THE TRANSLATION OF A BUSINESS STRATEGY TO A DESIGN STRATEGY:
A CASE STUDY ON THE REDESIGN OF A SILENCE BOX

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Industrial Design Engineering
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UNIVERSITY OF TWENTE.

VAN KEULEN INTERIEURBOUW

The translation of a business strategy to a design strategy: a case study on the redesing of a silence box

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PREFACE

I am proud to present this master thesis which explores the translation of a business strategy into a design strategy through a case study of a silence box. This research was conducted at Van Keulen Interieurbouw (VKI) in Nijverdal as a requirement for graduating with a master's degree in Industrial Design Engineering, with a focus on Management of Product Development at the University of Twente in Enschede.

This thesis had an initial objective that differed from its ultimate objective, making it intriguing for both my role as a designer and for academic outcomes.

I would like to express my gratitude to everyone who supported me during this process, particularly Ralph van den Berg, my supervisor at VKI, for providing unwavering support whenever needed. You have created a welcoming and very open working and learning environment at VKI. Furthermore, I am grateful to the employees of VKI who provided me with their time and expertise in answering my queries and contributing to this thesis.

I would also like to express my gratitude to Prof. dr. ir. Eric Lutters, my supervisor at the University of Twente, for his invaluable support, guidance, and feedback. Much has happened over the course of this project, and throughout these developments you have always provided me with guidance on how to navigate the changes and turn them into valuable contributions to the thesis.

Finally, I also want to thank my friends and family for their constant support and encouragement throughout this long project. In particular, I would like to thank Sabine Peters, who has been a constant source of inspiration and support in discussing any matters related to this thesis. I am truly grateful for this.

To conclude, this thesis aims to provide VKI with useful insights for their future endeavors and serve as a practical guide throughout the development process.

GLOSSARY

A few terms utilized in this thesis are translations of Dutch terminology. To provide clear understanding, these words are defined in this chapter and some are translated to Dutch.

Glass slat - Glaslat
: A profile that is mounted onto the glass and the adjacent pillars.

Baseboard - Plint (box 3)
: A frame mounted to the bottom of the wall or to the bottom of furniture to finish the wall or piece.

Modular - Modulair
: This term can be understood in different ways. According to Kwakman (2021) is the definition of modular product design: 'Bij een modulair productontwerp wordt rekening gehouden met de demonteerbaarheid waardoor het product, de onderdelen of materialen op een later moment gedemonteerd en hergebruikt kunnen worden' (Kwakman, 2021). Translated to English: 'A modular product design takes into account the disassembly that allows the product, parts or materials to be disassembled and reused at a later time. Definition of modular for this project: A product is considered modular if it can be disassembled and reassembled multiple times. Additionally, the individual parts or modules of the product can be used to construct a larger product, connect products together, or add value to the original product. Examples of modules include a ventilation module, side panels, and a shelf. The product's modules serve as the fundamental units that can be assembled in various manners, thus allowing for a range of product configurations and increased customer flexibility.

ABBREVIATIONS

Van Keulen Interieurbouw – VKI

Failure Mode and Effect Analysis – FMEA

TABLE OF CONTENT

1. SUMMARY

Currently, many companies have implemented open office spaces in their work environments to enhance communication and understanding among employees. However, this approach also presents certain drawbacks, such as concentration issues due to noise, reduced privacy, and poor air quality. One solution to this problem is the silent box. The purpose of this box is to provide users with privacy and reduce distractions without requiring an entire office redesign. This helps users to execute that difficult tasks they have to do or have a private phone conversation about a project, for example. The box shields the user from external noise and also protects the environment from the user's noise.

Van Keulen Interieurbouw (VKI), a large interior designer for supermarkets, retail stores and others in the eastern region of the Netherlands, has also developed such a product. However, the current two designs require a redesign to address, among others, production and functional problems. Thus, the initial objective of this thesis was to redesign a silent box that exceeds the current designs of VKI and improve their existing designs. The only requirement was that the box be modular.

The project began with research, including a field analysis and function analysis of existing boxes. The field research and function analysis identified some of the issues and a correlation between functions of the box. This correlation showed that both functions are interdependent and have different effects in different directions. Next, the target audience and stakeholders are considered. Concluding, no specific audience is chosen due to the many audiences having almost the same needs. Additionally, the primary stakeholder is not the end-user, but rather the buyer of the box who provides it to the end-user. End-users typically do not purchase the box themselves.

During the problem analysis, FMEA, RAMSSHEEP, and another field research examine the current box designs of VKI to identify problems and opportunities. While various issues and possible focusses were discovered, the focus of the analysis depends on VKI's priorities. The strategy analysis will explore these priorities in more detail, but before the strategy analysis is conducted, a market analysis will be conducted to explore potential market demand. During the market analysis, one possible gap was identified: a box with equivalent quality as Box 1 of VKI's current designs, but with a more affordable price point, falling within the moderate price range of €6000 to €10000.

Once all the necessary information has been gathered, it is time to make the initial design decisions. These design decisions included things like determining the price range and level of customer freedom that VKI wanted to offer. During this exploration, relationships between key factors (such as customer freedom and price) have been identified. Key points are aspects that can receive focus while designing the product. In order to determine which aspects to focus on, a design strategy should be applied to align with the business goals and provide guidance throughout the product development process. This approach ensures a solid foundation and clear direction for product design.

However, before implementing a design strategy, it was necessary to explore the key points in more detail. This is done using mind maps. First, all of the words that are related to a silence box were mapped, and then each of these words (i.e., key points) were examined as a primary key point and mapped with other related words. Through this process, it was discovered that the key points have a significant impact on one another. Therefore, these relationships were classified as either positive or negative based on their impact on the main key point. Additionally, it was discovered that two key points related to the main key point can also have a influence on each other, which ultimately affects the main key point once again. Ultimately, it was concluded that the key points and their effects were far more complicated than originally thought, changing the main objective from a redesign to a strategic issue.

As a result of changing the objective of this thesis, it was attempted to create a design strategy using the business strategy. Here, the new objective reached its final form: 'How to translate a business strategy to a design strategy?'. Before creating this design strategy, the relationships of the key points were explored again in order to create requirements once the design strategy is determined.

Next, VKI's business strategy was examined in order to create the design strategy. However, during the investigation of the business strategy, it was concluded that it was not explicit enough to allow a design strategy to be created. To address this issue, the decision-making process of VKI employees was examined, and it was hypothesized that they use a generic, unspoken strategy. To test this hypothesis, new strategy-focused concepts of silence boxes were developed. These concepts were presented to four project stakeholders in order to have an understanding of how the selection of the box for further development is made.

The results revealed an underlying strategy consisting of four key points, and personal strategies were also identified. Although not all four personal strategies included all points of the underlying strategy, they are kept in mind when making decisions.

Having concluded this, the personal and underlying strategy was then applied to VKI's current boxes and the concepts created. The purpose was to determine the impact of different strategies on the final box design and whether it was in line with VKI's image and portfolio. Executing these test cases showed that each strategy significantly influenced the final design. However, the effects depend on the specific strategy used, which could either positively or negatively affect VKI's image. Therefore, VKI requires a more explicit business strategy to ensure a design that aligns with their image and portfolio.

During this thesis, certain steps were taken to translate the business strategy into a design strategy. These steps were combined into a guiding framework and step-by-step plan to help VKI and other companies in future design development processes. Using these tools, a design strategy can be created from the business strategy, product, and customer needs. This design strategy will serve as the foundation for the rest of the design process. Additionally, two distinct feedback loops have been incorporated to evaluate the suitability of the design for the brand identity, company requirements, market relevance, and if the applied strategy should be changed. So, the thesis presents a developed framework and step-by-step plan for translating a business strategy into a design strategy.

2. INTRODUCTION

This report serves as a master thesis for the degree Industrial Design Engineering towards Management of Product Development at the University of Twente, Enschede. In this thesis, Van Keulen Interieurbouw (VKI) has assigned a task requiring a redesign. VKI introduced a product that presents various opportunities for improvement and added value. This product is known as conference and telephone boxes, also referred to as silence boxes.

SILENCE BOX

Currently, a lot of companies have open office spaces (Lai et al., 2021), which encourages communication between employees and improved their work satisfaction (Lai et al., 2021) However, others such as Pejtersen et al. (2006); and Allerman et al. (2007), argue that Danish open-plan office employees experience disadvantages such as noise, poor air quality and dissatisfactory ambient temperature. Furthermore, 'Haapakangas et al. (2008) found that Finnish workers in open layout offices experienced more stress, particularly overstrain and concentration difficulties and attributed these symptoms to office noise' (Lai et al., 2021). That same paper mentions that Kaarlela-Tuomaala et al. (2009) 'found that Finnish workers had increased distraction, reduced privacy, increased concentration difficulties and increased use of coping strategies, as well as lower self-rated performance due to noise.'
With these problems, a new solution has presented itself on the market: the silence box.

The purpose of these boxes is to create a quieter environment than the average open-plan office spaces. Many people are interrupted indirectly by colleagues who are talking on the phone or discussing something with another colleague. They are unable to concentrate in such circumstances, making it more difficult to complete their tasks. These boxes increase concentration, allowing employees to tackle complex tasks without interruption. It is important that these boxes provide sound insulation and absorption to create a quiet workspace for an employee. Nevertheless, the usefulness of these boxes extends beyond open-plan offices. The boxes can be a valuable addition to for example, a school library or train station to help create a quiet space for those who need it. The soundproof booth can be utilized for more private meetings and phone conversations without worrying about being overheard.

PROBLEM DEFINITION

VKI is already producing some silence boxes, more details on their silence box portfolio will be explained later, in the chapter 'product analysis'. The reason behind the tasked redesign is that they have run into some problems with their current designs. The designs created a few years ago have not been improved after its development. They still contain some errors during production as well as in construction and functionality aspects. The goal for VKI with this redesign is that it should resolve the above mentioned problems, and exceed the boxes in their current portfolio. In addition, this box provides an opportunity for VKI to expand into office furnishings as the owner wishes. This means that VKI is in need of a redesign of the silence box that will enable it to cater to both new and existing customers.

Thus, the goal for this thesis was to create a redesign of a silence box, that resolves the current problems and exceeds the current silence boxes. The one and only requirement is that this new box should be modular.

Next to this main goal, VKI asked to improve the production process of one of the boxes in their portfolio, without (major) changes in the design of the box.

To begin, research is conducted to identify the problems and opportunities for both types of boxes. This involves a research phase with a product, problem, and market analysis, as well as defining strategies and requirements. The results and data gained in this phase normally lead to a set of requirements, desires, and opportunities that serve as a foundation and guide for the project's further development.

But while defining strategies, many unknowns were found. Furthermore, it was discovered that these unknowns have relationships with each other. These unknows and their relationships had to be investigated further before the project's strategy could be defined. So, the main question shifted from a redesign to a strategic problem. To resolve this, the business strategy could be used.

Eventually the new goal of the thesis changed to translating the business strategy to a design strategy, using the silence box as a case study.

This thesis takes the reader through the process and steps that the author has followed while conducting the project. The thesis starts with some background information about the company VKI, followed by the research done with the first redesign goal in mind. A product analysis is done, including a function analysis. Here, a deeper dive into the product's characteristics is done to create a good understanding of the to be redesigned product. Then, the problem analysis identifies the problems and their possible causes, using methods such as a field research, a Failure Mode and Effect Analysis (FMEA), and a RAMSSHEEP analysis. A market research is conducted to determine how to differentiate from competitors and explore possible market demands. After that, the strategic decisions are lined out in the chapter 'strategy'. This chapter will also explain the shift to the strategic goal, instead of the redesign goal. After that, the business strategy of VKI is investigated in order to determine the design strategy. Here is found that VKI does not have an explicit business strategy. Therefore, using the silence box as case, as an attempt to find an underlying generic strategy that employees of VKI use when making decisions.

These underlying strategies are further investigated by creating test cases with the boxes in VKI's silence box portfolio. Based on these findings and the process the author has gone through, a framework was created to enable other businesses to translate their business strategy into a design strategy, without going through the same process.

During this project, a developer at VKI was also tasked with designing a new soundproof box by someone else, who was unaware of the author's project. Initially, the author and developer collaborated on this project, but under the tight time constraints enforced by VKI, it was not feasible to write a thesis and design the box while accurately justifying the design choices. The author stayed involved within this design project, while still carrying on with her own project. The importance here is that this box (box type 3) is not that extensively investigated as the boxes that already existed at the start of the project. The main reason behind this is that at the time this box was created, the author's project was past the research phase and had already shifted from the redesign goal to the strategic goal, making the extensive investigation unnecessary.

VAN KEULEN INTERIEURBOUW

VKI is a prominent Dutch company specializing in building interiors, with its headquarters located in Nijverdal. With more than 500 employees, the company serves a wide range of clients, from supermarkets, retail shops and offices to the catering industry and private customers. Their primary production facility is located in Nijverdal, where they have advanced machinery for working with wood, Perspex, metal, and painting. Production processes like CNC milling, laser cutting, and powder coating are performed in-house. Additionally, there is another metal production facility located in Tynaarlo, Drenthe where large batches of metal constructions are produced. The metal is laser-cut (sheets and tubes), bent, and welded to create structures for their designed products, for example. As most of their products are custom-made, and have a product line in supermarket shelfs. VKI has a development department that, for example, develops specials for supermarkets, such as the tuk tuk shelf that can be seen in Figure 1. Additionally, VKI has developed its own ERP system, which handles and automates much of the process from customer demand to final product delivery and storage.

