mapped and assessed in order to take into consideration every micro-interaction between the user and the product from installation to emptying the waste fractions. The fourth Design Brief will be presented lastly to summarize the chapter.



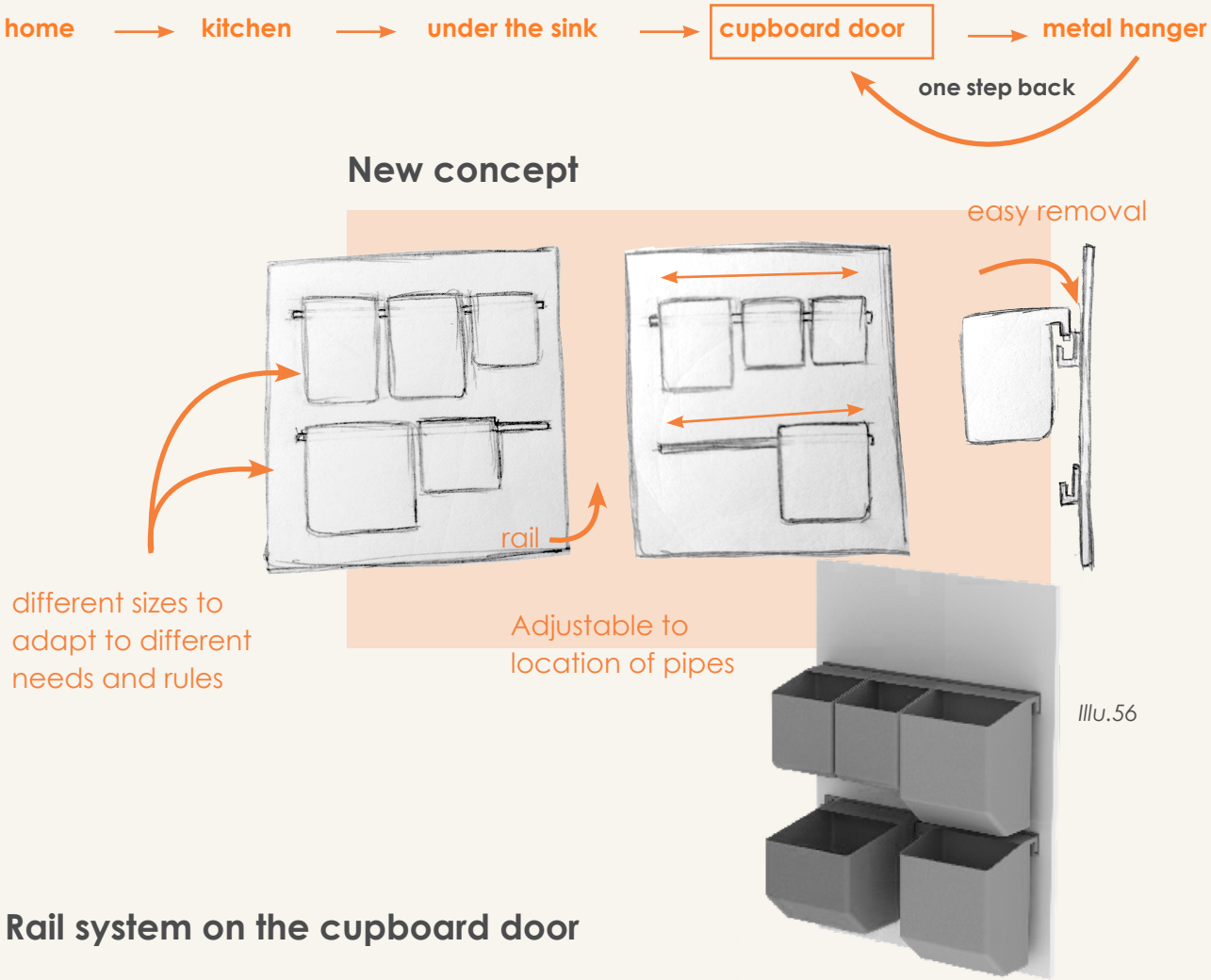
Illu.55

3.1 Pivot

The next section will present the processes and thoughts behind pivoting to another product in the same project framing. Moreover, an assessment of both cases will be presented such as how a change in product affects the business case.

Is the hanger future proof?

Even though the latest test was successful, an important question was raised: "What happens if the hanger is removed, or if kitchen companies stop incorporating it in the kitchens?" A quick ideation process was therefore repeated to **open up the solution space** for new perspectives **within the same frame**, under the sink.



Illu.56

Rail system on the cupboard door

The different bucket sizes fit the individual needs and the current or future rules in the given municipality. The space on the door is maximized and the buckets can change positions horizontally to fit into any kitchen cabinet and avoid the pipes and other stationary inventory. Should kitchen cabinets change their design with time, the system can also function as a wall hanging solution for waste handling or other storage use.

Comparison: metal hangar and rail system

The bag system is simple, can be flat-packed and no installation is required, which could therefore be very attractive for specifically housing companies as it would require minimal efforts to implement. Though, it is assumed that the rail system is a better storage optimizer and might respond to more of the user needs. The product itself has more potential, as it can easily be used in other scenarios than under the kitchen sink and secure future changes in regulation or kitchen designs. To assess whether it's worth changing the business plan, both cases are assessed and compared. The key points of this comparison are listed, and the full analysis is available in appendix 9.

Metal hangar

Pros

- Cheap production, easy implementation (can be picked up at the janitor's).
- One customer (housing associations) many sold units.
- No installation is needed as it can be placed in the existing hangar on the cupboard door.
- "Only" three manageable fractions.
- Same place and same number of interactions as the current residual waste.
- Transportable solution to empty all fractions at once.

Cons

- No insurance that people use it (can be removed)
- Difficult to clean
- Low capacity
- Not future proof: variants will need other products like a stand to be used as e.g. a free standing solution
- Limited by the existing hangar

Rail system

Pros

- Space optimizing the hole cupboard door.
- Can be more attractive to privates and kitchen companies.
- Modular: can be divided with the needed fractions to adapt to needs are regulations.
- Futureproof and has potential in other scenarios: can be wall hanged and used for other storage.
- Can't be replaced with current residual waste.
- Can be customized to fit pipes (can move horizontally).
- Easy clean and movable compartments.

Cons

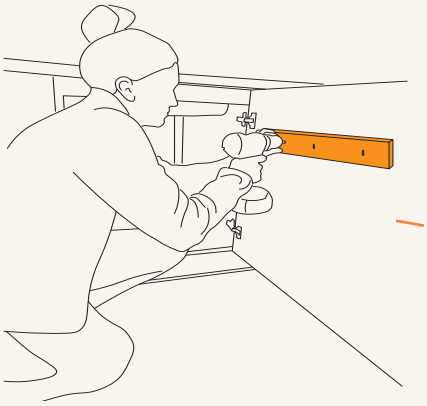
- Less attractive for housing companies as the product will be more expensive (moulds injection moulding) and require professional installation.
- Removable but not transportable

Subconclusion

The rail system is the most future safe concept but might be less attractive to specifically housing associations. Although it opens up the possibility of also aiming at the consumer market and kitchen companies, as it potentially could also meet some of the aesthetic wishes and requirements that were collected from the users in '1.0 Scope' as the product would be used in other scenarios than under the sink (cf. '4.0 Business & production - Future perspectives).

Concept and use scenario

In order to cover and solve most of the micro interactions that might affect the efficiency of the product and to develop it further, a use scenario is made to give a broader understanding of the different steps from set-up to going out with the trash bags. The sections following the latter will present the processes and decisions taken to answer the specific needs that there is in the several situations.



3.3 Installing the rail according the available space

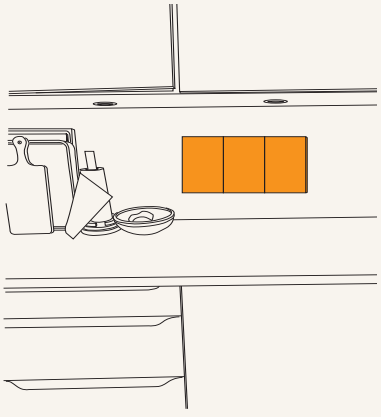
3.3 Placing the buckets on the rail

3.4 Inserting and fixing the plastic bag

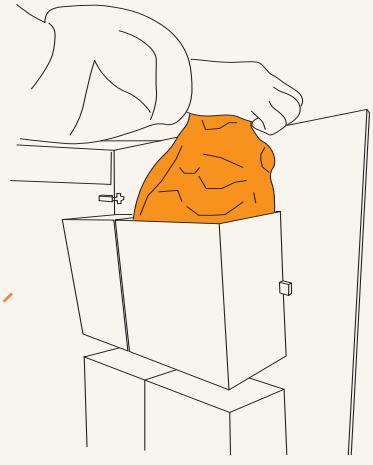
3.2 Usage: same interaction as current residual waste under the sink

3.4 going down with the trash

3.4 cleaning the buckets



4.3 Using the product in other ways



3.4 Removing the plastic bag

Illu.57

3.2 Dimensions, system & form

The next chapter presents the process behind the dimensioning and sizing of the modules composing the bucket system on the cupboard door as well as their form and function. Moreover, it will focus on what sizes would be most appropriate to fit the different types of waste, and how many buckets the final product family should include to cover the user needs.

Dimensions and bucket sizes

The dept measurements were based on a previous test aiming at dimensioning the bag concept in the metal hangar. Based on the data collection from '2.0 Framing - Initial tests and proof of concept', it is assumed that within the most basic, frequent waste, the biggest type answers to e.g the big yogurt bucket or meat packaging. Therefore, a **minimum dept is set to 15 cm** (see illu.x).

Minimum dept

15 cm

Illu.58

15 cm

Illu.59

25

Sizes based on successful tests from 2.2

Bucket sizes

Based on the feedback from the bag concept and the different fractions' volume, it was clear that plastic/metal should fill more, and that residual waste and cardboard could easily be compressed in smaller buckets. Glass was not as frequent a type of waste as first assumed and was therefore not an issue with the dimensions of the bag. As the buckets must fit the most frequent and typical types of household waste, two sizes are chosen for the modular rail system: one small and one big. A test was made with random sizes, to test which seemed most appropriate and tangible. (c.f. Appx. 7)

15x15x20 cm **4,5 L**

Illu.60

Can just fit the biggest types of plastic but most appropriate for residual waste and biowaste, cardboard/paper.

15x20x20 cm **6 L**

Illu.61

Big enough for the types of waste that can not be folded or pressed together like plastic/metal and glass

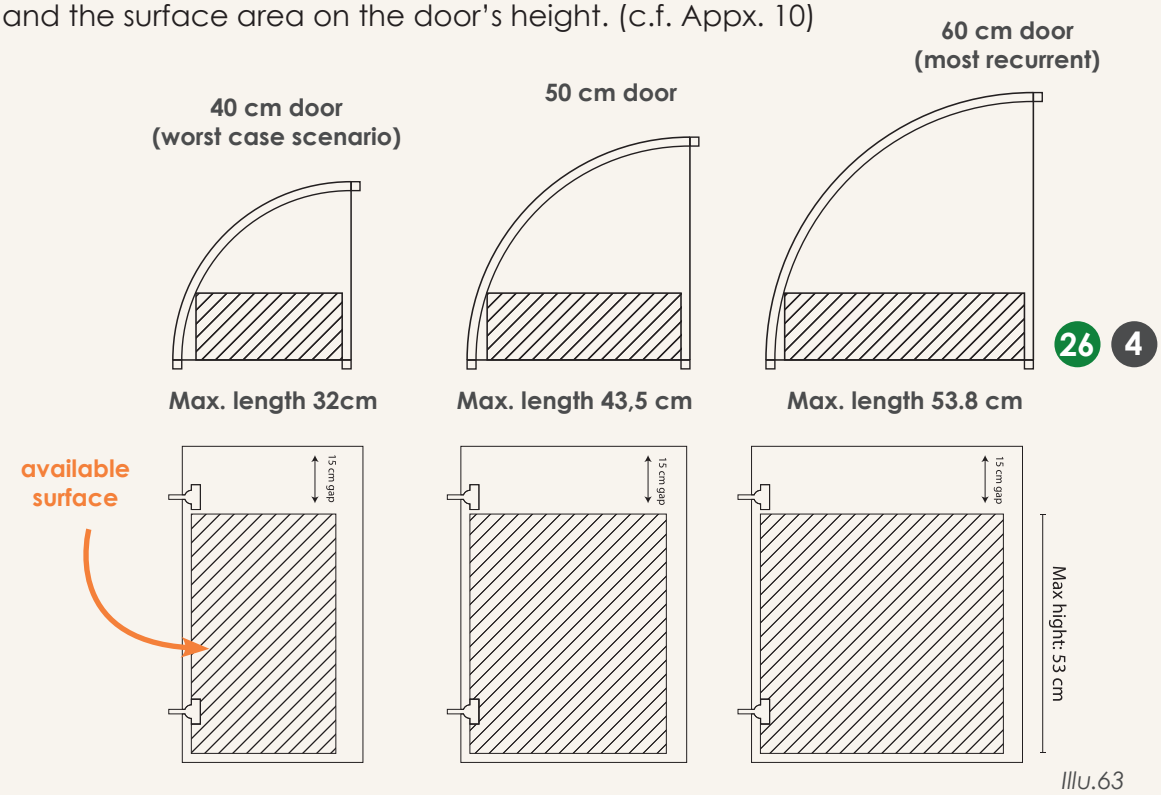
15x25x20 cm **7,5 L**

Illu.62

Two sizes are chosen based their minimal acceptable size, and will collerate with the following section.