MISSION

VKI's mission, retrieved from their website (Over Ons - WerkenbijvanKeulen, 2019) and translated to English:

'Van Keulen Interieurbouw is the absolute specialist in the Netherlands when it comes to interior design for the retail and project market. We offer our customers the optimal interior solution for every situation. Customized work is our standard. We produce everything ourselves and our employees are our most important assets. We continuously invest in good working conditions and the person and professional development of our employees. For our customers, we are an expert, reliable and committed partner. These qualities, and the willingness to always go the extra mile for the basis for all our business relationships.'

VISION

VKI's vision, retrieved from their website (Over Ons - WerkenbijvanKeulen, 2019) and translated to English:

'The retail sector is bubbling and buzzing like never before. The digital revolution is having a major impact. Traditional retail chains are fighting to survive in the online world. Old concepts are disappearing and there is plenty of experimentation with new formulas. Change is the norm in this dynamic field. Van Keulen Interieurbouw supports its clients with effective, fast and tailor-made interior solutions. With flexibility, craftmanship and great love of the retail trade, we are continuously building on our position as one of the leading interior builders in Europe.'

Figure 1. A 'special' for a Dutch supermarket

3. RESEARCH

A PRODUCT ANALYSIS

In this chapter, the current silence box portfolio of VKI is analyzed. This is done to get a better understanding of the to be redesigned product and to gain insights for decision making.pter, the current silence box portfolio of VKI is analyzed. This is done to get a better understanding of the to be redesigned product and to gain insights for decision making.

Van Keulen Interieurbouw has developed three different types of silence boxes. One box was initiated by and in collaboration with a customer (Box 1). This customer markets the boxes to buyers (not the actual end users) such as property owners, schools, and governments. The box is assembled on site by the customer of VKI. Another box was developed solely by VKI in response to a customer request (Box 2). This box is sold directly to the buyers who provide them to the end users. This box is built on site by mechanics of VKI. The last box, designed during this thesis, is initiated by VKI itself (Box 3). This box is developed because VKI wants to sell such a silence box themselves. The fundamental objective of this box was to exceed the design of Box 1. This box is also assembled by mechanics of VKI. All three type of boxes were developed by different developers working within VKI. This chapter will provide further explanations of all three concepts without disclosing confidential information.

BOX 1

Box 1, as mentioned above, is the box that is designed for a customer who then sells it to the provider for the end user. This box was developed together with the customer, who had certain preferences and ideas that they wanted to incorporate into the design.

The box consists of tubes, panes (made of wood or glass), and a roof. These tubes serve as pillars to support the panes. This combination of tubes and panes forms the main structure of the box. The tubes have 'ears', shapes sticking out at both ends of the tube, that slide into the pillar. The roof is then placed on top and secured with screws. Finally, the wiring for the ventilation and power outlets are added.

A pane consists of a buckling frame, wood or glass, and a connecting tube. The upper and lower segments divide the panel horizontally in the center by an additional connecting bar, as illustrated in Figure 4. Refer to Appendix 1.1 for further details on these compartments' construction, including flowcharts of the production process.

The inside of the box is lined with felt, to dampen the sound from inside. Rubbers are used to prevent the glass from cracking when it is directly mounted onto the metal tubes. Furthermore, the rubber acts as a sealant for the small gaps between the different materials. A thicker rubber is used as sealant on the bottom of the box. These rubbers have a D-shape (sealant bottom) and P-shape (sealant gaps).

This box has six different types of configurations (see Figure 3): (dimensions in W x D x H)

1. ONE: 128 x 128 x 249 cm, 1 person
2. TWO: 248 x 128 x 249 cm, 2 persons (Figure 4)
3. FOUR: 248 x 248 x 249 cm, 4 persons
4. SIX: 368 x 248 x 249 cm, 6 persons
5. NINE: 368 x 368 x 249 cm, 9 persons
6. TWELVE: 505 x 380 x 249 cm, 10 persons

The box is packaged in various cartons depending on the configuration. For instance, carton 1a includes a white top glass panel, while carton 1b consists of a black top glass panel. This provides a complete configuration, which is delivered in individual cartons. Customers do not order a complete box but a combination of cartons containing the necessary components. It remains unknown to VKI which box will be assembled from a specific order, because this is not done by VKI. Therefore, they never receive any feedback on how easy or difficult it is to assemble this box.

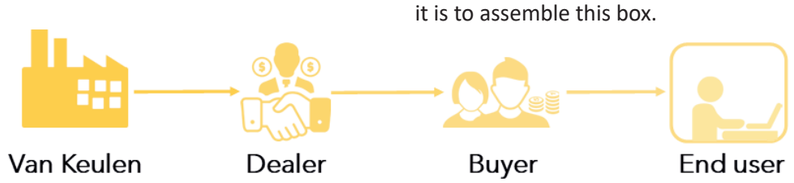

Figure 2. The roadmap of Box 1

Figure 3. The box configurations, from left to right: ONE, TWO, FOUR, SIX, NINE & TWELVE

In addition, if the customer requests a special box, a technical draftsman is required to design it and determine the cartons required for these configurations. However, such requests are rare.

Apart from the dimensions, the box configurations of Box 1 has the following product specifications:

- Sound insulating by 33 dB
- Ventilation 6 times per hour
- Plug & play. Uses only one plug to get the box working
- Includes 4 power sockets and 2 USB ports in the box (This number depends on the size of the box)
- Motion sensor for the lights (automatic lightning)
- Parts can be reused for different configurations of the box. A configuration will always include a glass door
- 60 minutes assembly time
- 2700K – 500 lumen lightning
- Standard work shelf included in the ONE configuration

All configurations can be customized to the customer's choice of the number of glass or closed wooden panels. For instance, a customer can choose a black ONE box with two glass and two closed wooden panels, or four glass panels without any closed panels. However, to replace a panel (because it broke, or a different configuration is desired), the roof must first be removed. Additionally, when replacing the bottom panel, the top panel must be removed as well. These boxes contain a safety stock to guarantee on-time delivery to the customer by VKI.

Box 1 consists of the following parts:

- Glass door
- Glass panels (top and bottom)
- Felt
- Wooden panels (top and bottom)
- Complete ventilation system
- Door handle
- Steel tubes
- Rubber
- Roof

Figure 4. Box 1 TWO configuration

BOX 2

This VKI box is non-modular, which requires a draftsman to redraw the 3D model when a customer requests different dimensions from the two existing configurations. This process is time-consuming and thus costly. This box type is sold to a buyer directly from VKI, who provides it to the end user.

This type of box consists of tubes, wood or glass panes, a roof, and profiles and is assembled by the mechanics of VKI. Certain tubes are preassembled at VKI. To be precise, these tubes are welded together to formulate the foundation structure, which serves as the box's base. In the next step, the column tubes are inserted into this structure. These columns already have profiles welded to the outside. For the placement of wood or glass panels, mounting profiles are used, which clamp the wood or glass between the tube's outer profile and the mounting profiles. Next, roof pipes are inserted and the wooden roof panel is mounted on the roof pipes using mounting profiles. The installation process concludes with the attachment of felt and the wiring of both ventilation and power outlets. In Appendix 1.2, additional information about the flowchart for production is available.

Each box comes with standard furniture. In this instance, the buyer collaborated with VKI to determine the specific furniture included in the box. Two dimensions of Box 2 are currently available:

1. 152 x 102 x 243 cm, 1 person
2. 150 x 190 x 243 cm, 2 to 3 persons (see Figure 6)

The profiles were included to solve the problem of gaps between the wood or glass and metal tubes, such as in Box 1. An L-profile is attached to the corner tubes of the structure that is wider than the tube on both sides. Consequently, there are no gaps between the wood and the tube when the wood is mounted into place, as the profile covers this gap. This is a major challenge for Box 1, which will be discussed in more detail in the chapter 'problem analysis'.

This box is also lined with felt and sealed at the panels and bottom with rubber, like Box 1. These boxes are produced upon request, thus no safety stock is generated or replenished.

The following features are added to this type of box (partially dependent on the configuration):

- Including work shelf in the 1 person configuration
- Including stool in the 1 person configuration
- Including benches for the multi-person configuration
- Including pedestal table for the multi-person configuration
- Ventilation 6 times an hour
- Motion sensor for light (automatic lighting)
- 2700K – 500 Lumen lightning
- Plug & play. Only uses one plug to get the box working
- Including power sockets, number dependent on which configuration

Box 2 consists of the following parts:

- Glass door
- Glass panels
- Felt
- Wooden panels
- Complete ventilation system
- Door handle
- Steel tubes
- Rubber
- Roof

Figure 5. The roadmap of Box 2

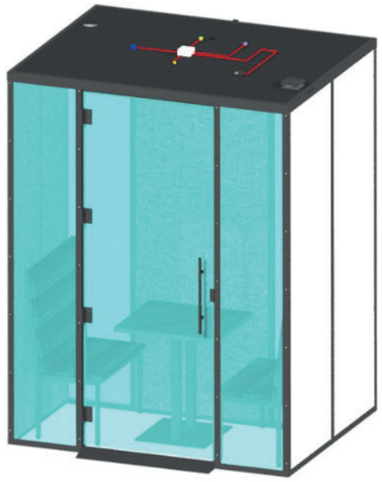

Figure 6. Box 2 configuration 2

BOX 3

Box 3 is another variation of a silence box, designed by VKI with the aim to improve the performance of the Box 1. In spite of the basic similarities, including the modularity, the boxes are different, especially in the technical aspects. This box is sold to the buyer, who provides it to its end user. This box is assembled on site by VKI as well.

The base is constructed with steel tubes, beams, panels, and a roof. The beams are suspended within the tubes, which serve as pillars, but with different 'ears' than in Box 1. Additionally a central beam horizontally divides the side of the box into two segments: the upper and lower segments. This design does not use prefabricated panels as in the first box, but rather unattached components as in Box 2. The horizontal beams, glass slats, and baseboard are secured with only two screws to hold either a glass or wood panel in place.

Both the bottom and top beam are identical, with one profile welded to the beam onto which the glass or wood rests. The middle beam consists of an extra welded tube and plate to create an H-shape cross section. This configuration enables wood or glass to be pushed and sandwiched in between so they are securely held in place.

Additionally, all configurations offer the option to interchange between glass and wooden panels. The box necessitates loosening two screws, removing the baseboard and two glass slats, making it easy to switch panels while the box remains in place.

Only a few elements need to be removed, which simplifies the process compared to Box 1.

The inside of this box is also lined with felt and sealed at the gaps and bottom with rubber.

Box 3 has the following configurations

- XS. 124,5 x 124,5 x 234 cm, 1 person (Figure 8)
- S. 244,5 x 124,5 x 234 cm, 2 persons
- M. 244,4 x 244,5 x 234 cm, 4 persons
- L. 364,5 x 244,5 x 234 cm, 6 persons
- XL. 364,5 x 364,5 x 234 cm, 9 persons
- XXL. 484,5 x 364,5 x 234 cm, 10 persons

Dependent on the configuration of the box, the following features are added to the box:

- Including a work shelf in the XS configuration
- Ventilation 6 times an hour
- Motion sensor for light and ventilation
- Plug & play. Only uses one plug to get the box working
- Parts can be reused for different configurations of the box. A configuration will always include a glass door
- 2700K – 1380 Lumen lightning

Box 3 consists of the following parts:

- Glass door
- Glass panels
- Felt
- Wooden panels
- Complete ventilation system
- Door handle
- Steel tubes
- Rubber
- Roof

Figure 7. The roadmap of Box 3

Figure 8. Box 3 configuration XS

B

FUNCTION ANALYSIS

With a better understanding of the product, a functional analysis was conducted to identify the current functions of the Silence Boxes. This analysis provided a deeper understanding of why and how the boxes were designed. It is important to conduct this analysis before delving into the problem analysis because a thorough understanding of the Silence Boxes is necessary to understand the problems and their underlying causes. The analysis identifies the required functions for the redesign and suggests reevaluating functions that, for instance, lack value.

The method proposed by Van der Vegte and Van Breemen (2009) encourages a thought process that considers the intended purpose of the product and how it can fulfill these functions without adhering to its current design approach. It provides the chance to think creatively while remaining mindful of the current product's obvious features. This approach is utilized to establish the necessary criteria that the new product must satisfy while generating novel brainstorm ideas.

When conducting this analysis, it was initially deemed necessary to examine two distinct box sizes: the phone booth, which can accommodate one person, and any size larger that can fit a minimum of two people. However, it became apparent that there was only one additional primary function of the box, which is the ability to function as a meeting room. This feature does not affect the necessary subfunctions or components required to fulfill the functions, both main and sub function.

Table 1 displays three primary functions of the box. Function 3, which provides space for meetings, only applies to boxes with room for at least 2 individuals, as previously stated. Providing climate control is crucial as it ensures a comfortable interior. So, logically it would be a necessary function. However according to Van der Vegte and Van Breemen's (2009) method, a necessary function meets the user's requirements. In this particular case, climate control is not a direct user need. This is because the lack of ventilation has a negative impact on the product within its system boundary. If it were not within these limits, like with noise and distractions, it would be an essential feature. Moreover, the adverse impact of a lack of ventilation is contained within the parameters of the product's system. Climate control transforms as it operates on the airflow, in this case. Finally, this function is preventive in nature, as it anticipates and avoids the formation of an uncomfortable climate within the box. Its automatic mode means that it is preventive and not corrective. If it were a corrective function, the user would have to manually control the climate settings, activating it only if necessary. However, since the climate has already become uncomfortable, a change is needed in order for the user to carry out one of the three primary functions.

Sound and distractions are not within the system's boundaries, making the functions of soundproofing and distractions shielding necessary. These functions are transformative as they do not support actions that the user can take to, for example, modify the product. Lastly, it is corrective since the undesirable effect is already present and cannot be prevented by this function.
The seventh and final function is derived and does not directly satisfy user needs. It only becomes necessary if the laptop or phone being used requires charging. If fixed monitors or computers are available, this function is mandatory. In the current design, this is considered a supporting function as it enables users to charge their devices.

The aforementioned classifications facilitate the identification of functions that require reassessment. Following the specified method, all derived functions are potential candidates for reconsideration, with the "derived corrective" functions considered to have the greatest need for reconsideration. These functions should be reviewed as they result from the underlying product concept choices and their undesirable effects. Consequently, functions four and seven should be reconsidered.

Finally, it is important to consider which specific parts of the boxes directly relate to these functions. Figure 9 provides an overview of this information. It is apparent from the figure that soundproofing and distraction shielding rely on the same components; these functions are therefore interconnected. This relationship is sensible given that sound is one of the primary distractions (Kaarlela-Tuomaala et al., 2009). In addition to shielding the user from outside noise, the soundproofing function of the box also enables private conversations within the product. Therefore, the soundproofing function 'delivers' privacy. The relationship between the two functions works in both ways. A highly distracting shielded box does not necessarily mean that it is soundproof, but it does positively impact soundproofing. If the box is sufficiently soundproof, it can have a positive impact on reducing distractions; however, it does not necessarily qualify as distraction shielding.

Furthermore, all three of the primary functions are dependent on the same subfunctions and components. If one subfunction cannot be fulfilled, then none of the three main functions can be fulfilled.
To conclude, functions of the box have interconnecting relations affecting each other in both ways, differently. Furthermore, functions four 'to control the climate' and seven 'to charge devices' should be reconsidered.

Table 1. The functions and their classification

Functions	Classification
1. Space for office operations	Main function
2. Space for calls	Main function
3. Space for meetings	Main function
4. Climate control	Derived transforming preventive function
5. Soundproofing	Necessary transforming corrective function
6. Distractions shielding	Necessary transforming corrective function
7. Charge devices	Derived support regular function

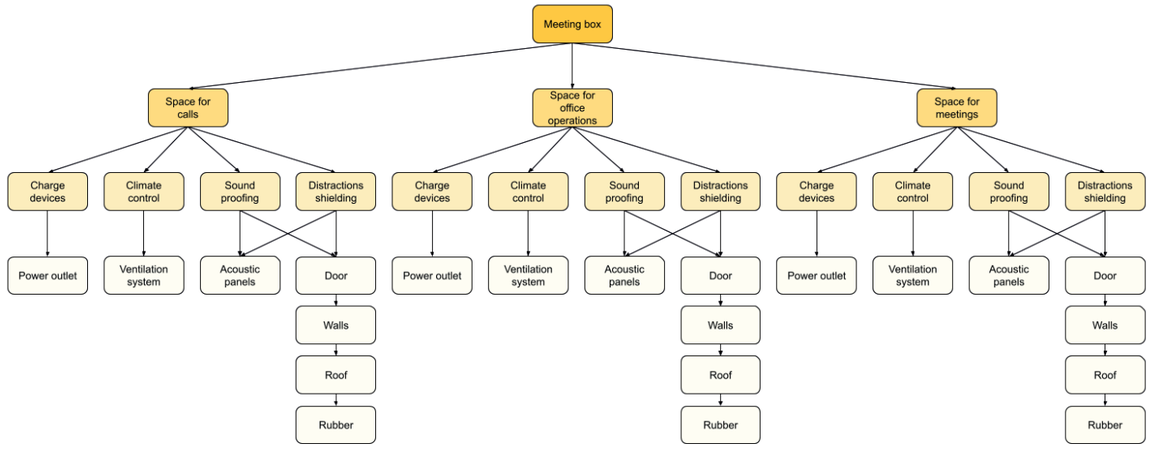

Figure 9. Overview of the main functions (bright yellow), subfunctions(yellow) and related parts (lightest yellow)

PUZZLE PIECE 1:
Here, a link has been discovered between two functions of the box. These functions affect each other in both ways, differently.

As mentioned previously, during the project a framework is developed that aims to provide guidance to companies when translating their business strategy into a design strategy, based on the project's process. Puzzle pieces are introduced in various chapters. These are part of this framework in different forms, such as input. In this particular case, a mutual relationship was found between two functions that affect each other, both ways. The puzzle pieces form the framework, to be explained in the chapter 'Framework'. These pieces represent the necessary steps for translating the business strategy into the design strategy.

C TARGET GROUP & STAKEHOLDERS

In order to gain a better understanding of the intended audience and those involved in the project, this chapter identifies the target audience and stakeholders for the product and project. The goal of this evaluation is an even better understanding of the product. Furthermore, it can act as a base for a better understanding of the problems and their causes that are found in the problem analysis. Who is the box being made for and what impact does this have on the design of the box? Different stakeholders and target groups may have different preferences and requirements. In addition, some problems may arise from a stakeholder requirement.

In this case, no target group was selected because VKI has no experience of the market, although it does have expertise in box production. One of the boxes was created for the dealer of the product, not the buyer or end user, while the other was intended for a particular customer. Consequently, as the end user does not purchase the box, they are not the most significant stakeholder for VKI and thus the redesign. The box is purchased by a building owner or a school organization for their employees, students, or building users. Therefore, it is unlikely that the purchaser will utilize the box. Moreover, no specific target group has been chosen as this box can serve a range of purposes. Setting a target group would limit its potential, especially looking at the fact that the box has more than one possible use. After all, VKI has a wide range of customers to whom this box can be offered. The box should be designed to accommodate various customers with minimal modifications. Therefore, VKI considers the perspectives of their target audience and determines customer freedom levels as a means of identifying their clients. With this approach, VKI will direct desired customers towards their business.

Therefore, the following stakeholders have been identified:

- Internal stakeholders
    - o Owner(s)
    - o Project manager of box projects
    - o Developer(s) of current boxes
    - o Technical draftsmen
    - o Mechanics
    - o Production employees
- External stakeholders
    - o Buyer (! Not the end user)

The internal stakeholders are all the employees of VKI involved in this project. It is obvious that these stakeholders have different job functions and unique perspectives that contribute to the development process. It is important to involve all stakeholders in order to produce a high quality product. This includes mechanics who will construct the on-site unit as well as production employees who also play a key role in the project.

The buyer is of interest as an external stakeholders because they are buying the box. The end user does not hold much influence in the buying process. An analysis was conducted on the buyer, focusing on their viewpoints depending on their branch or building. Important points for different branches are:

- School
    - o Fire security
    - o Overall safety
- Government
    - o Fire security
    - o Overall safety
    - o Norms and certificates
    - o Origin of materials
- Building owners
    - o Price

Different branches have varying requirements that affect different parts of the design. For instance, if the box is intended for use in a school, materials that comply with fire safety regulations will be utilized, whereas different materials may be used if the box is sold to building owners.

These points are conclusions of an interview with the project manager, who is involved in both Box1 and Box 2 projects.

In conclusion, the primary stakeholder in this project is the box buyer who provides it to the end-user rather than the end-user themselves. This stakeholder is not limited to a single target group, but depends on how much customer freedom VKI wants to offer. Furthermore, this box is designed for VKI's product portfolio and is not constrained by customer demands like boxes 1 and 2. Thus, VKI has significant freedom to adjust it according to their preferences while taking stakeholders into account.

D PROBLEM ANALYSIS

This chapter examines problems with the current boxes. VKI identified some problems, for example a hanging door or repeated production errors. However, other issues may still be undiscovered or could be contributing factors to the previously identified problems. "Problems" refers to the current difficulties of the silence boxes in the VKI portfolio. The investigation of these problems is important because VKI's intention is to solve them in the redesign. The understanding of the silence box developed in the previous chapters makes it easier to understand the problems and to find a possible cause. The results provide a starting point for requirements and brainstorming, as well as a more complete understanding of the products to be redesigned. This knowledge is critical for avoiding the recurrence of past mistakes and to focus the development on an improved product.

The current problems are examined with three different approaches. Firstly, field research is carried out through various activities during the research phase of the project. Additionally, a RAMSSHEEP analysis and a FMEA (Failure Mode and Effect Analysis) are performed. The corresponding subchapters present and analyze the conclusions of these investigations.. The complete analyses are presented in Appendices X, Y, and Z.

As mentioned before, Box 3 was not yet conceptualized in this period of field research, ad only came to the existence towards the end of this thesis' timeline. Consequently, certain analyses were carried out at a later stage to incorporate their value. For this stage, box 3 is not analyzed, except for one field research, assembling the box. Therefore, Box 3 is not included in this chapter.

FIELD RESEARCH

The field research is conducted through a variety of methods, including spending a day in metal manufacturing and conducting interviews with mechanics who previously assembled the boxes on-site. Such research is critical for comprehending the manufacturing and assembly processes of the boxes, which facilitates understanding of past design choices. Such research is critical for understanding some of the design choices that have been made in the past. Additionally, this knowledge is important for future concept development.

For Box 1, the following field research has been done:

- Metal manufacturing. In this department the buckling frames and pillars are manufactured.
- Panel manufacturing. The assembly of wood, glass and frames into components (panes).
- Assembly of the box (with mechanics). Creating a complete TWO configuration with one glass top pane, two roofs, four wooden top panes and five wooden bottom panes.
- Interview with project manager.
- Interview with mechanics. These mechanics have built the boxes from the start on. Now this is done by the customer themselves, who build the box at the end user.

For Box 2, limited field research has been conducted. Due to the fact that it was not in production at the time. One feasible possibility was to make adjustments for a customer who already had Box 2 installed. Through this method, VKI was able to solve some of the issues that the customer had reported. One problem was the significant gap in the door that allowed customers to see outside the box even when the door was closed. Additionally, an interview was conducted with one of the developers of Box 2 and the project manager (who was the same person as Box 1's project manager). Further, a new box intended to replace a prototype was constructed and tested at VKI, marking the second possibility of field research with this type of box. The box was constructed primarily by inexperienced mechanics. One of the experienced mechanics only assisted during the placement of the door. Although the design was revised to improve its neatness, it still had minor imperfections. Additionally, a final field investigation was conducted to resolve the problem of the gap between the glass door and the box. The gap closed when pressure was applied to the top corner. Therefore, a diagonal steel cable strut was mounted from the top beam to the bottom beam in an attempt to reduce the gap in the box's shape. However, even after trying at various locations, it was found to be ineffective.

CONCLUSIONS

BOX 1

- Many issues arise during the production process. Some of them can be resolved by changing the manufacturing process. For example, the fact that the buckling frame is not always welded in the middle to the top beam can be resolved by creating a mold for the welding. Others require redesign, such as the side window, which is a complex and critical aspect of the manufacturing process that requires redesign to resolve.
- Many practical errors have been made, such as the visibility of welding lines. This issue can be addressed through two solutions:

modifying the powder coat or programming the laser to turn the tube in the appropriate manner to prevent welding lines from being visible when the assembly is complete. However, some decisions are not under VKI's control, particularly regarding the desired matte black coat requested by the customer. But if the customer were to choose a powder coat with a sandy texture, which remains matte black, any small damages and the welding line would be concealed within this coat.

BOX 2

- The most important problem to solve is the ability to level the product, as the door cannot be fixed by any other means.
- A major contributing factor to these issues is the lack of time devoted to developing these boxes; both design and manufacturing were completed within a week.
- The design is a source of many problems such as the chattering of a straight profile on the tube. This is because the weld lacks strength, there are insufficient welding locations, and warping occurs due to the heat of welding.

RAMSSHEEP

To identify areas for improvement, the RAMSSHEEP parameters were used to analyze the current VKI boxes. RAMSSHEEP is a method to asses a product on its Reliability, Availability, Maintainability, Safety, Health, Environment, Economics and Politics. This method finds opportunities for improvement and highlights the current boxes' strengths. A clear explanation of all the parameters and how they are understood, as well as the complete analysis, can be found in Appendix 2. The parameters and their design guidelines are used to analyze the current product. This chapter presents the conclusions.

BOX 1

Opportunities

- There are many unnecessary parts, so the amount of parts can be reduced.
- An indication of what is broken can help for faster repair and a lower down time.
- An alternative to using felt for sound insulation in the box is recommended due to its lack of environmental friendliness.
- Standardize used screws; these are not specified in drawings so they can change over time. Therefore other tools may be necessary.
- Better assembly manual; not for the mechanic on location but for the assembler at VKI. They do not always know what they are doing (conclusion of field research) and may cause the mechanic on site more problems instead of helping them.
- Comply to norms and differentiate the box from competition.

Strong points

- Modular
- Very sturdy, rigid
- High quality, long lifetime materials
- Not much maintenance is required next to cleaning

BOX 2

Opportunities

- Reduce the amount of parts that have to be transported from VKI to the customer's location, like Box 1.
- An indication of what is broken can help for faster repair and a shorter down time.
- Due to more parts and non-modular parts the repair time is higher than with modular components. This also means that the down time is longer.
- Self-tapping screws cannot be used over and over again, not ideal for disassembly. Furthermore, these leave steel chip on the site of the assembly. That has to be cleaned and can damage the rest of the parts during assembly.
- An alternative to using felt for sound insulation in the box is recommended due to its lack of environmental friendliness.
- Redesign the box in such a way that it is modular.
- Comply to norms and differentiate the box from competition.
- Overall construction could be better.

Strong points

- Not much maintenance is required next to cleaning.
- Standard screws and tools can be used to assemble and disassemble the box.
- High quality, long life time materials.
- Lighter parts (but more…).