Most typical door measurements and dimension optimization

In order to find measurements for modules that would optimize the storage in all the different sized kitchens, the biggest and smallest cupboard door measurements were found. The hatched areas show the space within the swing radius of 15cm deep modules and the surface area on the door's height. (c.f. Appx. 10)

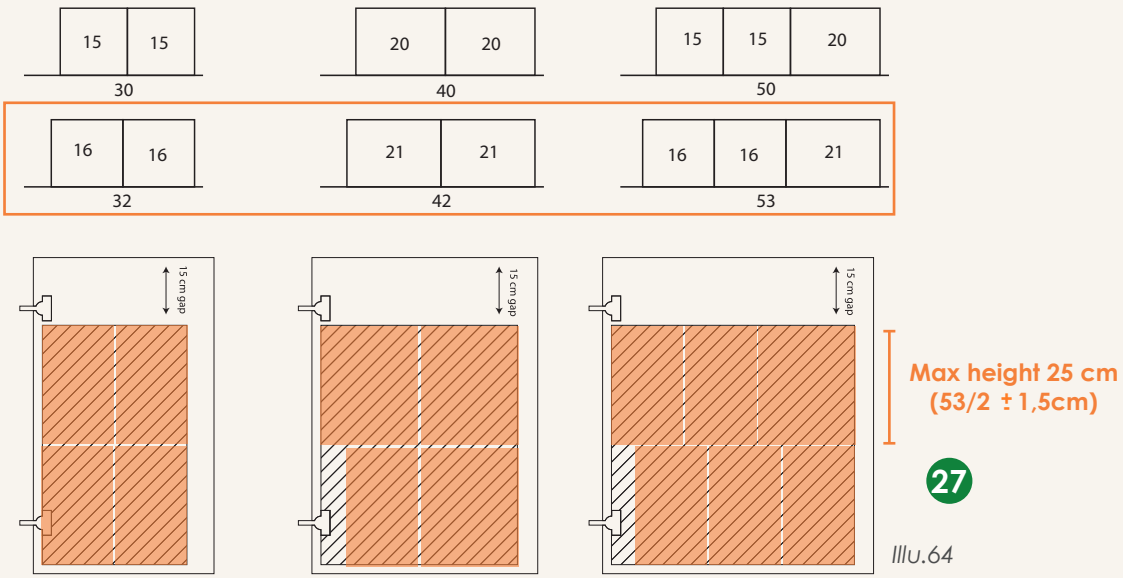


26 4

Illu.63

Optimizing two modules sizes

To optimize the buckets volume to utilize the hole space in different combinations for the three most typical cupboard doors, the outer sizes were increased to 16 cm and 21cm with a maximum height of 25cm. (c.f. Appx. 10; Appx.11)



27

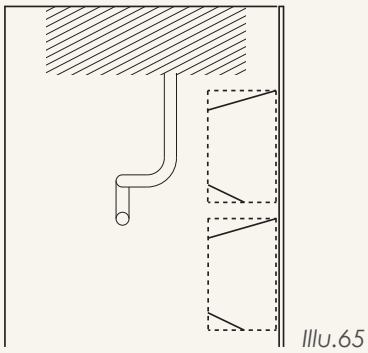
Illu.64

Form and system

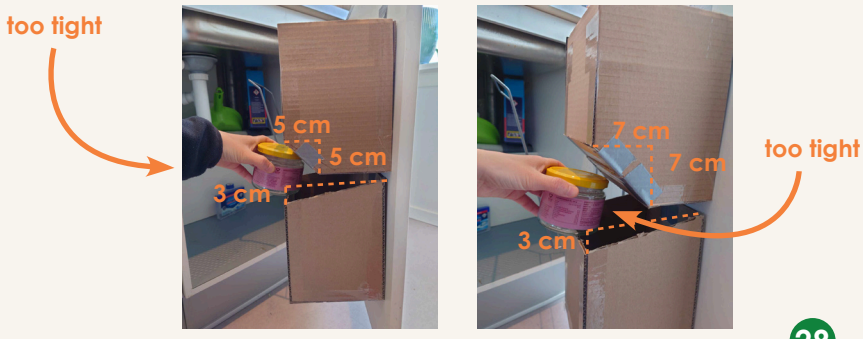
As the buckets are stacked (two rows), it was necessary to find a solution to leave easy access to the bottom bucket and have an opening big enough to store the typical types of waste like plastic or glass. Two solutions were tested, one focusing on forming the buckets after having an angled opening, and the other on a system not compromising the volumes within the buckets.

Angled buckets test

The first solution was to angle the top and bottom to leave an opening big enough to easy access to the lower bucket. (c.f. Appx. 12)



Illu.65



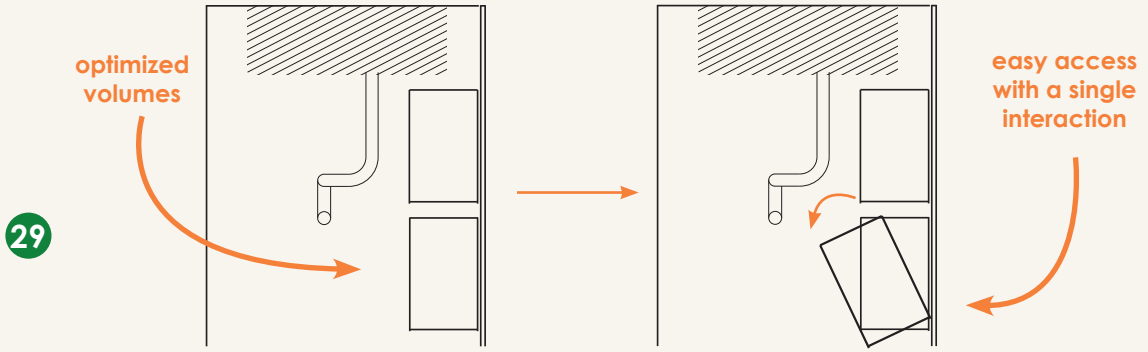
Illu.66

28

The angled buckets compromise the volumes too much. The optimal volume for best waste storage is therefore still a squared form, especially when the volume is already very compact.

Tilting concept

Another option is a mechanical system, that adds one interaction step to access the buckets on the lowest row but doesn't compromise the space and still is an open solution. (c.f. Appx. 12)

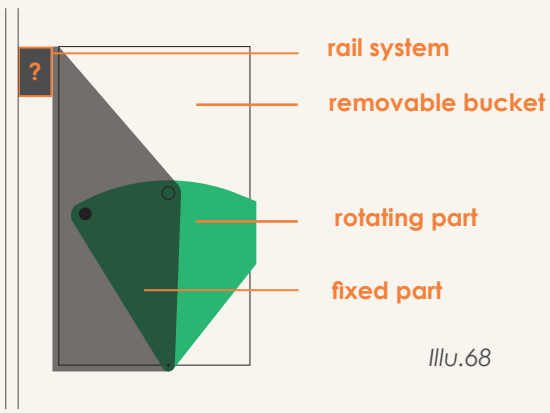


29

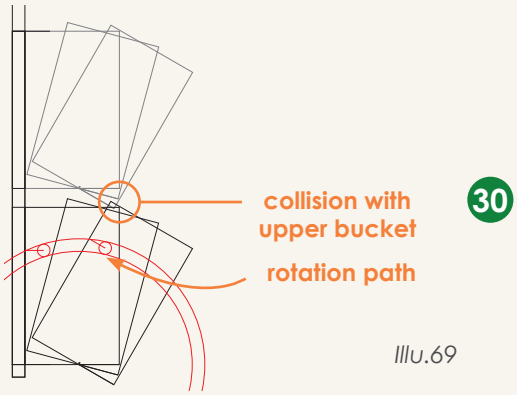
Illu.67

Tilting : mechanical systems

The initial idea for a mechanical solution for tilting the buckets is presented below. The system works in three parts: one attached on the rail; a second to allow a rotation and the removable bucket. (c.f. Appx. 13)



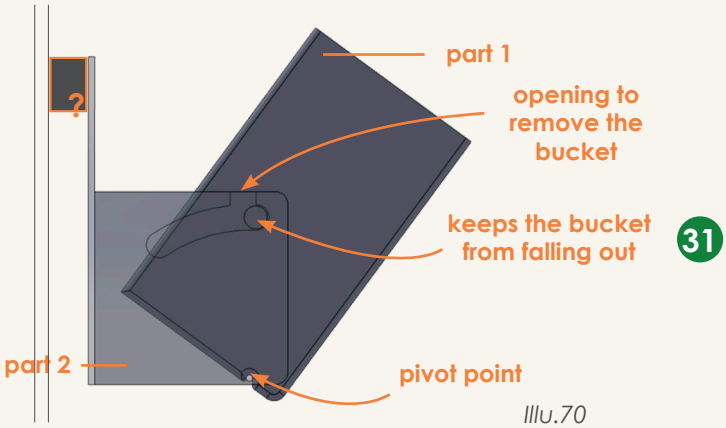
Illu.68



Illu.69

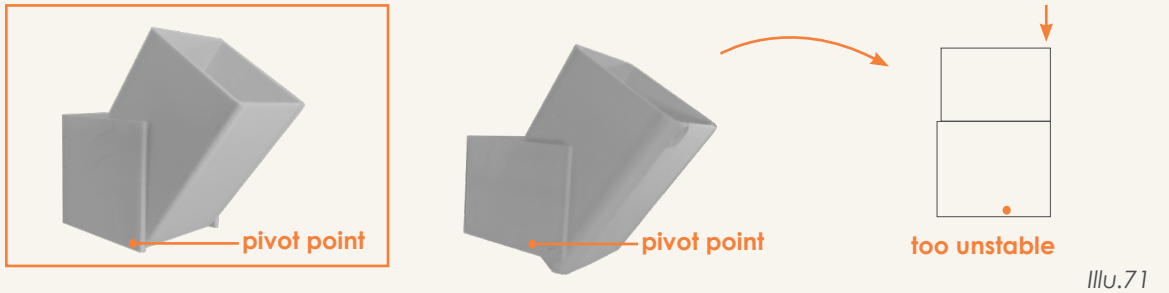
Are three parts neceassary?

Even though the system should function as intended, it is questionable whether it can be optimized even more. The production method will most likely be injection moulding and therefore it is important to consider material use and the number of moulds that the product will require, as the initial investment and thereby the affordable loss will only get bigger.



Illu.70

3D print tests



Illu.71

New requirements

25 *Fractions should be minimum 15x15cm*

26 *Should utilize the available space in all sizes of cupboard doors*

27 *Maximum module height of 25cm*

28 *The shape must not compromise the volume*

29 *Must not collide with the pipes or sink*

30 *Must not collide with upper bucket*

31 *Can be kept in tilted position*

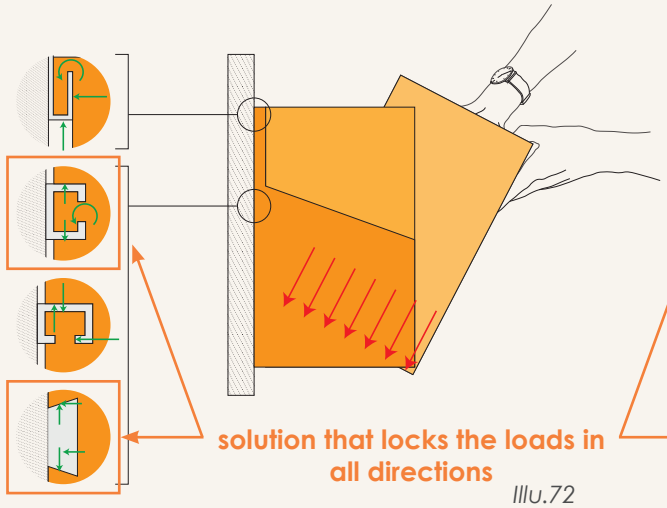
3.3 Rail system and installation

The next section presents the process behind detailing the rail system. The needs and requirements are found by mapping the worst-case scenarios that might put extra loads on the buckets and researching which existing solution that can fit to it. Some calculations are then made to make the assumptions measurable and optimize the dimensions of the system. (c.f. Appx. 14)

What loads will affects the system?

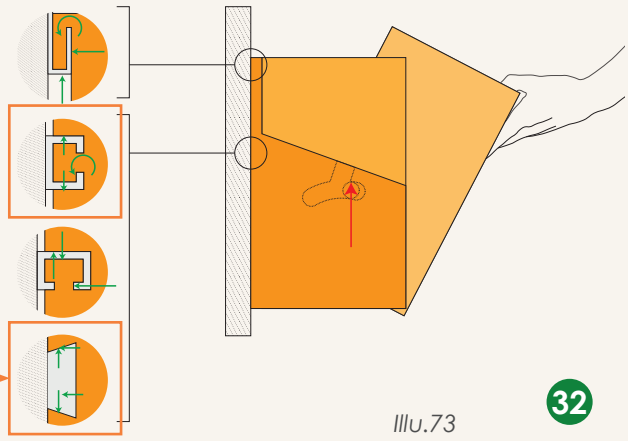
The illustrations below show what reactive forces the rail system would require in two scenarios. The red arrows show the force put on the bucket by the user, and the green arrows show the reaction forces from the rail.

Scenario 1: Pushing trash down in the bucket while it is in tilted position.



Illu.72

Scenario 2: Pulling the bucket upwards to remove it but hitting the edge instead.



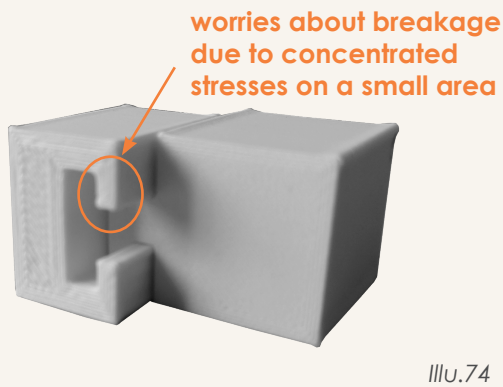
Illu.73

32

illu.x

Both the C-rail and the dovetails can lock the loads on the bucket and therefore 3D printed models are made of both to feel which is most delicate and prone to break easier.

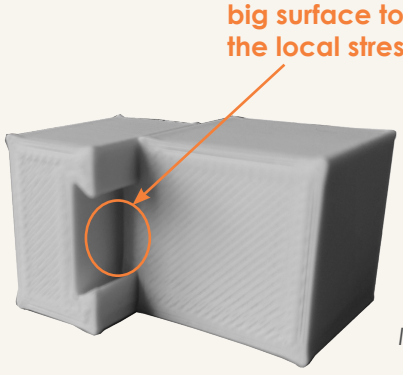
C-rail



Illu.74

illu.x

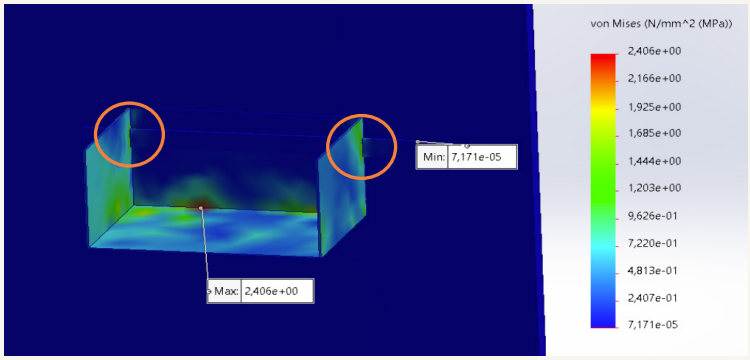
Dovetail rail



Illu.75

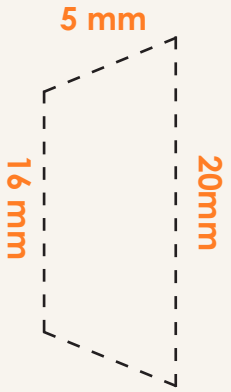
Dimentioning the rail/FEM analysis

In order to find dimensions for the rail, an FEM analysis is made with a simplified model. It is assumed that the pushing loads might be close to 5kg (c.f. Appx. 15).The first dimensions to be tested was a 2cm high rail, and the results showed that it could withstand the forces with a tolerance of 12,9. As a rail narrower that 2cm might look disproportionate and not express durability, it is accepted as the final high. The illustration below shows the final rail dimensions for the rail. (c.f. Appx. 15)



Yield strength for pp-plastic:
31.0–37.2 MPa

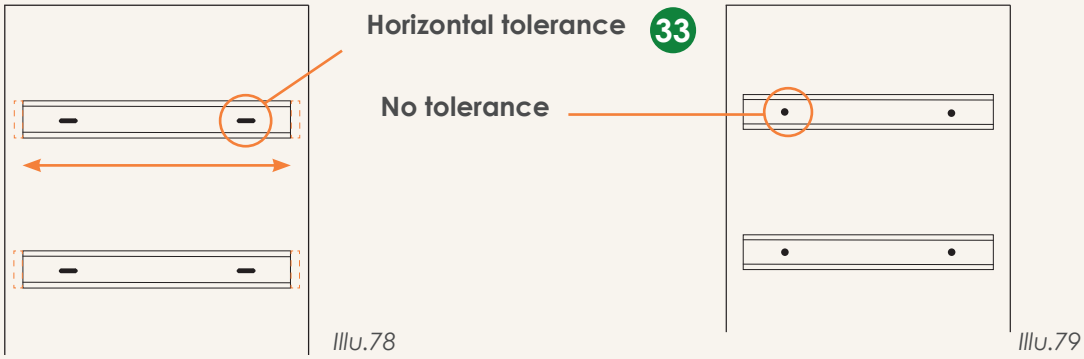
Illu.76



Illu.77

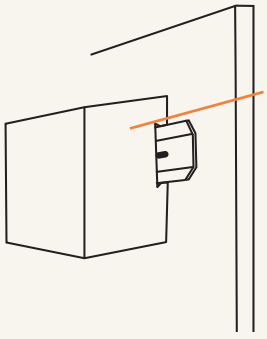
Facilitating installation

To ensure no collision with the edge of the next cabinet door, some tolerance is needed when installing the rails to make room for human error.



Illu.78

Illu.79



sliding the buckets from the side of the rail

Illu.80

New requirements

32 ***Must withstand pushing down waste and accidental knocks from below***

33 ***Installation must allow for some margin of error***

3.4 Micro-interactions and design changes

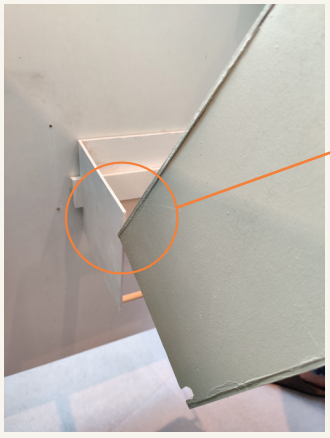
The next section presents the processes behind tackling the problematics around the micro interactions related to the use of the product, mentioned in the use scenario in '3.0 Detailing - Pivot'.

Placing the buckets on the rail

There is very little tolerance when placing the buckets back in the rail. It could therefore be an option to cut some of the edges on the side, in order to first hit the bottom rod and then place the bucket in place. (c.f. Appx. 16)

Test

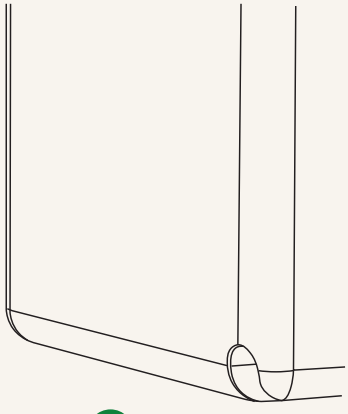
Illu.81



Illu.82

hitting the corner when placing the bucket in place

fillets could ease the fitting between the two parts



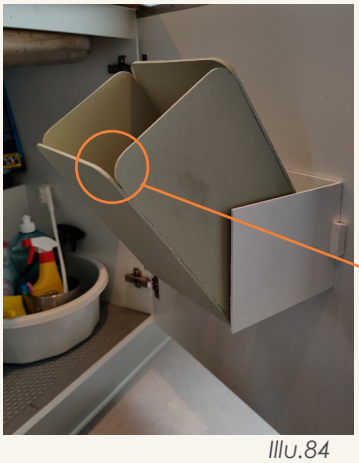
34

Illu.83

Inserting plastics bags

The cuts in the corners on the side are tightening the bag. The plastic bag can be folded in the corner if it is too big before tightening. (c.f. Appx. 16)

Model



rounded edges to not make holes in the plastic bag

Illu.84

Test

Crack along the side to maintain the bag

Illu.85

35

the plastic bag is held in place and can withstand pushing waste down in it

space needed between the buckets to place the bag

Illu.86

Emptying the trash

Another reason for not making the buckets too deep, is that it is easier to carry more than one bag at a same time if it is not overfilled and leaves a leash to hold aorund. The previous concept with the bag on the hanger also showed how difficult it could be with overfilled compartments. (c.f. Appx. 16)

No problem in relation to taking out the bag.

Illu.87

Illu.88

space enough to hold around the bag

36

Insight from previous concept

Overfilled bags don't leave much to hold on to

25cm might still be too high

Illu.89

Holding by the edge makes it difficult to carry more than one

Illu.90

Cleaning the buckets

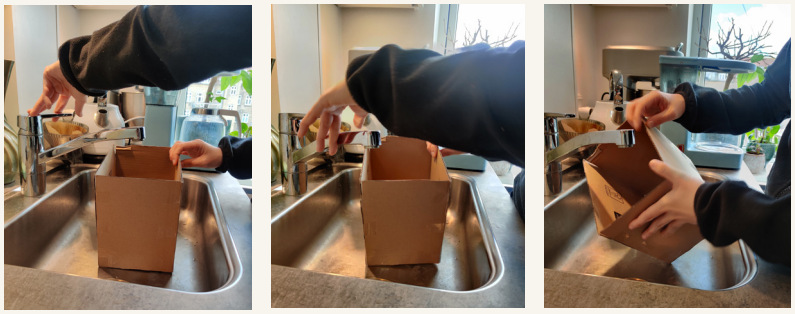
With the 25 cm deep bucket, it was difficult to fit it in the sink. The 20 cm deep bucket was therefore the best option. (c.f. Appx. 16)

25 cm high

Difficult to fit in the sink

Illu.91

20 cm high



37

38

39

40

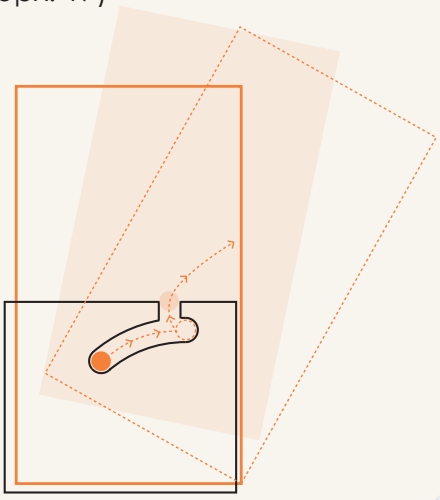
Illu.92

The choice of material will be further explored and presented in '3.0 Detailing - Material & form optimisation' in relation to weight requirements.

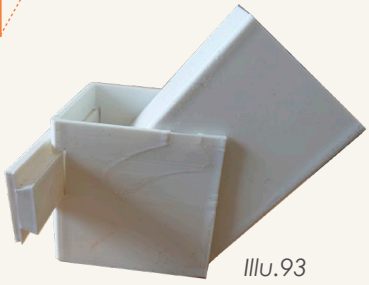
Optimizing the tilting system

Two versions are designed and tested through 3D printed models, to assess the easiest system to remove the buckets during use while keeping the functionality and stability. (c.f. Appx. 17)

1.

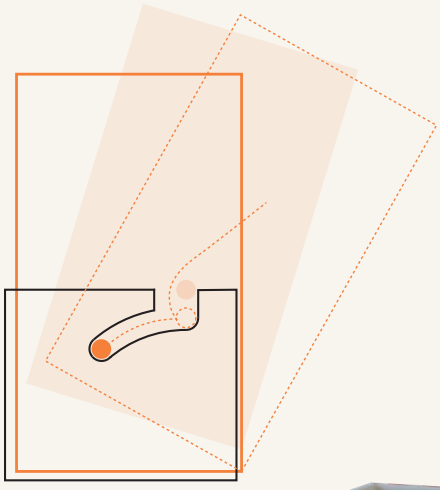


The bucket is held in place in a tilted position, but it takes a few tries to find the "way out".



Illu.93

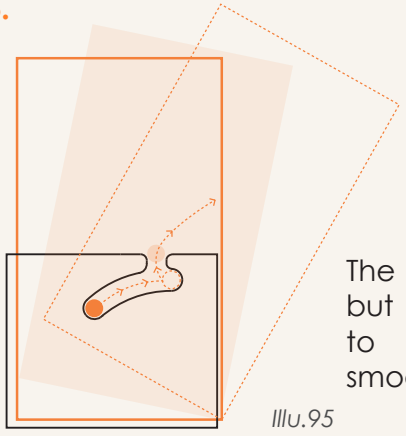
2.



It is easier to take the bucket out, but the system might be too unstable, and the buckets can easily fall out with small forces.

Illu.94

3.

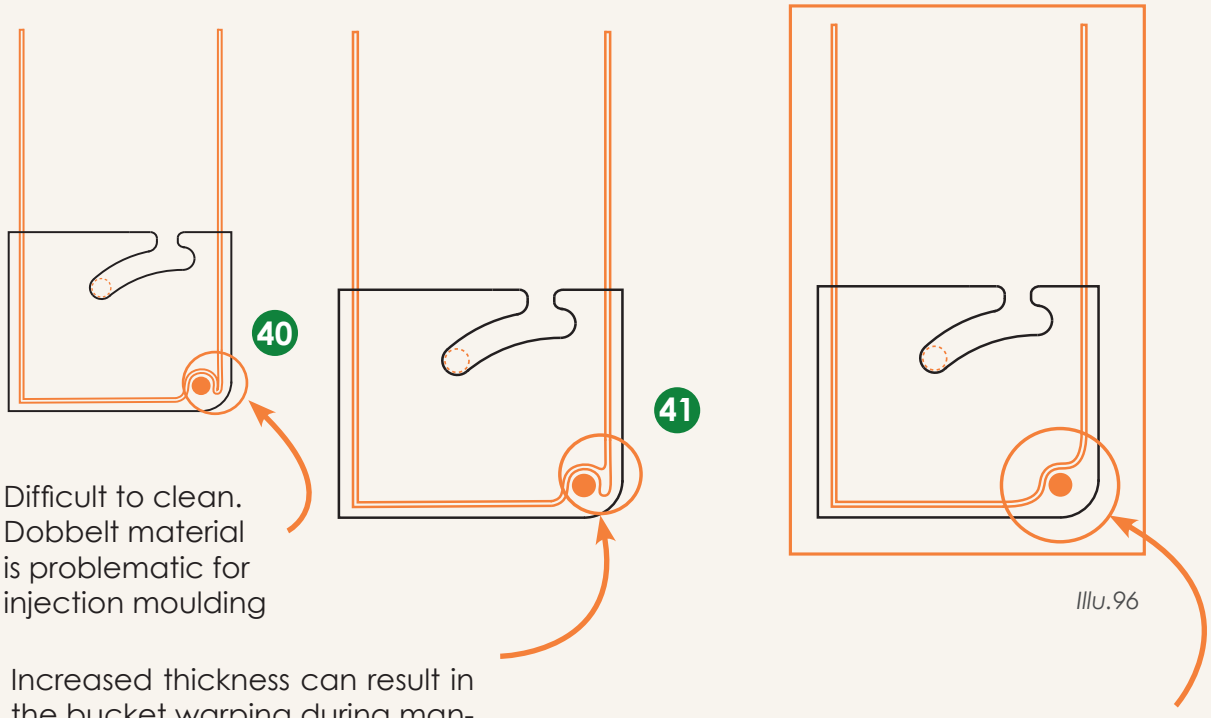


The first solution is chosen, but with filleted corner, to make the interaction smoother.

Illu.95

Pivot point and production

In the corner of the bucket around the pivot axis, a continuation of the material has been made to allow a rotation of the bucket and to keep it in place. Although, as the production method will most likely be injection moulding, the double shelled surface can be problematic. Moreover, it can be difficult to access the area in relation to cleaning and there can be doubts about the very narrow area breaking. (c.f. Appx. 17)



Illu.96

Difficult to clean. Dobbelt material is problematic for injection moulding

Increased thickness can result in the bucket warping during manufacturing as it takes longer for that part to cool off.

By eliminating the edge, it will save some material, and make a simpler geometry. The function of the edge is to keep the bucket in place on the axel, however when the slider on each side is in place, they help guiding the bucket and with gravity a smaller cutout underneath the bucket can do the same as the edge would.

New requirements

34 ***Can be guided in placed without colliding with the holder***

35 ***Must not puncture plastic bags***

36 ***Should be able to carry 3-4 bags in the same hand***

37 ***Maximum bucket height of 20cm***

38 ***Must be water resistant***

39 ***Must be resistant to chemicals***

40 ***No water stagnation in crevices***

41 ***Should have a uniform wall thickness***

3.5 Material & form optimisation

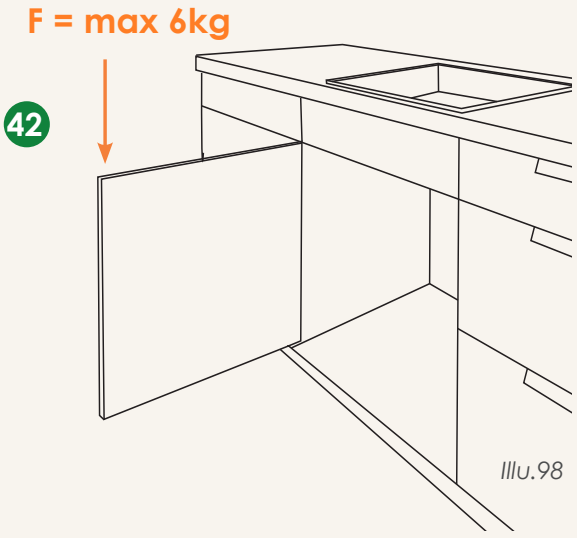
The next section presents the processes behind the choice of material and form optimization. Aspects like weight, production method and durability assessment through FEM analysis are taken into account.

Weight requirements

According to OL-Beslag, one hinge can withstand 5kg. A typical cabinet door weighs around 4kg which leaves **6kg for the sorting solution and waste**. Even though the limit of 5kg per hinge has a tolerance and probably can withstand more, the weight boundary might still be problematic. (c.f. Appx. 18)

Illu.97

To understand the loads that will affect the cupboard door, a typical, overfilled residual waste bag is weighted.



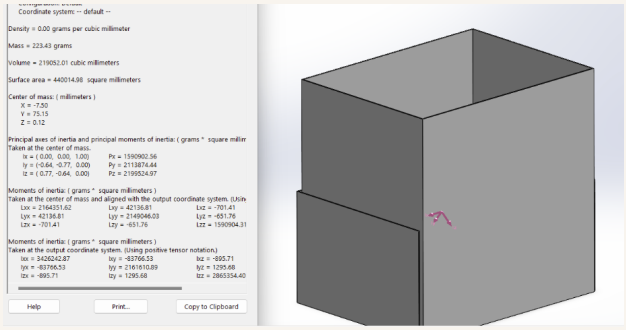
Illu.98

As the intention with the sorting system isn't to store more waste than what is currently thrown in the residual waste, but rather dividing the existing amount into several, easier accessible compartments, it can be realistic to set an assumable weight from the waste to approximately 3kg.