FMEA

A Failure Modes and Effects Analysis (FMEA) has been conducted for both boxes. This analysis provides insights into the product's risks and opportunities for optimization. These findings are important in order to avoid them in the redesign, but also to find opportunities for the redesign. First, a brainstorm is conducted to identify potential failures, which are then analyzed for their impact, causes, severity, occurrence, and detection probability. One issue with this analysis is that the FMEA is subjective, as data is not measured, in this case, for factors such as occurrence. These numbers are based on the author's expectations and knowledge. Thus, these numbers may vary if another individual were to conduct the same analysis. Nevertheless, the FMEA provides valuable insight into potential failures and opportunities. The most significant risks for each box are listed below, representing the primary opportunities for improvement. The complete FMEA of both boxes can be found in Appendix 3.

BOX 1

- A possibility of levelling the box should be added, because now the box does not fit together well if the floor is not completely level. Also, extra gaps are visible due to a non flat floor.
- Ventilation, electronics and wiring have to be done correctly; should get extra attention. Currently the wiring etc. are laying on the ceiling of the box collecting dust.

BOX 2

- It should be specified which screws should be used for each of the parts, to prevent wrong screws in the wrong parts which can cause damages or loosen up parts.
- A possibility of levelling the box should be added. This is more important than in Box 1, because there is a rigid frame on the bottom. If the floor is not level the box will never be level and problems like a hanging door and the resulting torque can never be resolved.
- Ventilation, electronics and wiring have to be done correctly; should get extra attention. Currently the wiring etc. are laying on the ceiling of the box collecting dust.

CONCLUSION

Numerous issues arise during the course of this analysis. The matters outlined in this chapter are key points to keep in mind when developing concepts and can be an inspiration for brainstorming, but also for requirements. Key points are aspects that can receive focus while designing the product. For example, a requirement could be introduced to allow for box leveling, which would not only solve the problem of problem of non-square products, but also solve related problems such as the gap between the door and Box 2. Important to note is that these requirements will determine the design's focus. However, it is crucial to identify what needs to be resolved and what is of lesser importance. The FMEA highlights key points with the RPN, but it is also important to determine what the focus of the new product development will be. What should be the focus of improvement and what should be less important. For optimizing Box 1, production process changes offer the most potential for addressing problems. This is especially true since the customer intends to maintain the current design, which limits the scope for optimization. Utilizing a welding mold to install the buckling frame precisely in the middle of the top beam is an effective way to optimize, as previously mentioned.

PUZZLE PIECE 2:

In this phase of the thesis, several key points have been found. For example, the RAMSSHEEP highlights that the ease of built for Box 2 is very low. So, for the new design a point of focus, or key point, could be 'ease of built'.

E MARKET ANALYSIS

To develop an optimized redesign and explore potential new market demands, market research is conducted. Before any design decisions are made, it is important to compare different boxes based on their characteristics and services. This helps to determine which aspects are required to fit into the market and which aspects distinguish certain boxes from the competition and fill a market gap. Market research is crucial to make an informed decision since its conclusions can influence the decision-making process. The objective is to identify market opportunities and determine if they align with VKI's goals and objectives. However, before conducting market research, it is essential to have a basic understanding of the product characteristics in order to compare and identify the best opportunities for VKI to pursue.

The market offers a wide variety of boxes, indicating a saturation that does not necessitate the creation of new designs. However, VKI remains determined to develop a new box, so this analysis is not about whether there is a need for a box and whether the new design can fill a gap in the market, but rather an exploration of the market, especially since VKI is not really known in this market.

Due to the numerous options are currently available online, the analysis is segmented into three distinct price ranges: low (€ 0 - € 6000), medium (€ 6000 - € 10000) and high (€ 10000+). Each category includes at least six competitors, with required information such as price and furniture inclusion. The boxes that are investigated can be found in the references, under the heading 'market research'.

To provide a comprehensive overview and make fair comparisons between brands, it is essential to first determine the size of the box. This will ensure a more precise assessment of the products. Comparing a one-person box to a six-person box can be difficult, considering various factors such as price and capacity. Therefore, it is decided to analyze the single boxes that can accommodate only one person. Further analysis with different sizes is unlikely to yield relevant results, as larger boxes have varying sizes and capacities for occupants, making fair comparisons difficult. For each price range, a minimum of six boxes are examined. The numbers in the "Assembly" column indicate the quantity of boxes that either include (yes) or exclude (no) assembly in the product's price. In the low price range, five out of the six boxes do not incorporate on-site assembly, while in the high price range, five out of six boxes include on-site assembly within the product price A summary of this analysis is displayed in table 2.

In conclusion, there is not a significant difference between the boxes in distinct price ranges. The variance is mainly observed in assembly and customer freedom. Customer freedom refers to the number of color and material choices available, for instance. The term 'much' denotes at least ten color choices and five material choices.

Additionally, it is emphasized that most of the boxes have a floor, which all current VKI designs do not have.

The dB reduction is lower in the higher price range compared to the others. However, it is difficult to draw a solid conclusion since only 2 boxes indicate their dB reduction in the low price range, while 6 indications are present in the high price range. As a result, one can conclude that the indication of dB reduction is more crucial in higher price ranges. This holds true for norms as well, considering that they become more significant in higher price ranges than in lower ones.

Of course, it should be noted that the following results are based on the analysis of only around six boxes per range, thus providing a general overview of the current competition. Nonetheless, they effectively summarize the key features per price range and their minimum requirements.

One "gap" exists in the price segment of Box 1 (medium). There are relatively few products available that offer comparable specifications to Box 1. To address this, there is a redesign opportunity to create a new silence box at the lower end of the medium price range that can achieve the same quality standards and provide similar customization options to the customer as Box 1.

One confusing observation is that as the price of the product increases, the number of power plugs decreases. It is often assumed that this feature is more common in higher priced boxes than in lower priced boxes, but this is not true. It is unclear if the analysis of only six boxes could have influenced this result, or if having just one plug is sufficient.

A few other points need to be highlighted as well. These observations in the analysis are peculiar, particularly for the market:

- There is inadequate information provided, as only a few specifications are clearly indicated. For instance, some mention their dB noise reduction without indicating the source of that number. This is concerning, as the product is high-priced and is expected to have well-defined specifications and justification for its price. Despite this, companies continue to buy it in large quantities.
- The shapes are quite the same, square and rectangular, is there a reason behind this?
- A lot of the boxes have a regular closing mechanism (like a door in a house), and do not use a magnet, like the current designs of VKI

As a final note to this analysis, the following features should be included or added for a competitive advantage in the redesign of the box as requirements:

Low:

- (Almost) no customer freedom
- Power plug
- Competitive advantage:
  - o Include furniture
  - o No floor

Medium:

- Customer freedom
- Included furniture (for 1 person box)
- Power plug
- Competitive advantages:
  - o No floor
  - o Include norms

High:

- High customer freedom
- Power plug
- Including assembly on location
- Competitive advantage:
  - o No floor
  - o Include norms
  - o Include furniture

Despite the saturated market, there remains an opportunity to develop a box that stands out from the current offerings. Moreover, many boxes do not differ significantly in terms of shape and materials used. Another notable observation is that, despite the lack of information resources, customers are surprisingly willing to spend money on the box.

Figure 10. Low price range silence box 'Akoestische belcel P-booth' (Akoestische Belcel P-booth, n.d.)

Figure 11. Medium price range silence box 'quiet.box concentratiewerkplek van König + Neurath' (QUIET.BOX Concentratiewerkplek Van König + Neurath, n.d.)

Figure 12. High price range silence box 'Qabin Call' (Ahrend, n.d.)

Table 2. A summary of price ranges and their characteristics

Price range	Minimal requirements to fit into the price range	Min/max €	Assembly
Low (< €6000)	- Minimal color choice - No material choice - 50/50 furniture included - Average 35,5 dB reduction (2 times indicated) - No norms - Average of 1,5 power plugs - With floor (100% of the analyzed boxes)	€2650	No (5)
Medium (€6000 - €10 000)	- Lots of color choices - Almost no material choice but if there the choice is big - Furniture included - Average 35,67 dB reduction (3 times indicated) - 50/50 includes norms - Average of 1,33 power plugs - With floor (100% of the analyzed boxes	€6091	No (4)
High (>€10 000)	- Lots of color choices - A few material choices - 50/50 furniture included - Average 32,4 dB reduction (6 times indicated) - 50/50 included norms - Average of 1 power plug - With floor (100% of the analyzed boxes)	€15875	Yes (5)

4. DESIGN STRATEGY

A STRATEGY

When designing or redesigning a product, research is conducted in order to uncover any problems and gather detailed information. Once this research phase is complete, it is used as a base for the redesign. Furthermore, a part of this information can be turned into requirements, which will create a structure to fall back onto in any phase of the process and when decisions are made. In order to create these requirements, some first design choices must be made. One of these decisions include determining the focus for this project. Which of the found key points are more important than the other key points, and why. Furthermore, in the market research the first decision has presented itself: What price range does VKI want to place their redesign? This will have an effect on the possible decisions that can and should be made later in the process. For example, choosing the low price range means that the materials of which the box will be made can not be of the highest quality. This choice and their effect should be examined, in order to be able to make a well-informed design decision. Because, why would VKI want to place their box into a specific category, and not in another category? This chapter discusses which strategic choices could been made and why certain directions are more preferable than others, to make a more informed strategic decision.

Decision making can be done in a few ways. One way is for the designer to determine the focus based on their vision and interpretation of the project and the business; however, it may not be fully underpinned. The business owner may rely on their intuition to make decisions, but this approach may lack sufficient support and it can be influenced by personal biases. In practice, it may be convenient to make decisions based solely on the owner or manager's preferences. However, it is important to consider the best option and which approach aligns most effectively with the company's goals. So how can the best approach be found and which approach fits the company the best?

Before designing the product, an exploration of strategic aspects was undertaken. During this investigation, crucial strategic decisions were found, such as the product's pricing target. This decision plays a significant role in the rest of the product design. Consequently, some design choices are altered to align with the pricing strategy. To illustrate this, consider the following example:

In the case of the silence box, price range, customer freedom, business strategy (PSS), and material decisions appeared to be the choices to be made. Upon examining each option, more interdependencies were discovered than initially anticipated. In particular, price range has an impact on all the aspects. To clarify, the strategic choice of the materials will be explained.

The options for materials include:

- Using the materials that VKI already uses
- Investigate new materials that are more sustainable or more sound insulating.

The choice of materials is influenced by the product's intended price range for the market. If VKI aims to sell the product at a lower price point, it would be more logical to opt for materials already available within the company as they possess familiarity with its processing and have a purchasing advantage due to a higher demand (from VKI) for the same material.

A designer is tasked with developing a coffee maker, considering the low, medium, and high price range options. Extensive research is done to establish a comprehensive list of requirements. Assuming the company wants the product to fall in the low price range, this immediately determines whether to create an electric or manual machine. Logically, the designer cannot craft an electric coffee machine of good quality in a low price range, assuming it to be a requirement. Therefore, this initial design decision serves as a filter for the next design decisions that can be made. Creating a manual coffee maker, such as a pour over or a French press (as Figure 13), would be more cost-effective. In addition, Figure 13 illustrates that the type of coffeemaker to be designed depends on the type of coffee desired; a lungo or an espresso? Ultimately, the design choices made will impact future design options available and the final outcome of the product.

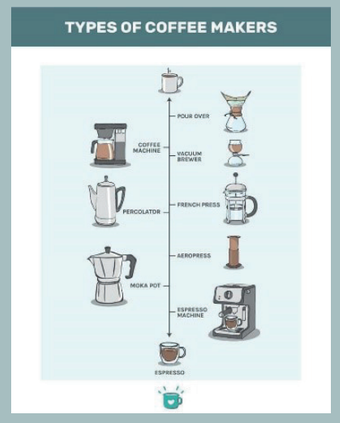

Figure 13. Types of coffee makers (Bobak 2023)

VKI purchases more supplies simultaneously and effectively minimizes waste as they repurpose the remaining sheet after creating a section for the box.

Introducing new materials can lead to improved sustainability and easier recyclability, reducing the overall environmental impact and providing a marketable advantage for the new box. This way, the box can stand out from the thousands of other boxes on the market. However, utilizing a novel material results in the loss of the bulk advantage, potentially increasing the cost of the new box. Alternatively, the new material could be used in other products already manufactured by VKI, in order to regain the bulk advantage. To use this material in more products, some minor adjustments may be necessary to ensure compliance with VKI's current clients. Another option would be to design the box in such a way that, with a standard size of new material, there would be little or no waste in the production of the box. Another important aspect to consider is whether the material aligns with the current production process. If not, it may be necessary to acquire a new machine or skills in order to use the material. This can result in increased expenses. A more detailed analysis of the other three key points can be found in Appendix 4.

The analysis revealed more underlying relations and connections between multiple product aspects than initially expected. For example, the key point 'material' has an effect on the size of the box and its price. So, the key points do not only affect the design, but they also affect each other, what then influences the design. During the initial research phase, the analysis of the box's functions revealed a two-way relationship between two of its functions. These relations were expected to be resolved with the explanation in Appendix 4. However, the information currently available is insufficient for a decision, as it only indicates that several aspects impact others but not the precise ways in which they do so. By just choosing with this information, VKI will go into the wild with no preparation, and everything can and will be changed any day. Furthermore, how will this new product with its design choices integrate with the company and is it the optimal solution? Will the design fit the portfolio of VKI?

THE IMPORTANCE OF A DESIGN STRATEGY

As mentioned before, it is possible for project managers or owners to make decisions solely based on their preferences, which can be biased and not aligned with the best interests of the company's portfolio. Additionally, these changes can occur frequently, disrupting the development process and causing delays that increase costs. One solution to address this issue and answer the above-posed questions could be to implement a design strategy.

The definition of design strategy according to Orozco (2023): 'the intersection between business profitability and value for people'. So why is such design strategy important for this project? Why is a design strategy of importance in overall product design?

An overall logic reasoning behind a design strategy is that the appointed decisionmakers can make a better decision with a strategy than without. Lockwood (2010) describes the role of design strategy in business as 'clarify design attributes and design policy' that defines and guides as a continuous process. 'Design strategy sets direction and road map, and is critical to helping an organization become more design minded' (Lockwood 2009). So, the design strategy acts as a base and guide during the product development process.

The previously mentioned reason is one that occurred during the course of this project: the designer could not make certain decisions without the available information, but the use of a design strategy made it possible to access more detailed information, especially about the directions. Directional choices are no longer options, because the strategy has already determined the focus of the project and the design. A design strategy offers a framework and facilitates informed decision-making, providing greater potential for success and meeting expectations, and requirements compared to operating without a strategy.

PUZZLE PIECE 3:

Some additional connections (relationships) between key points have been discovered. It is not limited to just the correlation between the 'distraction shielding' and 'sound proofing' functions. These interconnections are quite complex, as they all affect each other, not one point to another, but one point to three other points. As a result, it becomes a difficult task to determine which of these factors is the most crucial and what this means for the other points of focus.

Furthermore, another obvious reason of the importance of a strategy is to increase the feasibility of your design goal. This can be underpinned by the paper of Diaz et al., (2022) which focuses on circular product design strategies: 'Circular product design focuses on developing products able to pass through multiple life cycles (Moreno et al., 2016). This is enabled through design strategies that allow the preservation and recovery of products functionalities, physical integrity and embedded materials or energy for use in subsequent product lifecycles.' The goal here is to create a circular product, that are 'kept in the economic system for as long as possible' (Diaz et al., 2022), by using a specific design strategy, for example Design for Sustainability. By creating a structure with the design strategy, there is a higher feasibility of actually reaching that goal with the finished design.

But a design strategy is important for another reason as well. 'Strategic development of design can be explained as a way of developing and using design that is rooted in the company's overall strategy, and which should help the company build its position and reputation, achieve its goals and strengthen its competitiveness or other value creation.' In this sentence, Grimsgaard (2022) argues that a design strategy helps create a competitive advantage, as well as building its brand identity and company reputation. The latter is underpinned in the following sentence: 'Strategic design links design and marketing together and brings design into the company's management and boardroom as part of corporate development and branding' (Grimsgaard, 2022). Design strategies help bridging information gaps between different departments and fields of expertise within a company, which positively result in a product portfolio that is aligned with the business' goals. By aligning goals, the desired market position is more likely to be achieved, creating a competitive advantage.

Other papers mention this as well: 'Strategy makes an organization conduct activities in a distinctive way from its competitors, pivotal competences facilitate distinctiveness and diversity adoption, which ultimately provide the organization with competitive advantage' (De Toni and Tonchia, 2003). De Toni and Tonchia (2003) discuss in this sentence that by using a strategy, a company can differentiate itself in a way that is impossible for competitors to copy, thus creating a competitive advantage.

'The key factor for sustaining profitability in the modern competitive market is the possession of a competitive advantage, and the necessary requirements for competitive advantage is to possess an appropriate strategy' (Gabbar, 2007). Gabbar believes that implementing a design strategy is essential to gaining a competitive advantage.

According to Lee et al. (2022) incorporating the kano model in a design strategy in different ways can bridge the information gap between customers and provider/ manufacturer to 'maximize users' satisfaction and improve customer satisfaction'. By using the kano model introduced by Kano et al. (1984) the customers' needs and satisfaction can be measured, which creates more customer understanding. With this understanding, a product with greater potential for success on customer requirements identified in the Kano model can be achieved. Without this knowledge, the product has less chance to fulfill a need, whether it is known or not. Therefore, design strategies help enhance user experience and satisfaction.

Background information:
The kano model introduced by Kano et al. (1984) is a model that maps customers satisfaction. 'The model brings a different perspective in order to analyze the possibilities of improving the quality of products and services because it takes into account the nonlinear relationship between performance and satisfaction' (Paraschivescu and Cotîrlet, 2012). The model assesses the importance of quality attributes in a product or service and classifies them into several categories based on customer preferences. For instance, the 'Must-be' attribute refers to 'the basic quality requirements of the quality of the product (Paraschivescu and Cotîrlet, 2012). Leaving this attribute out leads to immediate customer dissatisfaction, although the inclusion of this attribute does not imply customer satisfaction.

The paper of Zhang et al, (2023), uses the same model to create a framework 'for mining customer requirements from initial and supplementary reviews to extract consumer product attributes and capture the dynamic changes of these attributes over time. This is a valuable attempt at customer centric product design based on both initial and supplementary reviews.' This paper is also focused on creating a design strategy by utilizing modern customer information platforms. This enables a better understanding of customer needs which helps enhance the user experience and satisfaction for future product development.

Furthermore, design strategies are driving innovation and creativity. In the paper of Norman and Verganti (2014), two types of innovation are distinguished, but both innovations are driven by design strategies. The example of Nintendo displays this: 'Nintendo declined to focus on the technology dimension (improving graphics) but instead on the meaning dimension (strategy) in video games, opposed to Microsoft and Sony. With the introduction of the Nintendo Wii, console games opened upon outside the normal, small niche of skilled expert and let the entire family play video games.' With this innovation, they expanded to a whole new market outside the niche segment of skilled game players. In this example, Sony and Microsoft are focusing on incremental innovation, while Nintendo took an opportunity for radical innovation, both driven by different design strategies.

In the paper of Ludden et al. (2008), they argue why surprise can be a design strategy. This strategy makes use of the 'visual-tactual incongruities in product design and the variety of strategies that create interesting and original products.' This design strategy also drives innovation and creativity, but by creating unique, surprising products a competitive advantage can be created as well.

And Lu & Hsiao (2019) agree: 'Good design strategy helps to improve product competitiveness and creativity in the new product development phase.'
A last argument for a design strategy: 'Generally speaking, the design strategy is convergent, but it will be divergent and convergent at different stages of the design process' (Cross ,1994). 'Specifically, product design is regarded as a problem-solving activity and divergence can expand the search scope of solutions, so as to find more creative design ideas and new design needs' (Goldchmidt, 1997). 'On this basis, convergence is not only to find suitable sub-solutions, but also to evaluate the optimal design scheme from a large number of alternatives.' (Hsiao and Chou, 2004) With this paragraph is said that a design strategy is integrates several entities together creating an optimal design scheme, and thus creating a structure that can increase the chance of good design outcomes.

So, why is a design strategy important for this project and new product development?

- Aligning design with the business goals
- Differentiating from competitors
- Enhancing user experience and satisfaction
- Driving innovation and creativity
- Strategy provides structure increasing the chance of good outcomes
- Create a base and guide during the product development process

EXPLORATION OF RELATIONSHIPS BETWEEN KEY POINTS

Once it is established that a design strategy is necessary to organize the relationships found between the key points, all relationships must be explored first. To accomplish this, a mind map was created to represent what is associated with a silencing box. Any topic that popped up is a key point and could have an underlying relationship which should be explored. Figure 14 displays the resulting mind map with the found key points.

Afterward, separate mind maps were generated for each key point to explore the relationships between the other key points. This step was taken because in puzzle piece 3, interconnections between key points were found. These interconnections also influence the end result of the redesign. Figure 15 displays one of the separate mind maps, which indicates which key points are influenced by the main key point of that map. The term "main key point" refers to the key point being explored in this map, such as "customer freedom" in Figure 15. The third step involved determining whether the main aspect has a positive or negative influence on the others. Additionally, this is dependent on whether the main aspect is negative or positive. For example, if the product is modular, it is easier to standardize the product, leading to positive effects. On the other hand, if the product is not intended to be modular, the standardization process could be more challenging (This is debatable because some assumptions and logical reasoning are needed to determine the precise impact). The relationship type (negative, positive) is also shown in Figure 15 for the "customer freedom" key point.

Moreover, this map provides additional detail by indicating and categorizing (positive, negative) the links between the different aspects related to the main factors. For instance, in Figure 15, the previously mentioned example can be applied again. A modular design is recognized to have a favorable impact on standardization.

However, standardization also affects the price in its own way. If the design is modular, the product becomes easier to standardize, resulting in a positive impact on pricing. This is because standardized design eventually leads to lower final costs. Furthermore, standardization has a positive impact on sustainability by preventing waste. Increasing standardization can have a significant role in waste reduction, thus contributing to environmental preservation. This, in turn, leads to a more sustainable design or product. This is also influenced by many other factors, such as the material. The type and standard size of the material used directly impact the amount of waste produced during manufacturing. Contrarily, the standard size of the material used can determine the size of the box.

It is evident that these relationships form a complex interdependent system with no clear right or wrong path. The discovered relationships, established through the creation of mind maps featuring main key points and their affected key points, can all be combined into an overview in Figure 16. This overview diagram reflects the complexity of the design project, particularly in the absence of a design strategy.

PUZZLE PIECE 4:
Figure 14 is actually the summary of all found key points, and a good method of finding these. But without the other three puzzle pieces, not all key points would have been found.

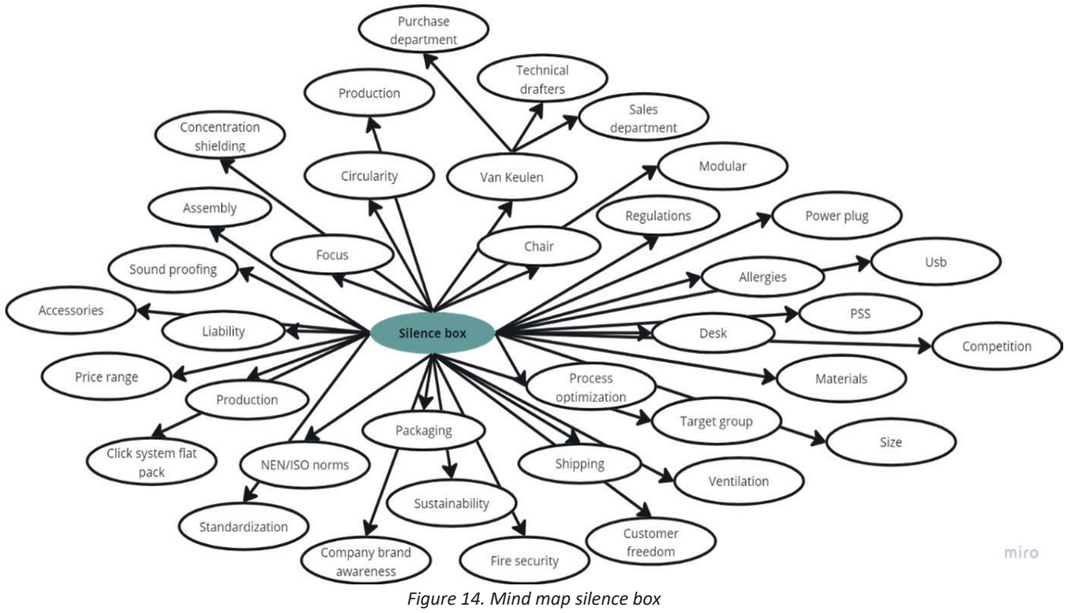

Figure 14. Mind map silence box

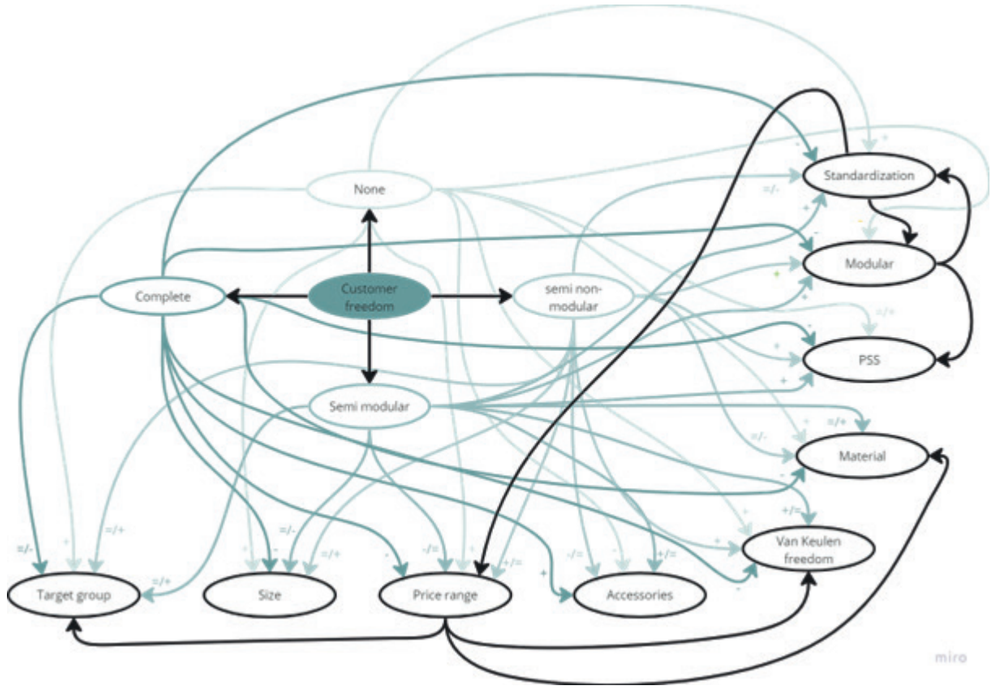

Figure 15. Mind map main key point customer freedom

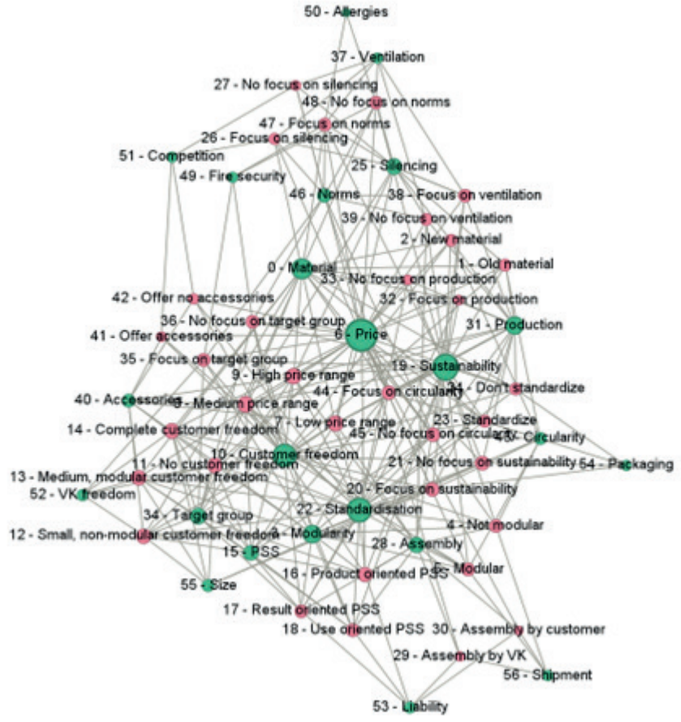

Figure 16. Gephi map

It has been researched why a design strategy is important, but this is a 'real life' example coming forward in practice. So, now it is clear that a design strategy is required, this adds another question:

How can a design strategy be created?