Material comparison: solidworks simulation

The current design has mostly focused on functionality like micro interactions, tilting system and potential future use in other contexts. Although, in order to optimize the weight and form, weight calculations are made in SolidWorks on a simplified model of the current design to evaluate whether plastic (e.g. ABS, LPDE or HPDE) or aluminium (lightweight metal) would be the better choice. (c.f. Appx. 19)

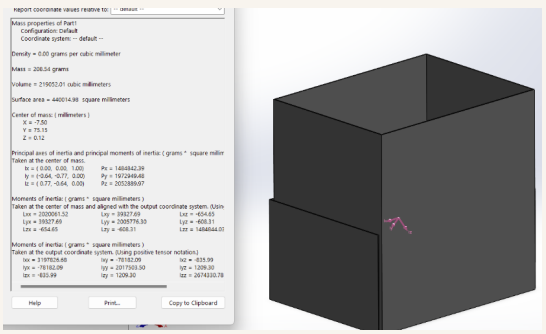
ABS (1,02g/cm³)



Illu.99

Mass = 223g

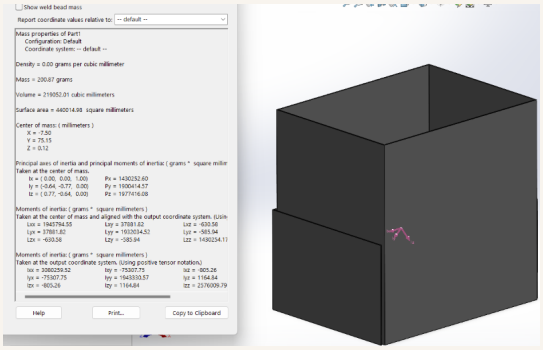
HPDE (0,97g/cm³)



Illu.100

Mass = 208g

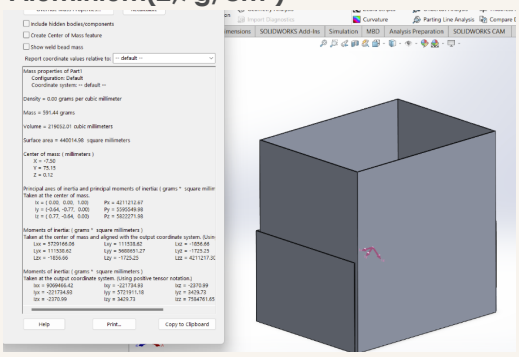
LPDE (0,93g/cm³)



Mass = 200g

Illu.101

Aluminium(2,7g/cm³)



Mass = 591g

Illu.102

With a thickness of **1mm**, plastics are clearly the lightest choice of material. Choosing e.g. HDPE, six of the "big" buckets will weight 1,2kg. In addition to the mass of the waste, (3,5kg), it **leaves 1,7 kg to reach the maximum weight.**

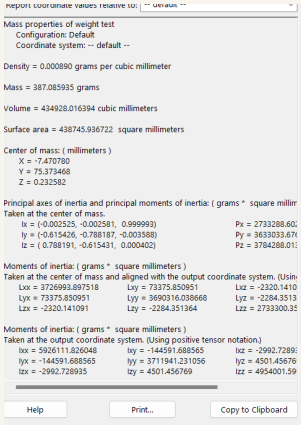
Inspiration from existing product

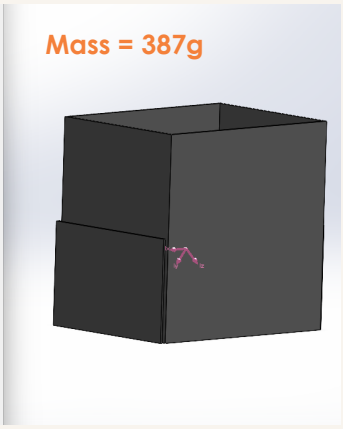
To ensure that the system can live up to the requirements, inspiration is taken from the waste buckets from Brabantia, that is also a lightweight solution for waste storage. They are **2mm thick** and made of **PP plastic**. A new simulation is made to assess whether the solution still is within the weight limits.

bucket from Brabantia

Illu.103

PP (0,89g/cm³)





Illu.104

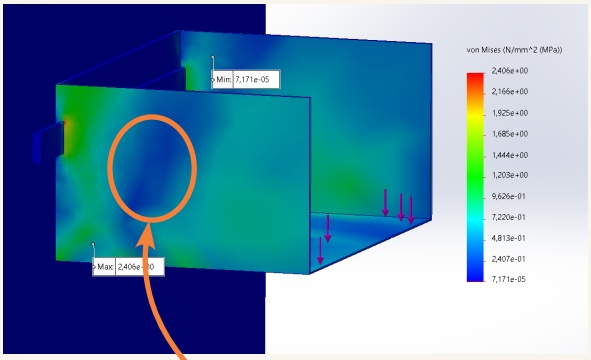
With 2mm thickness six of the "big buckets" will weight 2,3 kg. In addition to the 3,5kg waste, it leaves 0,2kg to reach the weight limit (total of 5,8kg). It can be assumed that the latter is a worst-case scenario, and that the final solution most likely will be composed of e.g. three small buckets and two big buckets, which further will lower the total weight.

PP plastic properties

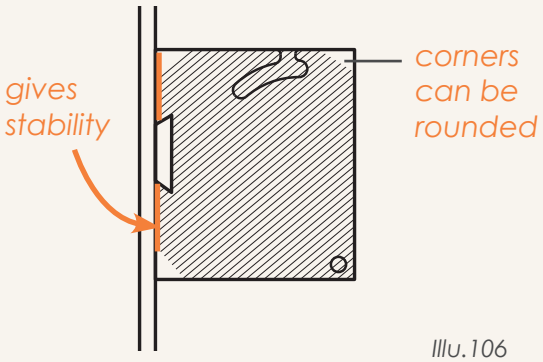
PP plastic has a good chemical resistance and will therefore not be damaged by cleaning with typical soap. The material has moreover low moisture absorption, which is an advantage in a scenario where a plastic bag e.g. is leaking. (Ensinger, 2024)

Material optimisation

Although the current solution (2mm PP buckets) lives up to the weight requirements, some material optimisation can still be made to lower production prices and keep them as lightweight as possible.



Illu.105



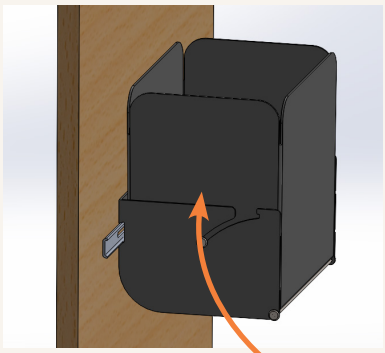
Illu.106

Simulations in Solid Works although showed that it is limited how much material that can be removed from the fixed part, as the surface up against the cupboard door supports some of the loads from the buckets. It could be possible to remove some of the surface material, but as the part is already only 2mm thick, it can also be seen as "bad" quality if it seems too slender. Therefore, only the corners will rounded. (c.f. Appx. 20)

Material stifness

A displacement evaluation is made in SolidWorks to assess the stiffness of the buckets and optimize it. (c.f. Appx. 21)

Current design



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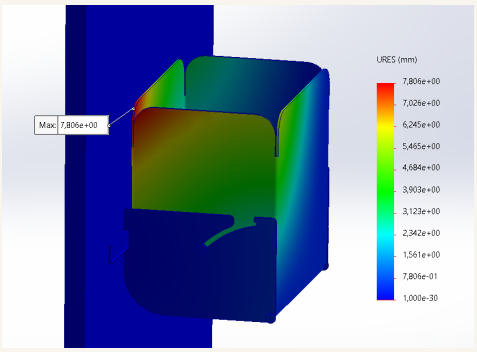
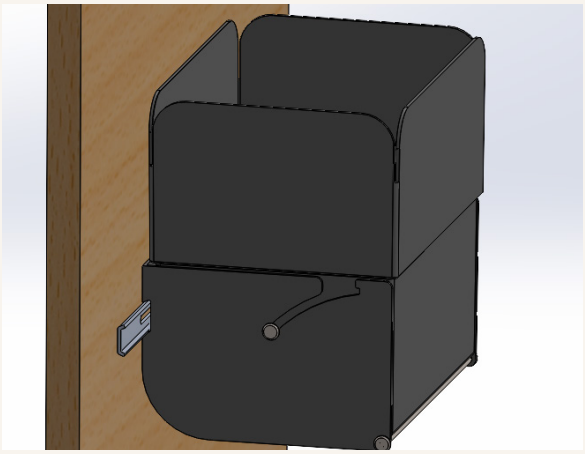


Illu.108

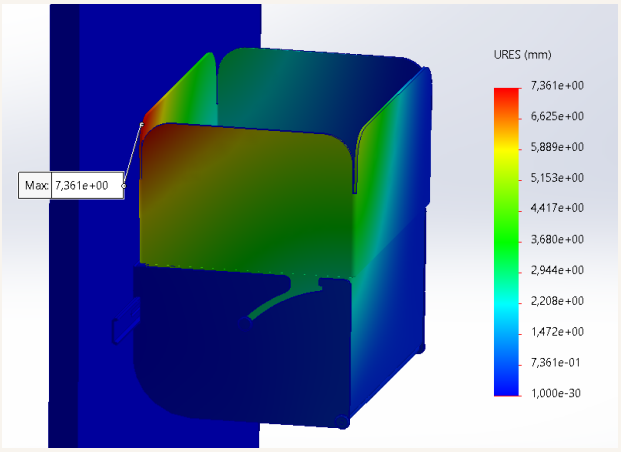
Material: PP plastic
Max displacements: 7,81 mm

3mm edge fold all the way around.



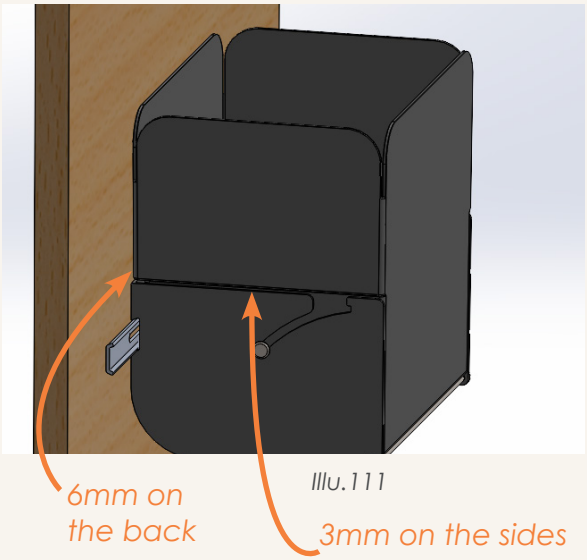
Illu.109

Material: PP plastic
Max displacements: 7,36 mm

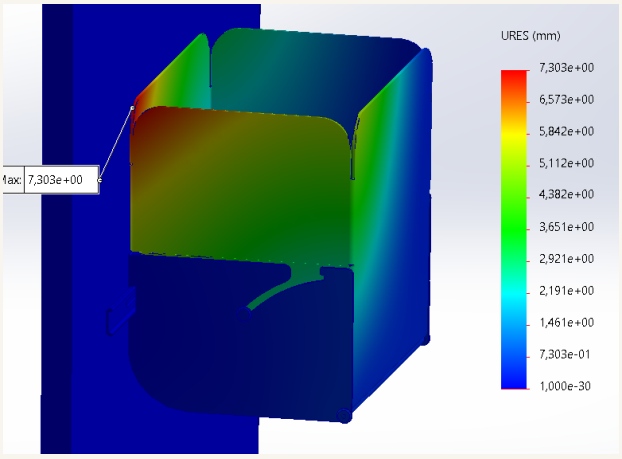


Illu.110

3mm edge fold on the sides and 6mm on the back.



Illu.111



Illu.112

Material: PP plastic
Max displacements: 7,30 mm

By offsetting and folding the edges on the sides of the bucket it reduces some of the displacements but the difference between the three tests is not that big. For aesthetical purposes, the last option is chosen, as it gives a plain, simple front surface. The optimal solution to give the buckets the best stiffness would be to have a folded edge all around the top edge, but it would compromise the sleeves to hold the bags.

Requirements

42 ***The whole solution should weight max. 3 kg***

DESIGN BRIEF 3.0

Vision statement

We want to aspire people to see a greater value in waste materials by making waste handling an unconscious part of the everyday life and change the behavioural norms towards waste handling.

Problem statement

How can we design a solution that replaces the current residual waste bag with a compact, open sorting system for the most recurrent household waste that utilizes the available space under the sink?

Customer

Private appartment owners but also contract markets such as housing associations and kitchen companies.

User

Apartment residents or owners with small kitchens.

Mission statement

We want to eliminate the use of single residual waste solutions and replace it with correct, non-invasive sorting systems for kitchens in smaller apartments and make it the new standard for kitchen inventory.

Value proposition

The product proposal offers a long-term, intuitive and open sorting system under the sink without adding extra interactions to the user's current behaviour. With two different sizes fractions, the system is customizable after the individuals' needs and local sorting requirements. The inner buckets can easily be removed to e.g use while cooking or for cleaning. A tilting system gives easy access to the lower row, without compromising the storing volumes. The open corners allow to hold the plastic bags that can be taking out to the communal bin on the move.

Requirements

1. ***Must fit in different municipalities***
2. ***Must be divided into several fractions***
3. ***The fractions should be visually divided***
4. ~~***Should be space optimizing***~~
6. ***Should be disposable***
7. ***Can be sorted by the bins***
8. ***Odors from dirty waste must be contained***
9. ***Dirty waste must not be touched after throwing it out the first time***
10. ***Dirty waste shouldn't need washing.***
12. ***Plastic should have more space than other compartments.***
14. ***Shouldn't take space from other storage units***
15. ***Should be easy to implement***
16. ***Should need minimal interactions***
18. ***Must replace the residual waste in the hanger***
19. ***Must have a lid if the trash is visible***
20. ***Must have clear, solid dividers***
21. ***Fractions must not take space from each other***
22. ***Inner bags must be held in place***
23. ***Must not collide with kitchen while using***
24. ***Plastic/metal fraction should fill more than residual waste***
25. ***Fractions should be minimum 15x15cm***

Market & business

The solution enters both the contract market, that will be approached by cold-canvassing methods, and the consumer market where the product will be sold through channels like online or physical shops. Kitchen companies can also be an interesting entry in the market, as an intermediary to get the product in the users' homes. A big initial investment will be required both in marketing and in human resources for cold canvassing.

Illu.113

Rail system on the cupboard door under the sink

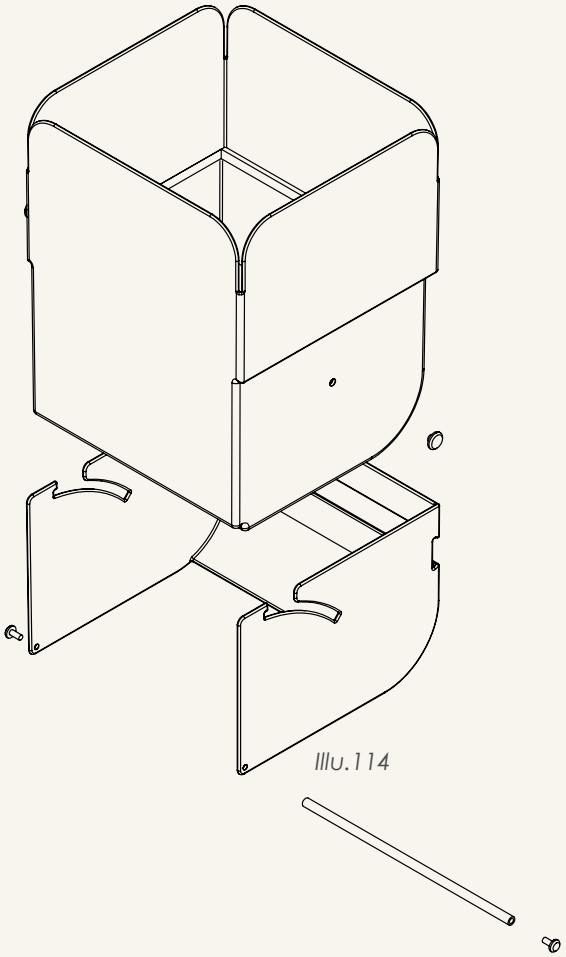
- 26 ***Should utilize the available space in all sizes of cupboard doors***
- 27 ***Maximum module height of 25cm***
- 28 ***The shape must not compromise the volume***
- 29 ***Must not collide with the pipes or sink***
- 30 ***Must not collide with upper bucket***
- 31 ***Can be kept in tilted position***
- 32 ***Must withstand pushing down waste and accidental knocks from below***
- 33 ***Installation must allow for some margin of error***
- 34 ***Can be guided in placed without colliding with the holder***
- 35 ***Must not puncture plastic bags***
- 36 ***Should be able to carry 3-4 bags in the same hand***
- 37 ***Maximum bucket height of 20cm***
- 38 ***Must be water resistant***
- 39 ***Must be resistant to chemicals***
- 40 ***No water stagnation in crevices***
- 41 ***Should have a uniform wall thickness***
- 42 ***The whole solution should weight max. 3 kg***

Wishes

- 1 ***There mustn't be doubt on where to put specific waste***
- 2 ***Should be integrated in the kitchen***
- 4 ***Can be emptied on the way out***
- 7 ***Should have adaptable fractions***

4.0 BUSINESS & PRODUCTION

The next chapter will present the considerations concerning business and production. First the manufacturing methods will be explored and the requirements for the latter will be presented and taken into account in the construction of the final product. Using datasheets for injection moulding a total production price will be calculated and used subsequently to assess a business strategy for both the primary and secondary buyer, and be assessed through its market fit. Eventually future possibilities as well as add-ons for other contexts and use will be presented, leading to the final Design Brief of the thesis.