Logically, the company's design strategy could be used. However, VKI does not have a specific design strategy. Therefore, an alternative approach for developing a design strategy is necessary.

In this chapter, it has been determined that this redesign case is more complex than originally anticipated. So at this point the primary objective of this thesis has changed from the redesign of a silence box and the optimization of an existing silence box to the determination of how to create a design strategy. Therefore, a thorough investigation was required to enable the redesign of the silence box. The goal of the investigation is the reduction of complexity and ultimately the development of a design strategy. Therefore, the focus is now on creating an effective design strategy rather than simply redesigning the soundproof box. Therefore, no steps were taken towards redesigning the silence box, but rather towards developing a proper strategy, since the "normal" approach was not sufficient to get to a redesign in this case. It should be noted that this investigation was applied to the case of a silence box.

Referring back to the definition of a design strategy according to Orozco (2023), determining the value for individuals is challenging since VKI lacks market experience. Conducting more market research and, if necessary, interviews with VKI's customers' customers could address this gap. However, the target group is not the primary focus of this project as VKI decides what to produce and the choices they offer to their customers and their customers' customers. What choices does VKI aim to offer its customers? How does this fit the image that is expected from VKI? Does it fit their product portfolio? It is evident that the business strategy plays a significant role in the design strategy, as business profitability is a crucial factor here. Thus, the question arises: how can a business strategy be translated into a design strategy?

The importance of a business strategy

Before being able to answer this question, it is important to consider why integrating the business strategy into the design strategy is necessary. While meeting customer expectations in alignment with the brand identity of VKI is one reason, there are other factors to consider as well.

Grimsgaard (2022) says: 'Design is part of the overall strategy. Using design that is rooted in the company's overall strategy, and which should help the company build its position and reputation, achieve its goals and strengthen its competitiveness or other value creation.' She states that design and business are directly related, and that design helps achieving the business strategy. Therefore, the design needs to have an aligned focus with the business strategy.

Furthermore, Heather (2007) argues that the business strategy initiates design, but contrarily, without design, there is no extra value and thus no business: 'Design is initiated by the challenge for businesses to stay ahead of the curve calls for new ways of strategizing for future success. By expanding the applications of design methodologies and mindsets to business enterprises can move beyond mere survival and open up new possibilities for breakthrough growth strategies and organizational transformation.'

And this is the same point that Liedtka (2010) is talking about: 'Here's why design needs business strategy: Because novelty does not necessarily create value. Furthermore, to survive long term, businesses need to be able to capture part of that value in the form of profits.' Design can only be of value with a business or add extra value to it.

Another reason why a business strategy is crucial is because of the purpose it serves. The business strategy is the direction or base to which fitting design strategies should be chosen or created. That can be done with, for example, the optimization approach by Lieder et al. (2017): 'if the relevant business model has been chosen and the maximum additional design effort decided, it is possible to obtain the best fitting allocation of End-of-Life strategies on component level.' This approach optimizes the design strategy for the chosen business model. First, a focus of the business is established, and the appropriate design strategy is chosen. Secondly, the design strategy should be aligned with these business goals. The approach is illustrated in Figure 17..

There is also a explorative approach that works the other way around, which is also illustrated in Figure 17. Different end-of-life strategies are allocated to different components to which the additional design efforts are specified. Finally, the business model through which the product is going to be delivered is decided. By going through these steps multiple times with different iterations, the best design and business potentials are explored (Lieder et al., 2017). Thus, this approach goes both ways; a design strategy needs the business strategy for direction, but a business strategy also needs a design strategy for reaching it's potential.

The directional purpose can also be underpinned with another example given by Magretta (2002). While the point that she is making is about the difference between business models and strategy, it is a good example of how business and design have an important relationship as well. The example is as follows (Magretta, 2002): 'While Dell's direct business model laid out which value chain activities Dell would do, the company still had crucial strategic choices to make about which customers to serve and what kinds of products and services to offer.' The latter may be in the context of a business strategy, it also has effect on the design strategy: 'in the 1990s, for example, while other PC makers focused on computers for the home market, Dell consciously chose to go after large corporate accounts, which were far more profitable. Other PC makers offered low-end machines to lure in first-time buyers. Michael Dell staked out his territory selling more powerful, higher margin computers'(Magretta, 2002). While other PC makers focused on consumers, Dell focused on professionals which requires a different design strategy, opposed to the design strategy required for a consumers market.

'By putting project culture at the center of organizational decision-making, or at least bringing the idea of designing the whole product-system, strategic design needs to seek references and foundations in other areas of professional performance already used to companies and organizations' decision-making process. It will have to bring together project competencies, personnel, and methods from areas such as management, marketing, and communication.' (Scaletsky and da Costa, 2019). This is actually proposed by Verganti (2009), who reasons that there are two essential points are required for design-driven innovation in strategic design. One of those essential points is 'to place the main design competence in the center of organizations' strategic decisions.

Hansen and Grosse-Dunker (2013), argue that in order to successfully bring a function innovation to the market, the business model needs to change. A function innovation is an innovation that is focused on how the product's function is fulfilled best, rather than concentrating on how to improve the product (Hansen and Grosse-Dunker, 2013). This is nicely displayed with an example in their paper: 'a car manufacturer engaging in carsharing services follows an entirely new value proposition linked to new pricing and revenue models, completely changed sales organization, and new partners in the value chain' (Hansen and Grosse-Dunker, 2013). Yes, the design strategy causes a need of change in business strategy but without this business strategy, it would be almost impossible to successfully bring this radical innovation or 'function innovation' to the market.

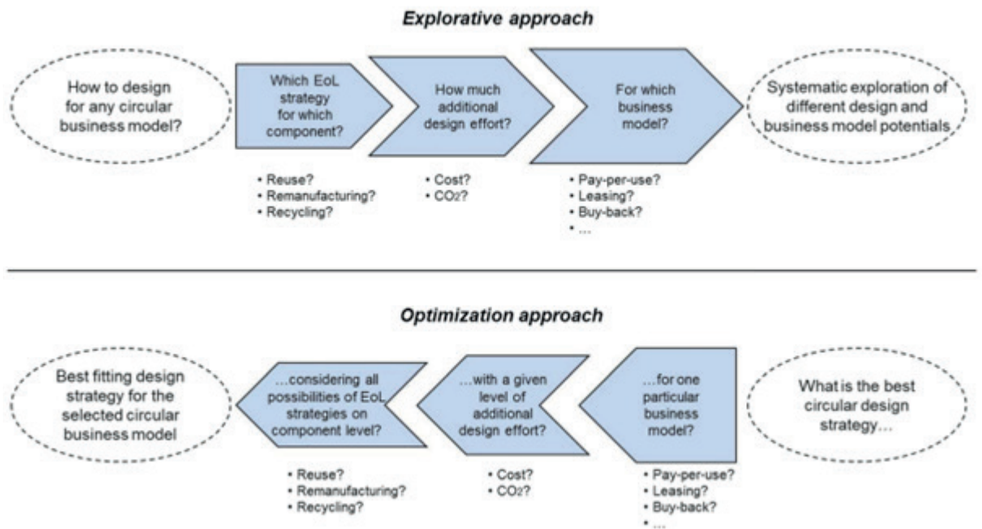

Figure 17. The Optimization and Explorative approach according to Lieder et al. (2017)

So, to summarize, a business strategy is important to a design strategy because:

- Initiates new design
- It has a purpose of direction and foundation for the design project
- It enables a new design to be of value and add value to the business

A main conclusion that can be drawn from both literature reviews on the importance of a design and business strategies is that they have an inevitable relationship which goes both ways. They influence each other, dependent on the goal and focus of the company.

Thus, the business strategy can be used to create a design strategy for this project. This can be done with the help of Gephi, the program used to create the map of Figure 16.

B CLUSTERING THE MAP

In this chapter, the identified relationships are used to generate potential requirements using Gephi software. Gephi was previously used in the chapter 'Exploring relationships between key points' to create an overview of all key points and relationships, resulting in a complex map. This map is then used for the generation of requirements by clustering the map. By doing so, the found interconnections between the key points were further explored by determining their importance. Ranking them by importance revealed their effects and made them somewhat controllable. This filtering method eliminated less significant key points and generated potential requirements. However, to use these requirements for the redesign, the business strategy must be employed as they are still not explicit enough. In this way, the focus of the business strategy was translated into the requirements by selecting the requirements that fit into the business strategy.

The clustering process begins with the Gephi map shown in Figure 16, which shows all the essential key points and their interconnected relationships related to a silence box. Key points are the aspects that can receive focus while designing the silence box. The initial step involves organizing the map to minimize complexity by categorizing the key points into different levels based on their corresponding relative importance. This analysis was conducted using the Gephi software to calculate betweenness, which assesses the number of paths that must pass through a key point to access other key points. If a specific key point is of significance to VKI, those with greater betweenness values are more likely to be the next important key point that needs to be made, or has the potential to be made, in the series of decisions. Key points with low betweenness values are unlikely to be the next important key point in the path the strategy takes, and are consequently eliminated during the map's organization process.

For example, the 'liability' key point is not directly related to the 'size' key points. To reach the 'size' key point, the path goes through 'use-oriented PSS' or 'result-oriented PSS', then through 'modularity', and finally to the 'size' key point (see the red colored lines in Figure 18). What can be seen is that the more lines that lead to a key point, the more likely it is that this key point is one of the decisions that will come next. This is exactly what betweenness calculates: the relative importance of a key point compared to other key points. Clearly, the map depicted in Figure 18 implies that price is the most important key point, since most of the lines go to it.

Now that the map is somewhat organized, the step to requirements can be taken. However, since these requirements will shape the design strategy, it is essential to use the business strategy to determine the right focus. To do so, scenarios are created to explore the underlying relationships of the key points. Gephi is used again as the tool to execute this task. Key points are extracted from the entire network and then arranged into sets (clusters in Gephi). For instance, three to four key points are settled at the outside of the map.

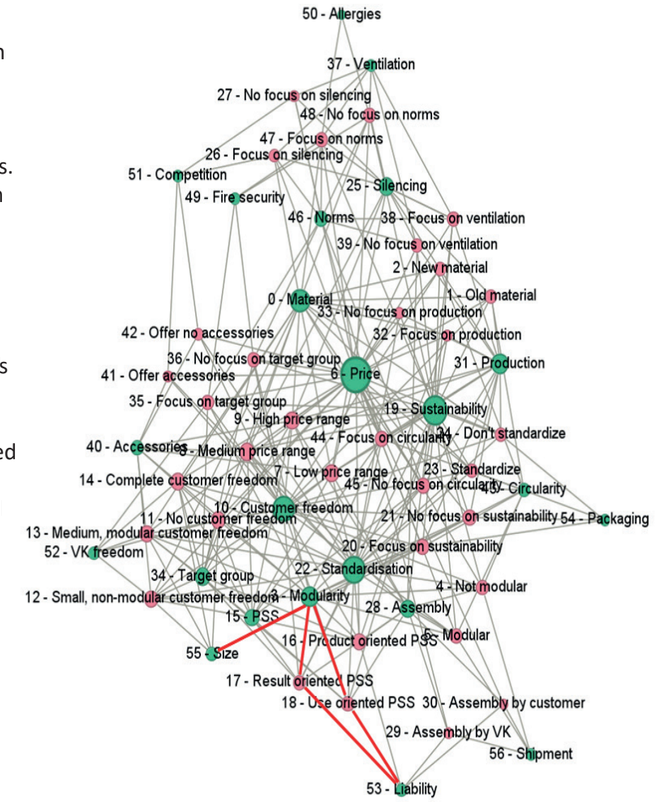

Figure 18. The path from the key point 'liability' to 'size' in the Gephi map.