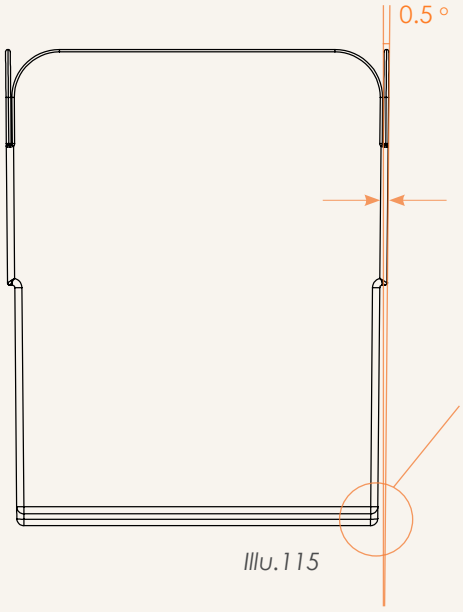
Illu.114

4.1 Manufacturing and construction

The next section will present the different chosen manufacturing methods and how the manufacturing requirements have impacted and shaped the final product.

Injection moulding: buckets and holder

The bucket and the holder are going to be manufactured through injection moulded as it leverages the advantages of the cost, properties and the processing of the PP plastic (Melito, 2023). By chosing injection moulding for the manufacturing, a set of requirements follows for the product to live up to.



Illu.115

Draft

The vertical surfaces should have a **draft angle at minimum 0.5 degree** to make it easier to remove the object from the mould (Protolabs,2024).

Wall thickness

By keeping a **uniform wall thickness** throughout the part helps to **prevent warping** and making shrink marks (Melito, 2022). If there are a change in thickness the transition should be gradual to minimize the risk of shrink marks (Melito, 2023).

Fillets

When two surfaces meet, radii helps reduce the stress concentration in the object, and for PP plastics it is **recommended to have a radius of at least 25% of the wall thickness** (Melito,2023).

100% recycled plastic can't be white

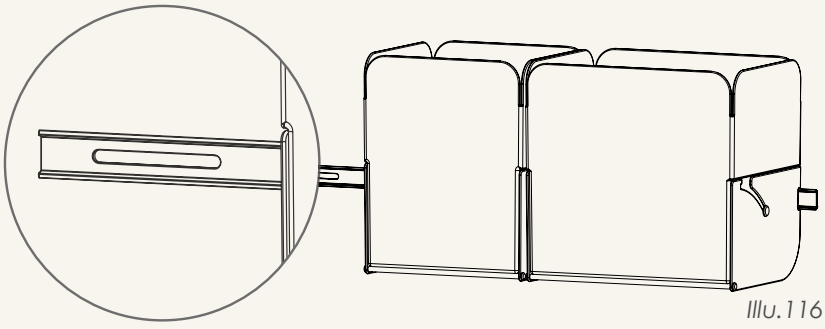
PP plastic can be sourced from the company Genplast, that recycle material from the medicine industry. Recycled PP is difficult to make white, as the machine that sorts the pellets has a margin of error, that adds a few colored pellets in the mix. Therefore grey, black or colored products are best (c.f. Appx. 22).

43

Aluminium rail

The rail can be found as a standard component and be sourced from a manufacturer that extrudes aluminium and CNC cuts the screw holes in the rail (Alu-Verkauf GmbH, 2024).

By extruding the aluminium, it is also possible to get the desired dimensions and lengths to create a lightweight rail that is both strong and resilient (Aluminum Extruders Council, 2024).


Illu.116

Standard components

Due to the following components being standard components, they will be sourced from different manufactures in the desired proportions as they are easily adaptable. The following shows examples of the needed components.

Chicago screws

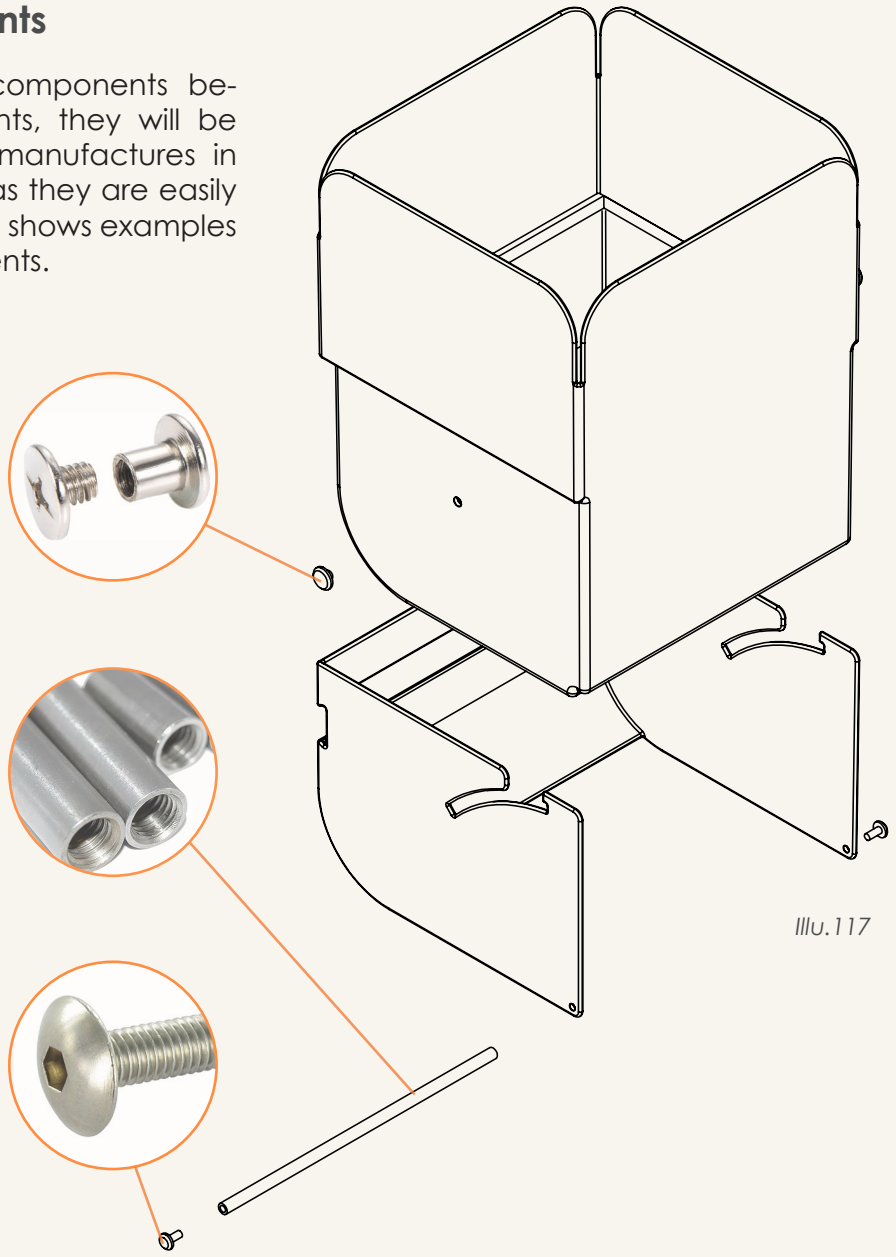
For the tilting function, chicago screws are assembled through the two holes on each side of the inner buckets. They can be tightened with a regular screwdriver.

Metal rod

Metal rod with internal threads in both ends.

Fasteners

The two fasteners to hold the rod in place will be a flatheaded screw compatible with an Umbraco tool.



Illu.117

New requirements

43 ***Plastic parts can not be white***

4.2 Production costs

This section will present the results of the cost calcution of the different parts of the final products, and its final production price. (c.f. Appx. 23)

Injection moulding

The students had previously been in contact with the production companies Genplast and Vink Moulding, in relation to another project. Therefore, data from those conversions are retracted, and a sum-up can be found in appendix 22.

Recycled PP plastic price at Genplast

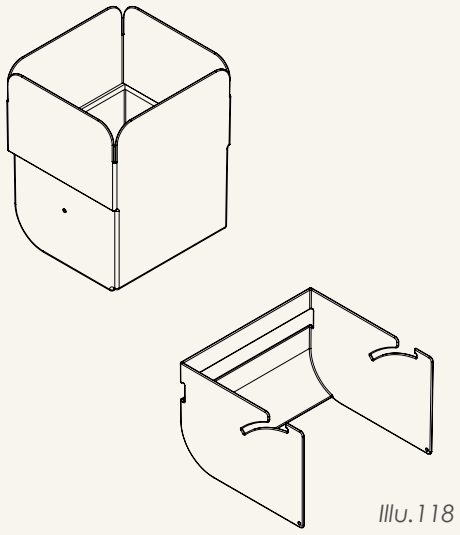
6.5 DKK/kg

2-cavity-mould price from Vink Moulding

300,000 DKK

16 cm fraction

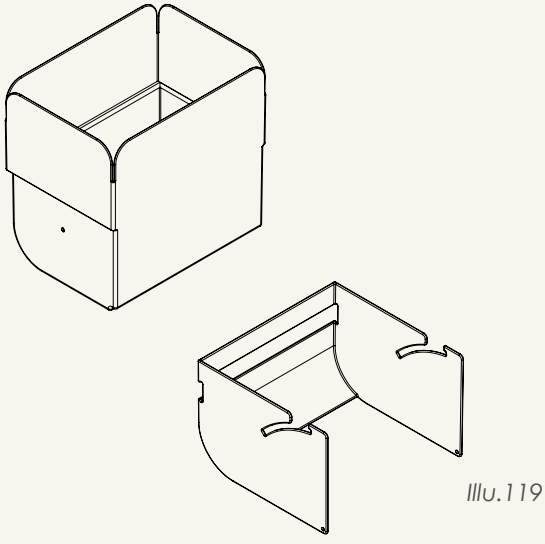
Bucket	
Material price	6.5 DKK/kg
Projection area	22,330 mm^2
2-cavity-mould price	300,000 DKK
Cycle time	40.8s
Hourly machine costs	174.6 DKK/hour
Total price per unit	***14.11 DKK***
Holder	
Material price	6.5 DKK/kg
Projection area	16,000 mm^2
2-cavity-mould price	300,000 DKK
Cycle time	37.0s
Hourly machine costs	174.6 DKK/hour
Total price per unit	***13.04 DKK***



Illu.118

21 cm fraction

Bucket	
Material price	6.5 DKK/kg
Projection area	29,580 mm^2
2-cavity-mould price	300,000 DKK
Cycle time	41.9s
Hourly machine costs	174.6 DKK/hour
Total price per unit	***14.41 DKK***
Holder	
Material price	6.5 DKK/kg
Projection area	21,000 mm^2
2-cavity-mould price	300,000 DKK
Cycle time	37.2s
Hourly machine costs	174.6 DKK/hour
Total price per unit	***13.10 DKK***



Illu.119

Aluminium rail

The price for the rail will be estimated based on a U-profile rail from the company Alu-Verkauf.de in Germany in the dimentions we would need.

36 cm	**23.05 DKK**
46 cm	**23.05 DKK**
56 cm	**27.15 DKK**

Fasteners

The fasteners for the rod can be sourced from Skrue-ekspres.dk

Price for minimum purchase of 200 = 1.04 DKK/unit

Rod

The price for the rod will be estimated on a tube from the company Aliexpress

5x2x250mm	**9.78 DKK**

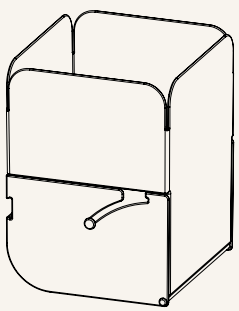
Chicago screws

The Chicago screws will be sourced from a manufacturer Hand Industrial Co., Ltd

Price for minimum purchase of 1000 = 0.07 DKK/unit

Total production price for 16 cm fraction

Bucket	14.11,-
Holder	13.04,-
Rod	9.78,-
Fasteners (2 pcs)	2.08,-
Chicago screw sets (2pcs)	0.14,-
Total price per unit	**39,15 DKK,-**



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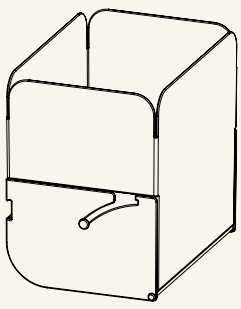
Total production price for 21 cm fraction

Bucket	14.41,-
Holder	13.10,-
Rod	9.78,-
Fasteners (2 pcs)	2.08,-
Chicago screw sets (2pcs)	0.14,-
Total price per unit	**39,51DKK,-**



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4.3 Business strategy for primary buyer

This section will build the foundation for the business strategy emphasizing the choices made for the first year of the business and how they will reflect on the bottom line of the estimated CVP that can be further explored in appendix 24.

Housing associations as primary buyer

Housing Associations are the primary customer due to the framing of this project as it has been proven to have a bigger potential to get people to sort '2.0 Framing - Two business cases'. One customer will therefore be buying larger quantities instead of one customer only buying one system, enabling a made-to-order strategy.

This however sets some requirements to market the product and sufficiently acquire customers. In Denmark there are about 593,000 apartments that are run by 511 housing associations (Landsbyggefonden, 2024). By using cold canvasing and seeking out the customers it is estimated that with a market share of 1% of the potential market could be a realistic starting point for the business. This equals to 5,930 apartments which is equivalent to approximately 5 housing associations.

It is foreseen that the apartments within the potential market share would come from multiple housing associations as it would be unrealistic that a housing association would replace the solution for all their apartments at once but rather test it out in some complexes and install the new solution between renting out the apartment and expand it from there (c.f. Appx. 8).

A B2C strategy is still a part of the business vision but to make the following calculations tangible, and have a realistic estimation of the business, only housing associations are taken into account.

Potential market			
What	**Value**	**Unit**	**Source**
Apartments in DK	1.434.000	pcs	(Nordicals, nd.)
Apartments run by housing association (HA)	592.959	pcs	(Landsbyggefonden, 2024)
Privately owned apartments	841.041	pcs	
Complexes throughout DK	7.257	pcs	-II-
Housing associations (HA) in DK	511	pcs	-II-
Mean number of apartments per complex	82	pcs	
Mean number of complexes per HA	14	pcs	

Table 1 : Potential market

Additional information		
What	**Value**	**Unit**
Assumed yearly market share	0,01	market share/year
	5.930	Apartments/year
	5	Housing associations /year
	1160	Apartments/HA
System w. Rail (36)	2	Rail (36)
	4	System (16)
	33%	% of the potential market
System w. Rail (46)	2	Rail (46)
	4	System (21)
	33%	% of the potential market
System w. Rail (56)	2	Rail (52)
	4	System (16)
	2	System (21)
	33%	% of the potential market
Estimated product use for the market share	3.953	pcs. / total of Rail (36)
	3.953	pcs. / total of Rail (46)
	3.953	pcs. / total of Rail (56)
	15.812	pcs. / total of System (16)
	11.859	pcs. / total of System (21)

Table 2: Additional information

Optimal system composition

As seen in '3.0 Detaling - Dimentions, system & form' the bucket sizes were optimized. Three standards are created for the foundation of the following CVP calculation where it is assumed that all three sizes combinaision stand for 33% of sells (c.f. Table 2: Additional information).
These systems are called Rail (36) system, Rail (46) system, and Rail (56) system respectively to the size of rail they use. Each system also consists of two rows, two rails each and the buckets fitting for the rails.

Initial cost volume profit

Fixed costs		
Various	Prototyping	20.000,00 DKK
	Marketing	55.000,00 DKK
	2x flex office spaces	28.800,00 DKK
	Total fixed costs	**103.800,00 DKK**

Variable cost per unit		
	System (16)	**System (21)**
Bucket	14,11 DKK	14,41 DKK
Holder	13,01DKK	13,10DKK
Rod	9,78 DKK	9,78 DKK
Fasteners (2pcs)	2,08 DKK	2,08 DKK
Chicago screws (2pcs)	0,14DKK	0,14DKK
Total	**39,15 DKK**	**39,51 DKK**
Rail - 38 cm		**23,05 DKK**
Rail - 46 cm		**23,05DKK**
Rail - 56 cm		**27,15 DKK**

Variable costs			
		total	**per system**
Manufacturing	Rail (36)	400.642,63 DKK	202,70 DKK
	Rail (46)	403.488,83 DKK	204,14 DKK
	Rail (56)	573.035,58 DKK	289,92DKK
Transport & Storage	transport (genplast - Vink moulding)	2.219,30 DKK	0,37 DKK
Packaging	pallet	10.544,76 DKK	1,78 DKK
	cardboard	1.124,04 DKK	0,19 DKK
	tape	86,74 DKK	0,01DKK
	plastic wrap	753,96 DKK	0,13DKK
	Total variable cost	**1.391.895,84 DKK**	
	Total variable cost per Rail (36) system		**205,18 DKK**
	Total variable cost per Rail (46) system		**206,62 DKK**
	Total variable cost per Rail (56) system		**292,40 DKK**

Table 3: Initial CVP

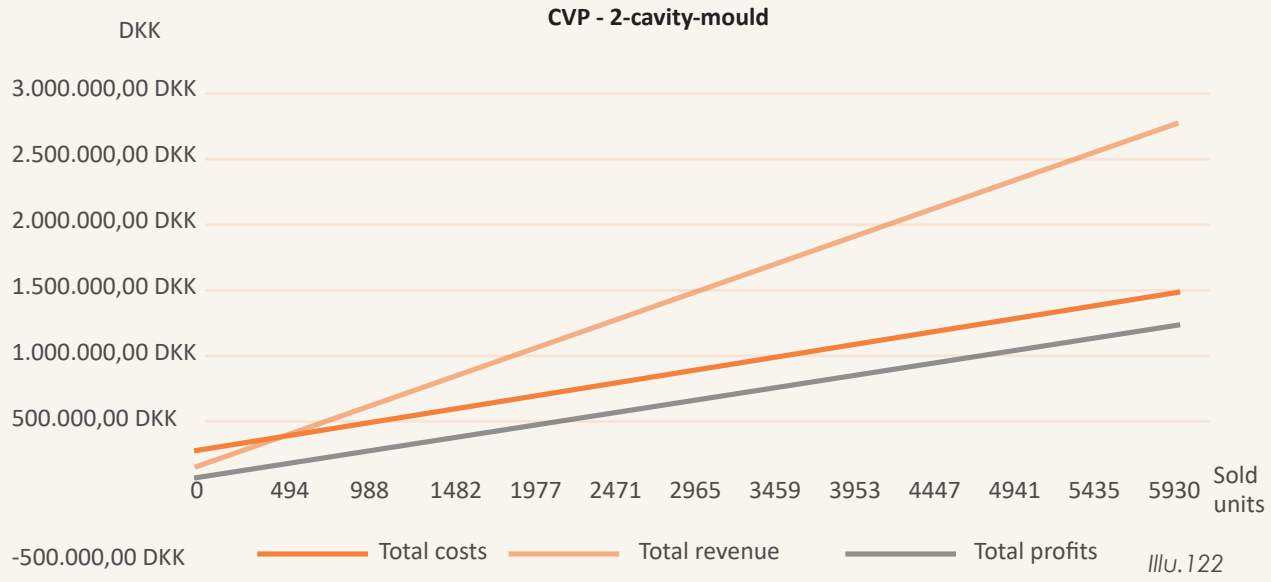
Contribution margin per unit	
Sales prices per Rail (36) system	410,37 DKK
Total variable costs per Rail (36) system	205,18 DKK
Contribution margin per Rail (36) system	**205,18 DKK**
Sales prices per Rail (46) system	413,25 DKK
Total variable costs per Rail (46) system	206,62 DKK
Contribution margin per Rail (46) system	**206,62 DKK**
Sales prices per Rail (56) system	584,81 DKK
Total variable costs per Rail (56) system	292,40 DKK
Contribution margin per Rail (56) system	**292,40 DKK**

Total costs	
Total fixed costs	103.800,00 DKK
Total variable costs	1.391.895,84 DKK
Total costs	**1.495.695,84 DKK**

Maximim profit	
Maximum revenue	2.783.791,69 DKK
Maximum profit	**1.288.095,84 DKK**

Breakeven point, systems	Systems in total	Breakeven i housing associations
447	5.930	1

Table 3: Initial CVP



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Subconclusion

With this CVP there is a great profit after the first year. This is due to the low fixed costs and that the investment for the 2-cavity moulds that are considered in the unit price. However, the 2-cavity-mould might not be necessary in comparison to how many units it can actually make a year. It could therefore be beneficial to look into how the CVP would look if only 1-cavity-moulds were used instead.

CVP with 1-cavity-moulds

Contribution margin per unit	
Sales prices per Rail (36) system	362,37 DKK
Total variable costs per Rail (36) system	181,18 DKK
Contribution margin per Rail (36) system	**181,18 DKK**
Sales prices per Rail (46) system	365,25 DKK
Total variable costs per Rail (46) system	182,62 DKK
Contribution margin per Rail (46) system	**182,62 DKK**
Sales prices per Rail (56) system	512,81 DKK
Total variable costs per Rail (56) system	256,40 DKK
Contribution margin per Rail (56) system	**256,40 DKK**

Variable cost per unit		
	System (16)	**System (21)**
Bucket	11,11 DKK	11,41 DKK
Holder	10,04DKK	10,10DKK
Rod	9,78 DKK	9,78 DKK
Fasteners (2pcs)	2,08 DKK	2,08 DKK
Chicago screws (2pcs)	0,14DKK	0,14DKK
Total	**33,15 DKK**	**33,51 DKK**
Rail - 38 cm		**23,05 DKK**
Rail - 46 cm		**23,05DKK**
Rail - 56 cm		**27,15 DKK**

Total costs	
Total fixed costs	103.800,00 DKK
Total variable costs	1.225.867,32DKK
Total costs	1.329.667,32 **DKK**

Maximim profit	
Maximum revenue	2.451.734,65 DKK
Maximum profit	**1.122.067,32 DKK**

Breakeven point, systems	Systems in total	Breakeven i housing associations
507	**5.930**	**1**

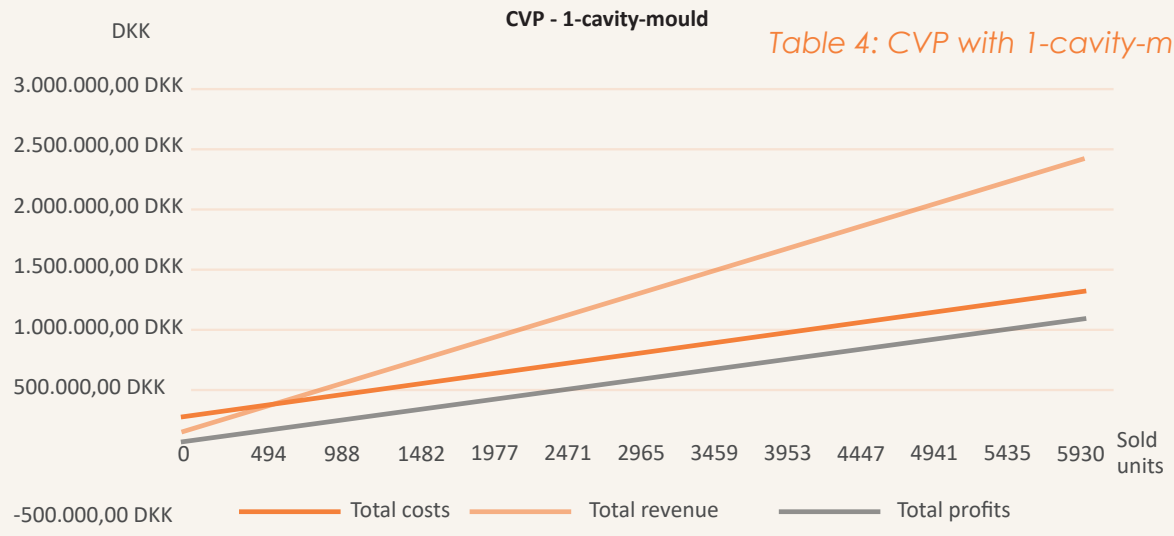


Table 4: CVP with 1-cavity-mould

Illu.123

Subconclusion

With only having 1-cavity-moulds for the manufacturing of the systems the break-even point is a bit higher with 60 more systems that needs to be sold and the maximum profit has dropped with approximately 166.000 DKK. This is due to the cost for the systems being lower and thereby lowering the sales price, as they are estimated as the double of the cost, creating a smaller contribution margin per system.

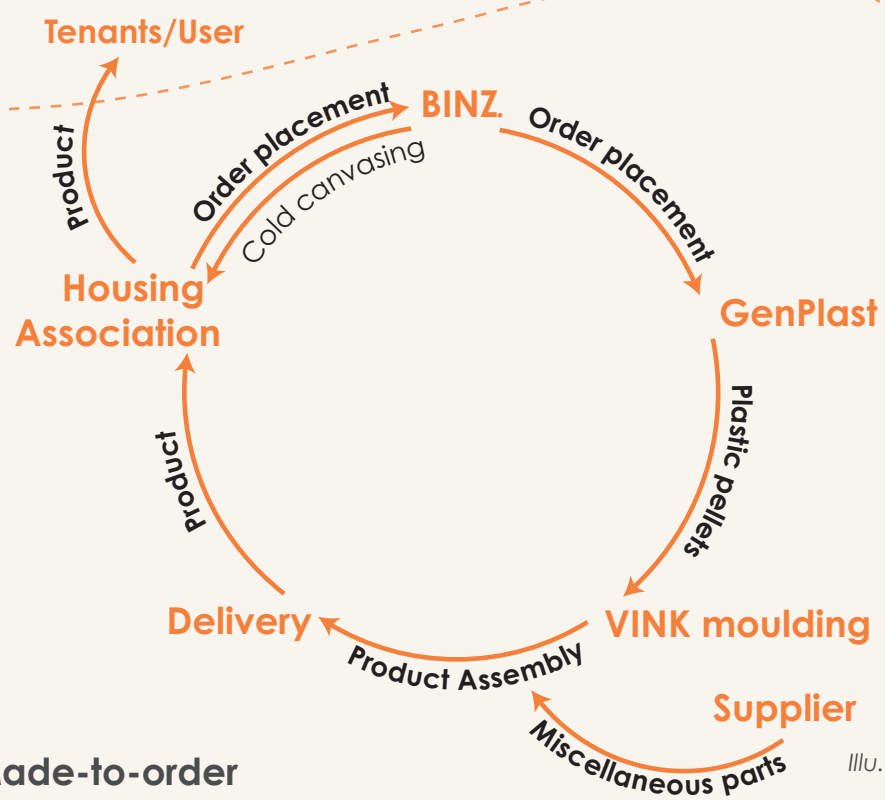
Even though this gives a lower profit in the end it may benefit the business case as the sales price of the systems will become more competitive and better to pitch for the housing associations. Moreover it lowers the affordable loss.

4.4 Supply chain

The following section illustrates on a logistic level how the structure of the business will potentially look. It will enlighten where the different stakeholders are placed in relation to each other. From now on, the product will be called Binz.

Cold canvassing

In the beginning of a sale the products are introduced to the housing associations by seeking them out, promoting the product through presentations. This is a more costly approach making each customer expensive to reach. However, as each customer willmost likely place big orders, the costs will be distributed accross bigger quantities of sold units.



Illu.124

Made-to-order

With a 'Made-to-order'-strategy the number of systems the housing associations have ordered will be sat in production. Here an order will be sent further for materials at GenPlast and the manufacturing at VINK moulding. When the sufficient parts have been made, the additional parts from miscellaneous suppliers are added and shipped to the customer.

Installation

Since the systems require drilling holes and some tools to be installed, the housing associations can install the systems in between the tenants.

Marketing through cold-canvassing, e-mail newsletters and social media.

Exact number of buckets in sizes 16 cm and 21 cm specified after customer need

Amount of material is calculated and placed at GenPlast

Recycled PP plastic from the medical industry is collected and send to Vink Moulding

Production line for both bucket sizes and holders.

Chicago screws, rail, rod and fasteners.

Packaging (bucket, holder and miscellaneous parts as one system)

System is installed by housing associations' handy man.

Strategy changes for B2C

An expansion to the consumer market would require some strategy changes. A new marketing strategy can be made by being present in several retail stores like interior shops on kitchen showrooms that will advertise the sorting system, or/and through online activities on social media.The marketing post will surely be bigger in a B2C constellation, but the market for privately owned apartments is also bigger (c.f. Appx.24) which still means that each customer takes more to convince. Although, the market is already filled with many sorting products and there is therefore a lot of competition. The following shows the retail price for each Binz system, based on the estimation that the retailer will want a 50% margin.

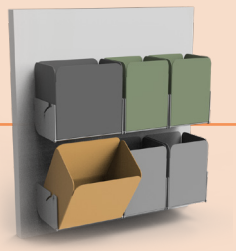
Price /system	System 16 (1 unit)	System 21 (1 unit)	Rail 36	Rail 46	Rail 56
Cost	33.15 DKK	33.51 DKK	23.05 DKK	23.05 DKK	27.15 DKK
Price for retailer	66.30 DKK	67.02 DKK	46.10 DKK	46.10 DKK	54.30 DKK
Price for consumer	132.60 DKK	134.04 DKK	92.20 DKK	92.20 DKK	108.60 DKK

Table 5: Price estimation

The following shows how Binz' price compares to some products from the biggest competitors on the market.

149,95. - per unit

(Amager Isenkram, 2024)



approximately 135.- per unit + rail (920.- for a system of six)

1265 ,-

(AnKøkken, 2023)

475. - per unit (1900.- for four)

(Susanne Schmidt ApS, 2024)

price

Illu.125

In comparison to existing products, Binz provides good value for money. It is cheaper that the classic rail solutions under the sink and can competes as well on the aesthetical aspect with the wall hanged solution which gives it more functionality and longer lifetime as it can be used on the wall as well. Binz can be assembled in sets of the costumers' choice, and therefore can also bring the customizing features like Brabantia or Ikea.

Subconclusion

To conclude, Binz has good potential within the consumer market on a product level. It can though be discussed whether the business case is strong enough with only one product, or if the opening for consumer market would have bigger benefits after scaling the business to other products or variants of Binz.

4.5 Future perspectives

The next section presents how the rail system can be adapted and used to other scenarios than on the door under the sink. As mentioned in '3.0 Detailing - Pivot'. it was important to take into consideration users moving, changes of needs or kitchens being redesigned and having another inventory under the sink. Therefore, the possibility of making the system wall hanged is also interesting. To do so, previous requirements for wall hanging systems are reevaluated and will dictate how variants or add-ons can fit the user needs in new contexts.