By rerunning the algorithm, it becomes evident which nodes are more important of these settled key points. The network is drawn towards the most important key point. Herby, a focus can be derived an thus a requirement. This also means that if the focus does not lie on the most important key point, the choice has a big effect on the most important key point.
The sets are determined by current designs, stakeholders, and logical influences. For instance, the material selection affects the noise reduction capacity of the box, which in turn affects its pricing. Clusters lacking underlying relationships between the key points are uninteresting, since they may create distinct requirements for each keyword without combining or influencing one another. The comprehensive explanation of the clusters and their outcomes is provided in Appendix 5.

To illustrate and clarify the methodology outlined above, Set 6 will be explained. The Gephi network of Set 6 from Appendix 5 is shown in Figure 19, with the most important nodes in this case being ‘competition’, ‘accessories’ and ‘noise reduction’. This grouping was determined by their logical relationship; the inclusion of accessories and noise reduction directly impacts the box’s competitive advantage when compared to other products in the market. After running the Gephi algorithm (Figure 20), the network clearly pulls towards both ‘accessories’ and ‘noise reduction’. The unifying element between them is ‘competition’, as they have no direct connection to each other. It is unnecessary to focus on ‘competition’, as the competitive advantage of the box is influenced by the other two aspects, as expected. Both ‘accessories’ and ‘noise reduction’ contribute equally, so prioritizing one will inevitably result in less attention to the other. For instance, accessories play a crucial role in the modularity of the box as they should fit on various modules and constitute a module in its own right. In contrast, soundproofing is not a design consideration, but instead the result of construction methods, material selection, and ventilation. The other way round, the box should be sound-absorbing, thus the ventilation should not produce more than (e.g.) 20 dB, and at the same time the material should be sound-insulating. However, further information is required to determine the significance of both in terms of differentiation from competitors. This is highly dependent on the customer and their requirements, regardless of the target group. This is because customers within the same target group may expect and want different things. VKI is therefore free to determine its priorities and approach to revenue generation. This can be determined by the business strategy.

So, by using this cluster, it is clear that competition is affected by the accessories and noise reduction. Therefore, the two requirements that are created from this are:

- Accessories: The modules should be designed in such a way, that if new, extra modules are developed later on, as little as possible components in modules should be replaced to be able to add the extra module.
    - o Since the only initial requirement of VKI was that the box should be modular, this requirement is related to that initial demand of VKI
- Noise reduction: The box should mute outside noise for at least (e.g.) 30 dB and should mute inside noise at least (e.g.) 15 dB.
    - o The amount of decibels that should be muted should be based on competition and research.

By analyzing the key points in small groups (clusters), more of their effects can be identified and organized. Through this organization, specific requirements have been generated. However, not all of them can be met and only certain aspects need to be focused on. Here, VKI still needs to decide where to focus. The other found requirements can be found in Appendix 5.

PUZZLE PIECE 5:
During the clustering, the underlying effects of every key points are found. So key points influence each other, which in return influences other key points; A influences B. But influenced B influences C and the influenced C influences A again.

Figure 19. Gephi cluster set 6 before rerunning

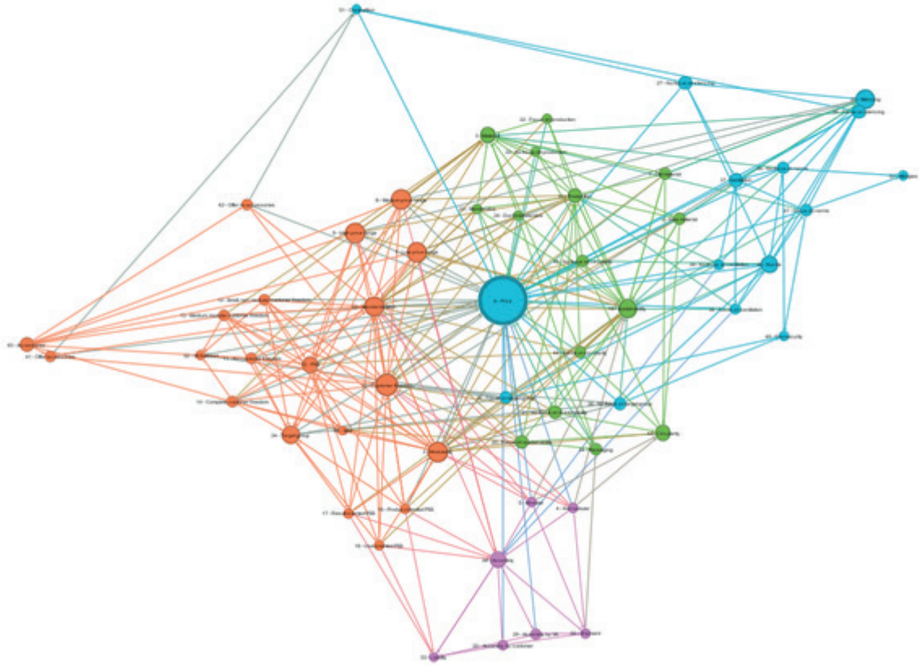

Figure 20. Gephi cluster set 6 after rerunning

5. VAN KEULEN INTERIEURBOUW'S BUSINESS STRATEGY

VAN KEULEN INTERIEURBOUW

To determine the final requirements for the redesign, the business strategy is employed. The business strategy should have a clear focus that can be used to distinguish which requirements are in line with the strategy and which are not. The business strategy can then be used to translate the requirements into a design strategy.

VKI's approach follows Porter's differentiation strategy (Tanwar, 2013), which entails producing unique, custom-designed products for customers. VKI's products are characterized by their quality and reliability, as well as by a high level of customer satisfaction. Such offerings are considered premium products, providing them with a competitive advantage because they are harder to duplicate, but on the expensive side of the market. VKI would rather have an unbreakable product than a product that breaks when the customer does something for which it was not designed. Additionally, as VKI develops for both internal and customer development, the corresponding financial risks increase, including concerns around investments and copycats. Overall, this business strategy lacks a specific target group or market focus, as well as a specific focus. The business strategy is not explicit enough to translate this into a design strategy.

To map out who VKI is to their customers, a brand identity analysis (Figure 21) is done by using the brand identity prism model of Kapferer (2009). The brand identity prism depicts the brand identity of VKI in 6 aspects, divided over 2 categories (Kapferer, 2009):

- The constructed source and receiver: 'a well presented brand has to be bale to be seen as a person and also as the stereotypical user' (Kapferer, 2009).
- Eternalization and internalization: 'a brand has social aspects that define its external expression and aspects that are incorporated into the brand itself' (Kapferer, 2009).

This prism can also be used later on, to evaluate whether the product fit VKI their brand identity and portfolio.

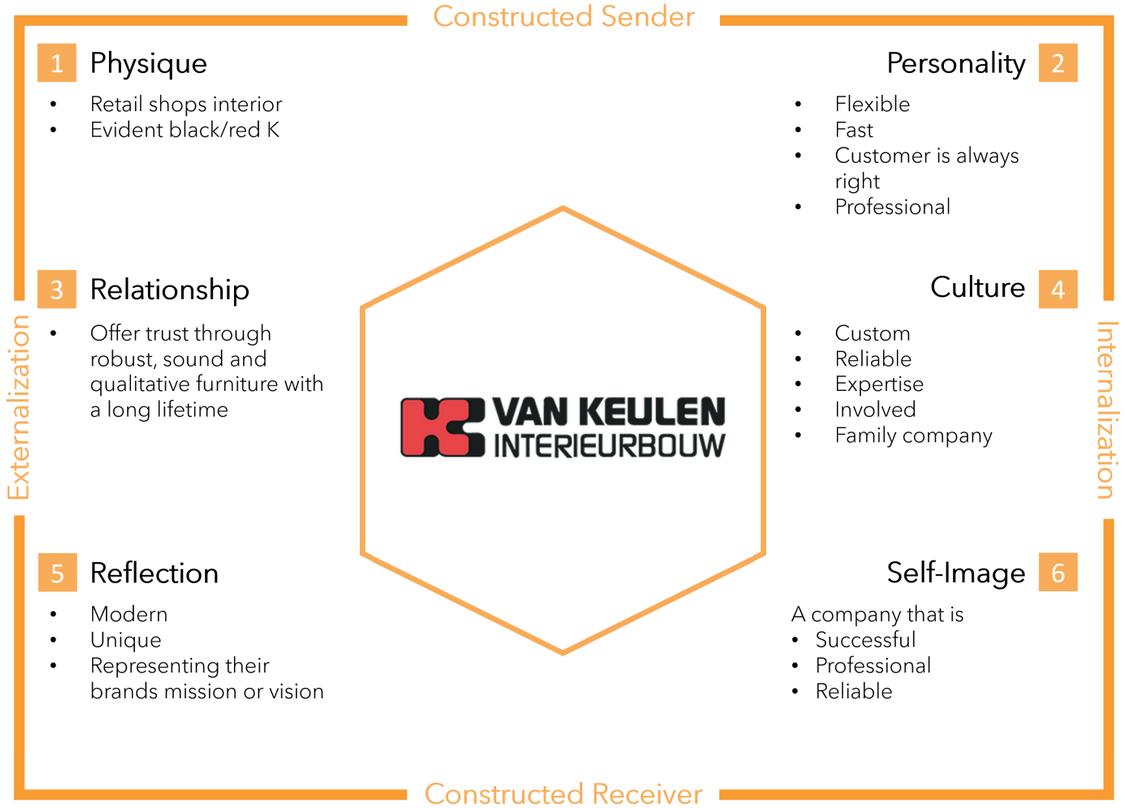

Figure 21. The brand identity of VKI using the brand identity prism

For this project, the lack of an explicit business strategy across the company results in a disconnect between business and design strategies. This hinders effective decision making and overall coherence. For instance, consider the decision of 'customer freedom': since VKI strives to provide great customer freedom (see Figure 21, brand identity prism), it is obvious that the choice between complete customer freedom or no customer freedom is easy. With that choice, VKI will choose complete customer freedom. But the business strategy is not clear enough to determine whether VKI wants to offer its customers partially customer freedom in the form of modularity or just in color and material options. How much customer freedom do they want to offer?

To identify the requirements, a clear focus is required. Although it was expected that VKI's business strategy would provide this focus, it is not explicit enough to achieve this goal. VKI lacks a design strategy because there is no explicit business strategy to guide the design strategy.

PUZZLE PIECE 6:
VKI's business strategy is the final required input.

CONCEPTS

In order to find this unspoken strategy, concepts have been generated. These were all generated with different strategies per concept. After the concept is generated, they were presented to several stakeholders to determine how these stakeholders make decisions. The presentations aimed to find the underlying strategy by determining the personal strategy of each stakeholder. Then, similarities and contradictions are evaluated into one strategy.

To determine the unspoken strategy, 3 different concepts with 3 strategies have been created. These concepts were not completely developed as in a design project. These concepts were designed without a certain design approach and proper requirements, but that is not important for their purpose. The concepts were designed with a specific strategy aimed at understanding how and why respondents make choices in the absence of decision-making structures, and were used to identify the personal strategies they use when making decisions. In Figures 22 - 24, all three concepts, a small explanation and their strategy can be found. The details of the concepts can be found in the Appendix 6.

B UNDERLYING STRATEGIES

During the author's time at VKI and in the field research, it became clear that decisions are still made without always consulting the owner or a manager. Why not? Is there an implicit underlying strategy being applied by decision makers, including the owner? This question can be answered by seeking input from current stakeholders regarding their preferences for new design concepts and how they determine the best option. By utilizing this method, one may identify the employed strategy and distinguish between its similarities and differences. Through this identification, a design strategy can be formulated, since it was discovered that there is no explicit design as well as business strategy that is used within VKI.

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These 3 concept are presented to several stakeholders in this project. The stakeholders that are interviewed are:

- Project manager of previous silence box projects.
- Company owner that was part of the project of Box 1 & 3.
- Technical developer that developed Box 3.
- Lead technical planner & drawer that is involved in this project as a supervisor.

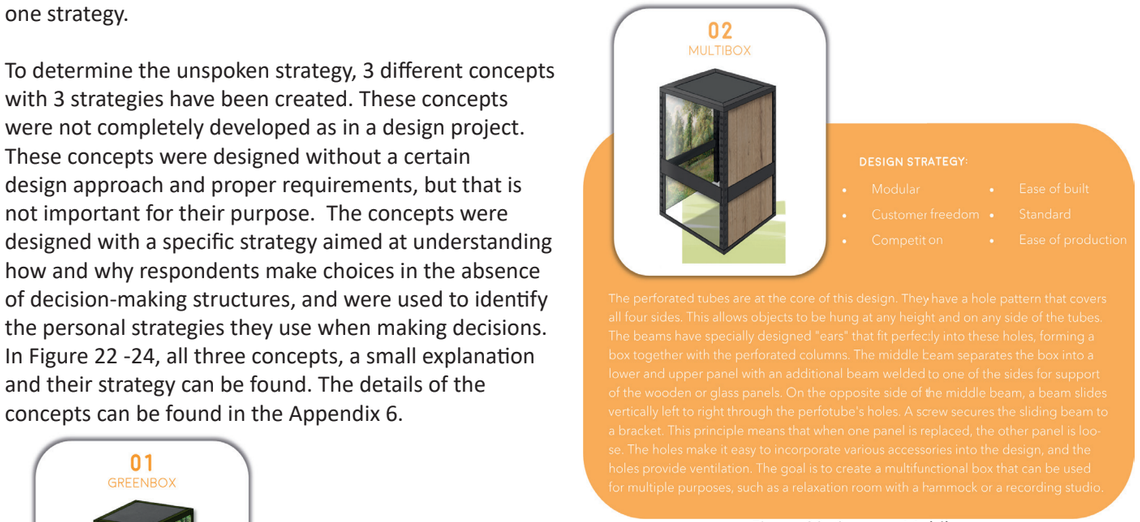

Figure 22. Concept Greenbox

Figure 23. Concept Multibox

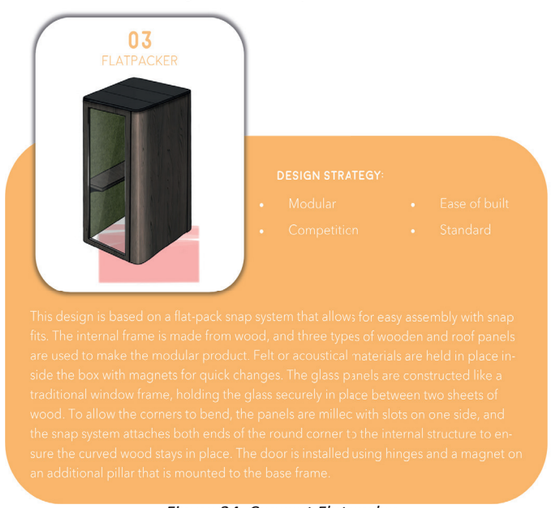

Figure 24. Concept Flatpacker

The interviewees are all internal stakeholders of this project. The owner of the company who participated in Box 2's project, was interviewed differently from the rest of the stakeholders because he was approached purely for a strategic standpoint that could compare with the other owner involved in the Box 1 and Box 3 projects.