Add-ons: meeting aesthetical requirements

There are different needs according to the context and use of a sorting system. Under the sink, the trash is hidden and therefore the requirements are only functional and practical. Although, as soon as the products are visible in the room, there are some other requirements. There must not be odors from the waste and therefore must have a lid. Moreover, it has more value if it fits aesthetically into the rest of the home/kitchen interior.

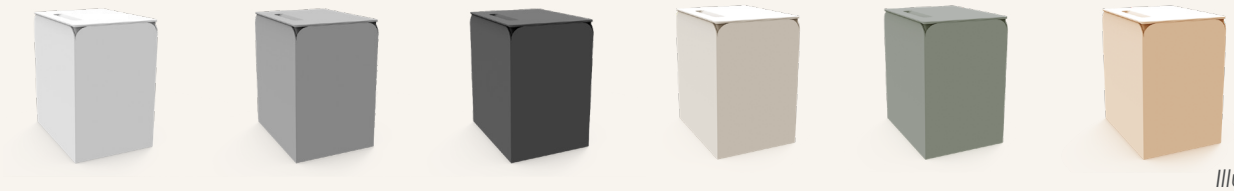
*"**When it's inside a cupboard it doesn't need a lid**, but if it's outside we don't want to see our trash" Anders (c.f. Appx. 5)*

Wall hanged solution and different colors

6

Illu.126

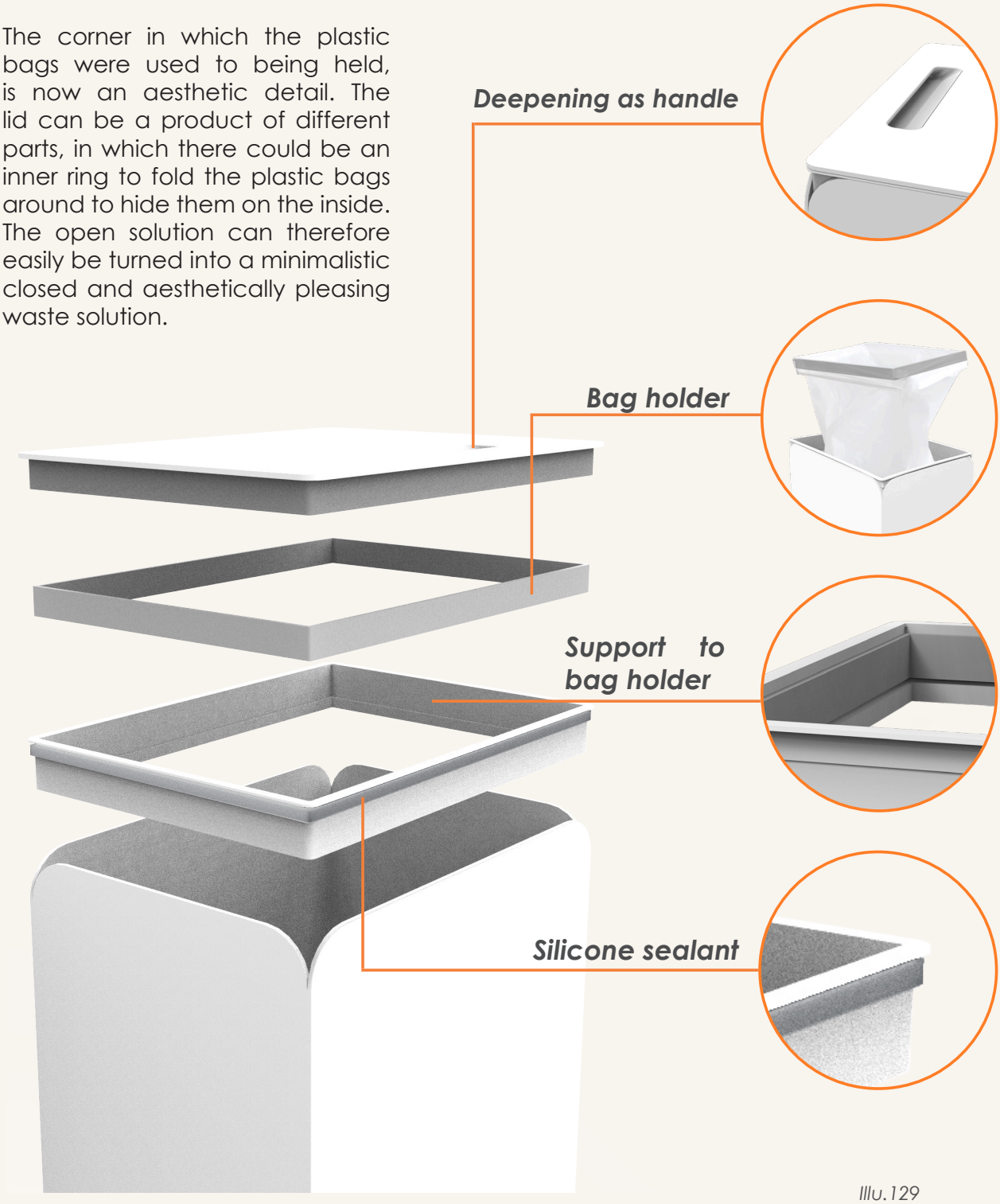
Illu.127



Illu.128

Lid to contain smell when not under the sink

The corner in which the plastic bags were used to being held, is now an aesthetic detail. The lid can be a product of different parts, in which there could be an inner ring to fold the plastic bags around to hide them on the inside. The open solution can therefore easily be turned into a minimalistic closed and aesthetically pleasing waste solution.



Illu.129

DESIGN BRIEF 4.0

Vision statement

We want to aspire people to see a greater value in waste materials by making waste handling an unconscious part of the everyday life and change the behavioural norms towards waste handling.

Mission statement

We want to eliminate the use of single residual waste solutions and replace it with correct, non-invasive sorting systems for kitchens in smaller apartments and make it the new standard for kitchen inventory.

Problem statement

How can we design a solution that replaces the current residual waste bag with a compact, open sorting system for the most recurrent household waste that utilizes the available space under the sink?

Customer

Contract markets such as housing associations but also private appartment owners and eventually kitchen companies.

User

Apartment residents or owners with small kitchens.

Value proposition

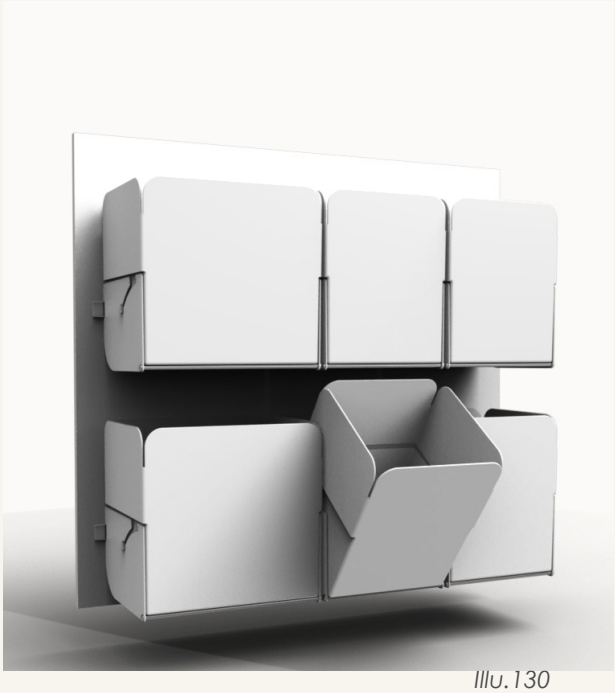
The product proposal offers a long-term, intuitive and open sorting system under the sink without adding extra interactions to the user's current behaviour. With two different sizes fractions, the system is customizable after the individuals' needs and local sorting requirements. The inner buckets can easily be removed to e.g use while cooking or for cleaning. A tilting system gives easy access to the lower row, without compromising the storing volumes. Binz brings moreover housing associations an affordable sorting solution for their residents to sort correctly on their buildings' properties and avoid economic consequences.

Requirements

1. ***Must fit in different municipalities***
2. ***Must be divided into several fractions***
3. ***The fractions should be visually divided***
6. ***Should be disposable***
7. ***Can be sorted by the bins***
8. ***Odors from dirty waste must be contained***
9. ***Dirty waste must not be touched after throwing it out the first time***
10. ***Dirty waste shouldn't need washing.***
12. ***Plastic should have more space than other compartments.***
14. ***Shouldn't take space from other storage units***
15. ***Should be easy to implement***
16. ***Should need minimal interactions***
18. ***Must replace the residual waste in the hanger***
19. ***Must have a lid if the trash is visible***
20. ***Must have clear, solid dividers***
21. ***Fractions must not take space from each other***
22. ***Inner bags must be held in place***
23. ***Must not collide with kitchen while using***
24. ***Plastic/metal fraction should fill more than residual waste***
25. ***Fractions should be minimum 15x15cm***
26. ***Should utilize the available space in all sizes of cupboard doors***

Market & business

In the first year the focus will be kept on housing associations, where the marketing strategies will be kept on cold-canvassing and a made-to-order strategy to keep the investments and affordable losses at a minimum. After the breakeven point, the profit will be reinvested in more marketing such as social media and entering retails shops such as furniture or kitchen stores. Eventually, further reinvestment in product scaling can be made to allocate some of the initial costs in production and marketing and cover more of the market for sorting systems.



Illu.130

Rail system on the cupboard door under the sink

27 *Maximum module height of 25cm*

28 *The shape must not compromise the volume*

29 *Must not collide with the pipes or sink*

30 *Must not collide with upper bucket*

31 *Can be kept in tilted position*

32 *Must withstand pushing down waste and accidental knocks from below*

33 *Installation must allow for some margin of error*

34 *Can be guided in placed without colliding with the holder*

35 *Must not puncture plastic bags*

36 *Should be able to carry 3-4 bags in the same hand*

37 *Maximum bucket height of 20cm*

38 *Must be water resistant*

39 *Must be resistant to chemicals*

40 *No water stagnation in crevices*

41 *Should have a uniform wall thickness*

42 *The whole solution should weight max. 3 kg*

43 *Plastic parts can not be white*

Wishes

1 *There mustn't be doubt on where to put specific waste*

2 *Should be integrated in the kitchen*

4 *Can be emptied on the way out*

6 *Should have an aesthetical value*

7 *Should have adaptable fractions*

5.0 EPILOGUE
Reflection & Conclusion

The last chapter of the thesis presents a thorough reflection on the design process, the methodological approaches used in the project development as well as an assessment of the achievements of the overall project goal and motivations. There will be focus on how the product can be improved and how future work on the subject might be tackled based on the experiences in this project. The final product will be evaluated according to its actual potential impact on the users and the environment. Lastly, an illustration and reference list will be found on the last pages.

Reflection

Looking back on the design process, there are a lot of aspects that can be discussed for future work on the project proposal. From a methodological perspective, the use of some tools can be discussed in comparison to their purpose. Additionally, the final product will also be assessed according to its actual social and environmental benefits. A final evaluation is crucial for future iteration and to align the methodological approaches with the product to assess the overall goal of this project.

Methodological Approaches

The project framing processes have illustrated several factors on waste handling that often escape the awareness of both users and designers. User behaviour towards waste handling is deeply influenced by subconscious habits, social acceptance, and concrete practicalities. Reflecting on the tools used by the students to gather data is although essential to ensure more qualitative iterations in potential future work on the subject (c.f. '0.2 Methodology'). The most used tool, 'Situated interview' can be discussed as it is questionable whether the presence of the students and the presentation of the project topic might have influenced the opinion of the users, making them more prone to say what they think would be helpful for the project. A sense of "shame" could moreover have affected the honesty about their 'bad' waste sorting habits. Considering alternative methods, such as shadowing of relevant situation such as cooking or cleaning, or change interviewees more frequently, could provide a broader understanding of behaviours without the same level of bias. It could also have been beneficial to distinguish between data on behavioural changes over time with the product in use, feedback on concept ideas, and interviews on waste handling behaviours. Using different users for each data collection could therefore have brought more objective results. The users' behaviour has e.g. improved their sorting habits during the project, but it is unclear whether this was due to heightened awareness on the subject or the product's successful function of easier sorting.

Apprenticeship Method

During the project the 'Apprenticeship' method has been used to collect data although the students have had difficulties assessing when to use it and when they might have a too subjective influence on the project. Consequently, valuable data was actually unused in the project

and could have been beneficial. The students have e.g. mapped out exactly when and how much they emptied the different types of waste over a longer period of time with the current concept, to get an idea of the frequency and thereby the most appropriate volumes for the solutions. Though, it has not been used qualitatively in the paper, and instead as more unconscious data probably biasing following relevant decisions.

Post-Pivot Testing

After the pivoting point of the project (c.f '3.0 Detaling - Pivot') with a change of product, the quality of the tests decreased significantly. Time has certainly had a big impact by the time of pivoting, which resulted in the final product not being user-tested in its totality as it had been with the previous bag concept. Indeed, with the bag concept, a minimal viable product was very easy and straightforward to build and resembled much the potential final product. In contrary, testing the rail system required a lot more. In retrospect, it could have been beneficial for the students to take some time and tailor the tests specifically according to the exact feedback that they needed, and make prototypes that could represent that, to gain some time. E.g. the lower rail and the tilting have not been tested with the users, but only on a construction level with 3D printed models. As it is the most crucial function of the product, it could have been beneficial to have it tested.

Bag vs. Rail System Impact

Pivoting from the bag to the rail system can be discussed. The arguments for changing product direction were due to concerns on the bag being difficult to see in a business scenario where the cabinet door was removed, or other potential contexts, making the business case short sighted. Even though the volume and number of fractions give better predispositions for sorting correctly in the right fractions, it is still questionable which solution in the end would have the actual biggest positive impact. The framing of the project has clearly shown that motivating users to actively go out and purchase a sorting solution without a bigger purpose or consequence for not sorting, is very difficult and the requirements for the product are many. The entry point of this project was therefore to design a solution that was attractive for other stakeholders that have an interest

in people being better at sorting. Here, the housing associations were a very interesting customer, as they get fines and other economic consequences from their residents not sorting correctly and frequently. But to be very attractive for them, the solution must be compact, cheap, and not require any costs regarding installation.

The bag might not offer as many fractions as the rail system, but it still had a great potential of getting a lot of people to sort at least three fractions, even if some waste still goes unsorted. Even though the rail system is still targeting housing associations, the impact might not be as big, as the price most likely will be too high for many. It can therefore be discussable which case would have the greatest social and environmental impact, and if the pivoting of the project still would have happened, if business and future perspectives had been left out of the equation.

On the one hand, a compact, maybe short-term solution, free for the users, cheap for the buyer, that creates new 'normal' by making sorting in at least three fractions another subconscious habit. On the other hand, an effective sorting solution that also has potential of feeding into the existing habits of the user but might only be seen in a smaller percentage of the user homes, as the higher price makes it less attractive for housing associations and expensive if bought in retail shops.

Conclusion

During this project, many facets and complexities of waste handling has been gathered. This project might have highlighted some interesting aspects and principles to move towards creating a new normal, but there are still a tremendous number of unsolved problems that partially are in the hand of designers. The users of this project as well as the students themselves, have shown and experienced how habits steer our everyday flow. Placing an open, non-invasive solution at the exact spot where the current waste disposal solutions are, were shown to be successful and not disturb the flow, other than having to think twice before the disposal and taking more than one bag out when going out anyway. On a product level, the rail system can have some potential of fulfilling both the current needs of easy waste handling

solution, but also as a space optimiser in a place where the users normally never organise. As a business proposal, Binz proposes both functional but also aesthetical values, that opens up the possibilities of other use than under the kitchen sink. With its pivoting and removable buckets, the fractions are still easily accessible and make the interactions as short as possible, even in a future context where they could be hanged on the wall. The solution is moreover also perfectly adaptable to other use disregarding waste handling as e.g. an organiser for kids' toys, or bathroom organisers, which prolongs the product lifetime. Although Binz fits right in the needs and wishes for the private market, the main target customer for this project has been housing associations, as they have the biggest influence in 'forcing' behaviour changes in their resident's everyday life. Binz' requires installation by a handy man, but still is very attractive to keep track on waste handling and disposal on the associations' properties, escaping economic consequences. Binz' form and material choice have no impacts on price but are meticulously chosen to meet the functional requirements and also the aesthetical ones. Binz values local production and use of recycled PP material from the medicine industry. With further business expansion, the product price can fall in parallel with the production 'batches' being bigger, making it better fit to the market for housing associations.

To change the core of the problem there are still some boundaries to what a single product can do. In combination with bigger investments in better functioning sorting solutions in the urban space, as well as better awareness on the subject in education, there might be some potential in Binz being a very helpful and functional sorting system for smaller households with plenty of room for improvements.

Bibliography

Affaldsbekendtgørelsen, 2012. [Online] Available at: < https://www.retsinformation.dk/eli/lta/2012/1309 > [12-05-2024]

Aluminum Extruders Council, 2024. Aluminum Extrusion Features & Benefits. [Online] Available at: < https://aec.org/features-benefits > [13-05-2024]

Alu-Verkauf GmbH, 2024. Alu-profiles-U-profiles. Alu-Verkauf.de. [Online] Available at: < https://alu-verkauf.de/en/products/aluminium-profile-u-profile?_gl=1*1c926h1*_up-*MQ..&gclid=CjwKCAjwouexBhAuEiwAtW_ZxycnzBQkPQuuwFiTbk2JHSrTxEfWoLAoMcx-jQCID6rJJiBgPVv7MnBoCxFgQAvD_BwE > [13-05-2024]

Amager Isenkram, 2024. Brabantia Affaldsspand m/ Låg 6 Ltr. - Grøn. Amagerisenkram.dk [Online] Available at: < https://amagerisenkram.dk/produkt/brabantia-affaldsspand-m-laag-6-ltr-groen/ > [13-05-2024]

AnKøkken, 2023. BLANCO BOTTON II 30/2. Ankøkken.dk [Online] Available at: < https://xn--ankkken-s1a.dk/produkter/ankoekken/affaldssystemer/spandesystemer/blanco-botton-ii-30-2 > [13-05-2024]

Ensinger, 2024. PP Plastic – Polypropylene. [Online] Available at: < https://www.ensinger-plastics.com/en/thermoplastic-materials/pp-plastic > [13-05-2024]

Flyvbjerg, A., Hansen, L. B., Heltborg, A. P., Fick, T., Iversen, S., 2023, Vi er for dårlige til at sortere vores affald: 'Alt der, jeg er i tvivl om, ender i restaffald', DR, [Online] Available at: < https://www.dr.dk/nyheder/regionale/syd/vi-er-daarlige-til-sortere-vores-affald-alt-det-jeg-er-i-tvivl-om-ender-i > [12-05-2024]

Foli-Awli, M., 2023. Design Thinking Tool: Unlock Insights with the powerful Affinity Clustering Technique. Pulse [Online] Available at: < https://www.linkedin.com/pulse/design-thinking-tool-unlock-insights-powerful-mawusee/ > [13-05-2024]

Galán, S. K., 2019. Sociolog: Affaldssortering skal være normalt og ikke til forhandling. Videnscentret Bolius. [Online] Available at: < https://www.bolius.dk/sociolog-affaldssortering-skal-vaere-normalt-og-ikke-til-forhandling-98230 > [12-05-2024]

Griskevicius, V., Tybur, J. M., Bergh, B. Vd., 2010. Going Green to Be Seen: Status, Reputation, and Conspicuous Conservation. Journals of Personality and Social Psychology. [e-jour-nal] 98(3). Page 392-404. Available at: < https://assets.csom.umn.edu/assets/140554.pdf > [12-05-2024]

Hartman, K., n.d. A summary of the book: The Lean Startup – How today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. [PDF] Available at: < https://www.kimhartman.se/wp-content/uploads/2013/10/the-lean-startup-summary.pdf > [13-05-2024]

Hasso Platner Institute of Design, n.d., An introduction to Design Thinking Process guide. [PDF] Available at: < https://web.stanford.edu/~mshanks/MichaelShanks/files/509554.pdf > [13-05-2024]

Kanade, V., 2022. What is Finite Element Analysis? Working, Software, and Applications. Spiceworks. [Online] Available at: < https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-finite-element-analysis/ > [13-05-2024]

Katan, L., 2021, Vi skal gøre op med skraldespandens modsatrettede kommunikation. ING/ Wastetech, [Online] Available at: < https://pro.ing.dk/wastetech/holdning/vi-skal-goere-op-med-skraldespandenes-modsatrettede-kommunikation > [12-05-2024]

Kristiansen, S. M., 2015. Børn skal lære deres forældre om affald. DR. [Online] Available at: < https://www.dr.dk/nyheder/regionale/syd/boern-skal-laere-foraeldre-om-affald > [12-05-2024]

Landsbyggefonden, 2024. Almene Data. Almenedata.dk [Online] Available at: < https://almenedata.dk/ > [13-05-2024]

Lou, H., Zhao, L., Zhang, Z., 2020, The impacts of social interaction-based factors on household waste-related behaviors. Waste Management. [e-journal] 118. Page 270-280. Abstract only. Available through: < https://doi.org/10.1016/j.wasman.2020.08.046 > [12-05-2024]

Malinin, L., 2018. Situated Design-Thinking in Architectural Practice: Analyzing and Extending Schön's Epistemology. Ardeth. [e-journal] 2, page 52-75. Available at: < https://journals.openedition.org/ardeth/754?lang=fr#quotation > [13-05-2024]

Melito, S., 2022. The Ultimate Guideline to Injection Molding Tolerances. Fictiv. [Online] Available at: < https://www.fictiv.com/articles/injection-molding-tolerances-an-in-depth-look > [13-05-2024]

Melito, S., 2023. Polypropylene Injection Moulding. Fictiv. [Online] Available at: < https://www.fictiv.com/articles/polypropylene-injection-molding > [13-05-2024]

Mellerup, S. A., 2022, Forkert affaldssortering kan give gebyrer. Videncentret Bolius, [online] Available at: < https://www.bolius.dk/forkert-affaldssortering-kan-give-gebyrer-92525 > [12-05-2024]

Nielsen, P., Engedal, I., 2021. Støt børnehaverne i deres arbejde med at lære børn om affaldssortering. ING/Wastetech. [Online] Available at: < https://pro.ing.dk/wastetech/holdning/stoet-boernehaverne-i-deres-arbejde-med-laere-boern-om-affaldssortering > [12-05-2024]

Nordicals, n.d., Flere og flere bor til leje – og forskydningen mod lejebolig fra ejerbolig fortsætter. Nordicals.dk [Online] Available at: < https://nordicals.dk/om-nordicals/nyheder/flere-og-flere-bor-til-leje-og-forskydningen-mod-lejebolig-fra-ejerbolig-fortsaetter/ > [14-05-2024]

Protolabs, 2024. Draft Angle Guidelines for Injection Molding. PROTOLABS Manufacturing Accelerated. [Online] Available at: < https://www.protolabs.com/resources/design-tips/improving-part-moldability-with-draft/ > [13-05-2024]

Rambøll, 2022, Survey om affaldssortering, [PDF] Miljøstyrrelsen. Available at: < https://www2.mst.dk/Udgiv/publikationer/2022/01/978-87-7038-383-7.pdf > [12-05-2024]

Susanne Schmidt ApS, 2024. ReCollector affaldssorteringssystem. Susanne-schmidt.dk [Online] Available at: < https://susanne-schmidt.dk/produkt/recollector-affaldssorteringssystem/ > [13-05-2024]

Sperschneider, W., Bagger, K., 2003. Ethnographic Fieldwork Under Industrial Constraints: Toward Design-in-Context. International Journal of Human-Computer Interaction. [e-journal] 15(1) page 41-50. Available at: < https://doi.org/10.1207/s15327590ijhc1501_04 > [13-05-2024]

Tonglet, M., Phillips, P. S., Bates, M. P., 2004. Determining the drivers for household pro-environmental behaviour: waste minimisation compares to recycling. Resources, Conservation and Recycling. [e-journal] 42(1). Page 27-48. Available at: < https://doi.org/10.1016/j.resconrec.2004.02.001 > [12-05-2024]

Zeuthen, F. A., 2021. Én ud af tre danskere: Der er for besværligt at sortere affald. Fagbladet 3F. [Online] Available at: < https://fagbladet3f.dk/artikel/det-er-besvaerligt-sortere-affald > [12-05-2024]

References from product report

Flyvbjerg, A., Hansen, L. B., Heltborg, A. P., Fick, T., Iversen, S., 2023, Vi er for dårlige til at sortere vores affald: 'Alt der, jeg er i tvivl om, ender i restaffald', DR, [Online] Available at: < https://www.dr.dk/nyheder/regionale/syd/vi-er-daarlige-til-sortere-vores-affald-alt-det-jeg-er-i-tvivl-om-ender-i > [12-05-2024]

Himmerland Boligforening, 2024. Affaldsguide for Pontoppidanstræde. Abhim.dk [Online] Available at: < https://www.abhim.dk/afd9042/Om-afdelingen/Praktisk-info/Affaldsguide > [17-05-2024]

Melito, S., 2023. Polypropylene Injection Moulding. Fictiv. [Online] Available at: < https://www.fictiv.com/articles/polypropylene-injection-molding > [13-05-2024]

List of illustrations

Front and back page

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Illu. 3
[SDG_RECT__0006_E-WEB-Goal-11] n.d. [Image online] Available at:< https://www.humanrights.dk/tools/human-rights-guide-sustainable-recovery/sdg-11-sustainable-recovery > [14-05-2024]

Illu. 4
[e-web-goal-12] 2024 [Image online] Available at: < https://ojelectronics.com/floorheating/news/uns-sustainable-development-goal-12-takes-a-world-encompassing-view/ > [14-05-2024]

Illu. 5
[Goal-13-A] n.d. [Image online] Available at: < https://www.globalgoals.org/goals/13-climate-action/ > [14-05-2024]

Illu. 6
UTTENHAL, 2024 [affald01] [Image online] Available at: < https://freeobjvs.life/product_details/24169579.html > [14-05-2024]

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Self-made

Illu. 23
Christensen, S. K., 2017, [Skraldespand-1-1200x720] [Image online] Available at: < https://migogaalborg.dk/byen-har-faaet-nye-skraldespande/ > [14-05-2024]

Illu. 24
Rich, K. C., 2018, [Forsøg-med-affaldssortering-Valby-Tingsted-deling-450x236] [Image online] Available at: < https://www.valbylokaludvalg.kk.dk/sorter-dit-skrald-paa-tingstedet/forsoeg-med-affaldssortering-valby-tingsted-deling/ > [14-05-2024]

Illu. 25
Nielsen, N. H., 2022, [Aalborg-Forsyning-affald-container-1200x720] [Image online] Available at: < https://migogaalborg.dk/nedgravede-containere-affald-aalborg/ > [14-05-2024]

Illu. 26
[images] n.d. [Image online] Available at: < https://www.fors.dk/erhverv/erhvervsaffald/affaldssortering-for-virksomheder/ > [14-05-2024]

Illu. 27 – Illu. 32
Self-made

Illu. 33
[Plast Hard plast Kodbakke Sort Med folie-162741da] n.d. [Image online] Available at: < https://tonfor-sortering.dk/materiale/k%C3%B8dbakker-med-rester > [14-05-2024]
[Restaffald Beskidt emballage Nutella Marmelade Karry Dressing Uden lag-4682ace2] n.d. [Image online] Available at: < https://tonfor-sortering.dk/materiale/emballageglas-beskidte-og-med-indhold > [14.05.2024]
[Restaffald Beskidt metalemballage Makreldase-687ef3bf] n.d. [Image online] Available at: < https://tonfor-sortering.dk/materiale/d%C3%A5ser-beskidte > [14-05-2024]
[Restaffald beskidt plastemballage Smorbakke-495cadee] n.d. [Image online] Available at: < https://tonfor-sortering.dk/materiale/sm%C3%B8remballage > [14-05-2024]

Illu. 34 – Illu. 35
Self-made

Illu. 36
[affaldsboks-og-opbevaringboks-hvid] 2024 [Image online] Available at: < https://bybrorson.dk/produkter/1039-affaldsboks-og-opbevaringboks-hvid.html > [14-05-2024]

Illu. 37
[1140 9061427] n.d. [Image online] Available at: < https://www.jemogfix.dk/hailo-affaldssortering-mudtraek-3-x-10-liter/1140/9061427/ > [14-05-2024]

Illu. 38
Nielsen, A. K., 2023 [_P6A5287Ørnevej_kopier] [Image online] Available at: < https://www.minboligforening.dk/blog/2023/1/22/g-sammen-om-affaldssortering-i-boligforeningen > [14-05-2024]

Illu. 39
IKEA UK, 2017 [ef3345bc4c0b854211da2f830e23aa7e] [Image online] Available at: < https://se.pinterest.com/pin/642396334328091574/ > [14-05-2024]

Illu. 40
Organized, n.d. [OR800651-1000x1000] [Image online] Available at: < https://www.simply-organized.dk/produkt/affaldssorteringsspand/ > [14-05-2024]

Illu. 41
[ReCollector-affaldssorteringssystem.] 2024 [Image online] Available at: < https://susanne-schmidt.dk/produkt/recollector-affaldssorteringssystem/ > [14-05-2024]

Illu. 42 – Illu. 116
Self-made

Illu. 117
[61Fo1osngZL._AC_SX679_] 2024 [Image online] Available at: < https://www.amazon.nl/-/en/Buchbinderschrauben-Set-Kreuzkopfschraube-Stiftschraube-Chicago-Knopf-dekoration/dp/B07CWK7GBD > [14-05-2024)
[61nCDEDmeNL._AC_SX679_] 2024 [Image online] Available at: < https://www.amazon.de/-/en/Stainless-Threaded-Internal-Rustproof-Diameter/dp/B0B7S2TG2W?th=1 > [14-05-2024]
[skrue-kopskrue-sekskantet-fatning-4-m6x20-rustfrit-stal] n.d. [Image online] Available at: < https://www.skrue-ekspres.dk/skrue-kopskrue-sekskantet-hul-rustfrit-stal-plan-3220/6866-27242-skrue-kopskrue-sekskantet-fatning-4-m6x20-rustfrit-stal-3663072166813.html?SubmitCurrency=1&id_currency=3&utm_campaign=googleads&utm_source=shopping&utm_medium=English&gad_source=1&gclid=Cj0KCQjwxeyxBhC7ARIsAC7dS39baLvl_pmstxmRx07P3sAGNvNktxBL_UfkZLPmYdWr0V-uV6h_kjoaAr5FEALw_wcB > [14-05-2024]

Illu. 118 – Illu. 124
Self-made

Illu. 125
[ReCollector-affaldssorteringssystem.] 2024 [Image online] Available at: < https://susanne-schmidt.dk/produkt/recollector-affaldssorteringssystem/ > [14-05-2024]
[129841-Sort-Go-Waste-Bin-6L-Fir-Green-8710755129841_6-750x750] n.d. [Image online] Available at: < https://amagerisenkram.dk/produkt/brabantia-affaldsspand-m-laag-6-ltr-groen/ > [14-05-2024]
[planlaegning_vaelg-affaldssystem_botton-ii(1)] n.d. [Image online] Available at: < https://xn--ankkken-s1a.dk/guides/planlaegning/vaelg-det-rigtige-affaldssystem > [14-05-2024]

Illu. 126 – Illu. 130
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