The interviews were conducted using the following steps:

- Presenting the 3 concepts: the Greenbox, Flatpacker and Multibox.
- Let the interviewee choose one of the 3 concepts with their initial thoughts, without discussions.
- Present the advantages and disadvantages of each concept, recommendations for future development, and facilitate a discussion between the designer and the interviewee about the ideas. A radar plot comparing all three concepts was used to help discuss this, which can be found in Figure 25. The method of building this radar plot can be found in Appendix 7.

CONCLUSION

The main conclusion drawn from these interviews is that while an internal underlying strategy exists, it is insufficiently explicit to make strategic design decisions. These decisions ultimately rest with the responsible individual of a given task or project, who may face time pressure in making them.

The primary focus for all five respondents is price, which is not surprising when referring back to the Gephi map (Figure 16) and seeing that it is the biggest key point with the most lines going to it. It is important to note that this could be influenced by the fact that their goal in the Box 3 project is to outperform Box 1, especially in price. It is worth mentioning that during the interviews, the development of Box 3 was ongoing. But upon further investigation and during the author's time within the company, it was found that price plays a big role in many projects.

Other common points raised during the interviews were modularity, customer freedom, and ease of production. Modularity is a logical requirement for the design of Box 3 and was also a prerequisite for the initial project assignment. Furthermore, the owner stressed that modular thinking is not only important in product design but also in running the business. For instance, modular machines in production enhance flexibility within the production environment. The focus on customer freedom is in line with the business' strategy. Even though the strategy is not that explicit, this point of focus is translated well to their employees.

Lastly, the ease of production aspect is a predominant focus among the interviewees, which is understandable since VKI is a production company. All of the interviewees demonstrate a practical mindset that leads to such a focus point.

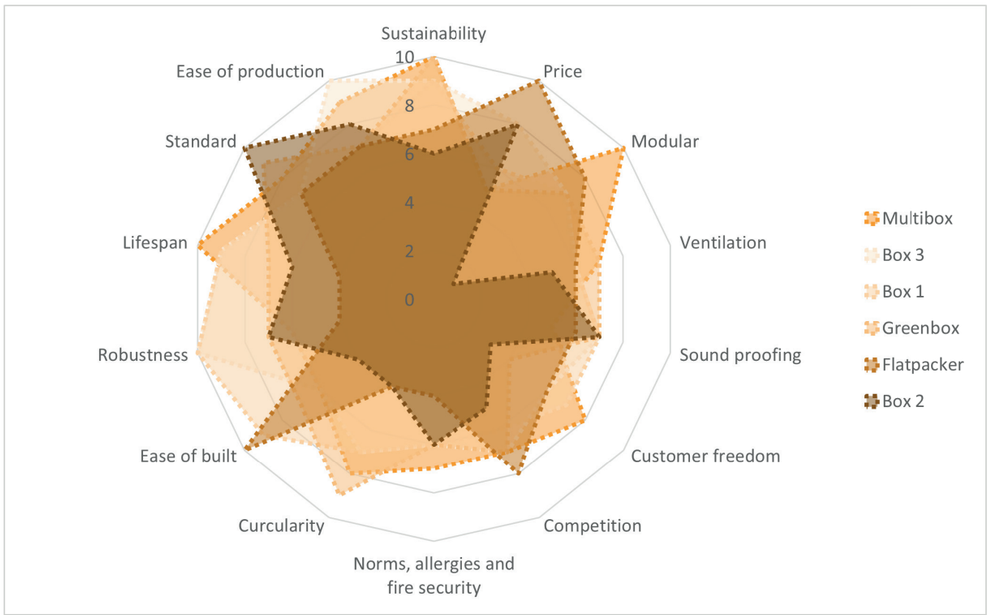

Figure 25. Radar plot of the three concepts, the current boxes and their strategy

There are differences between the Box 3 project owner's priorities and the project manager's priorities. The owner prioritizes soundproofing while the project manager focuses on competition, norms, and ease of construction. These differences are understandable: the owner aims to create the best possible product to represent their company, while the project manager incorporates feedback from various stakeholders such as on-site mechanics and direct customers.

Remarkably, only the technical planner considers the long-term perspective. The Greenbox was selected for its circularity potential by the technical planner despite it not being a key point of the planner's personal strategy. In contrast, the other individuals primarily focused on short term objectives such as generating quick revenue and meeting present customer demands.

An underlying strategy emerges when all responses are plotted on a radar chart. Two key points were mentioned by the majority of interviewees (5), while the other two were mentioned by four. The dominant, general unspoken strategy is:

- Price
- Modular
- Customer freedom
- Ease of production

The personal strategies identified do not fully align with the overarching internal strategy, but a few points are used in their personal strategy. In Figures 27 - 30, these corresponding points (of the general unspoken strategy) are colored white.

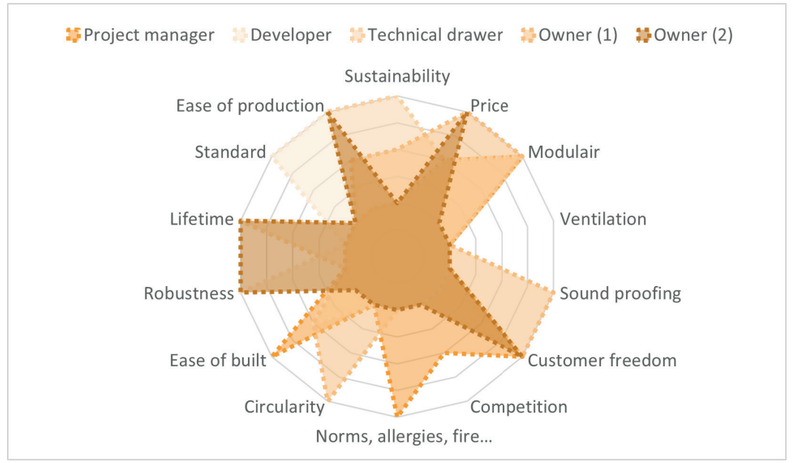

Figure 26. Radar plot of the personal strategies

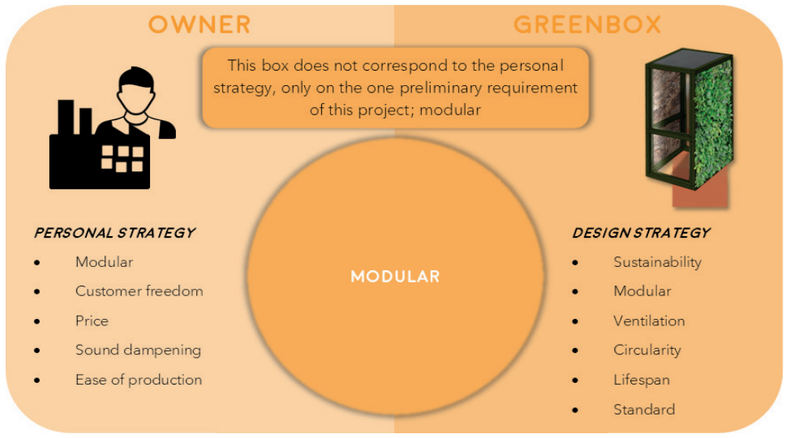

Figure 27. Personal strategy of the owner

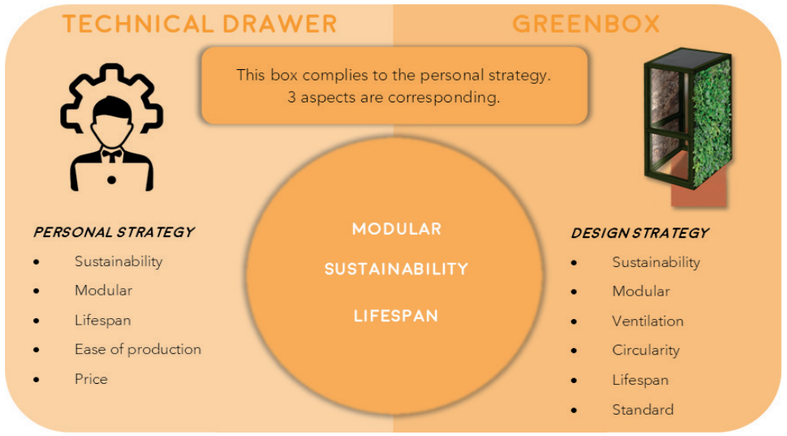

Figure 28. Personal strategy of the technical drawer

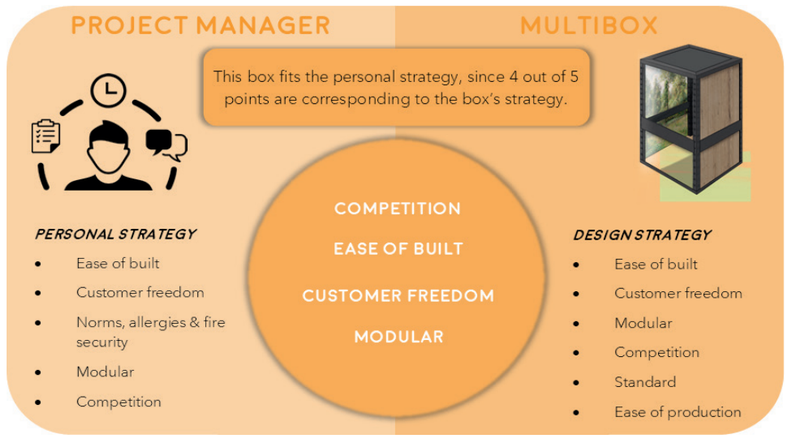

Figure 29. Personal strategy of the project manager

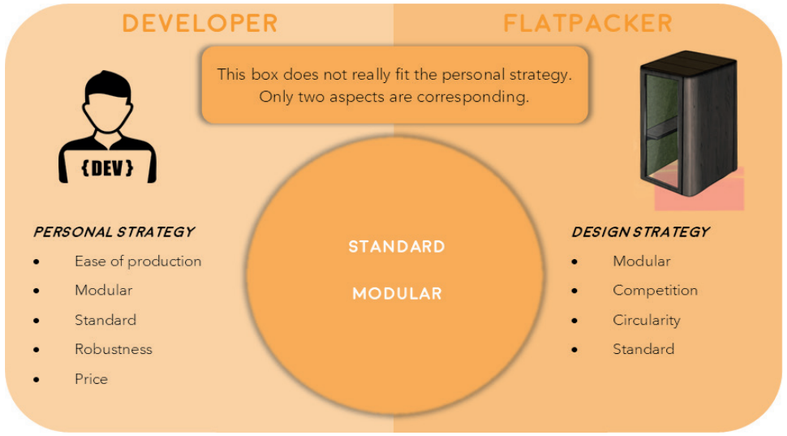

Figure 30. Personal strategy of the developer

A TEST CASES

In this chapter, the personal and underlying strategies were applied to the current designs (Boxes 1, 2, and 3) as well as the concept designs (Greenbox, Flatpacker, and Multibox) of the silence box. In this way, the effects of these strategies were discovered: What are the consequences of applying a certain strategy and, more importantly, what does this mean for VKI? Who has what kind of influence on the designs and thus on the image of VKI? In this chapter, three aspects are examined:

1. *The alignment with the box' strategy*
2. *The alignment with the scores (radar plot) and strategy*
3. *The alignment with the brand identity*

Analyzing both the concept designs and current designs allows for determining the effects of each strategy and identifying possible gaps. This analysis provides VKI with insights into which strategies would have worked well and which could have a negative impact.

In this thesis, a significant gap is already identified: the absence of a clearly defined design and business strategy. This analysis aims to demonstrate the positive impact of implementing a design strategy to address this gap. Next to that, a radar plot has been created for the scores, showing how well each box scores on certain key points, based on the author's knowledge and judgement as well as Appendix 7. This was done because the strategy of the concept could not be aligned, but the box could still score well on a particular key point, for example, due to an effect of focusing on the key point. Additionally, strategies are evaluated with consideration to the company's brand identity, as product design must align with the brand identity. Failure to do so can have a negative impact on the image of VKI and ultimately it's business. This chapter aims to answer the following questions:

- *Do the concept designs (Greenbox, Flatpacker, and Multibox) fit the business strategy?*
- *Do the current boxes fit into the business strategy and brand identity?*
- *What effects do the personal strategy on the current boxes and if these effects are applied, would they still fit VKI's strategy and idetity?*

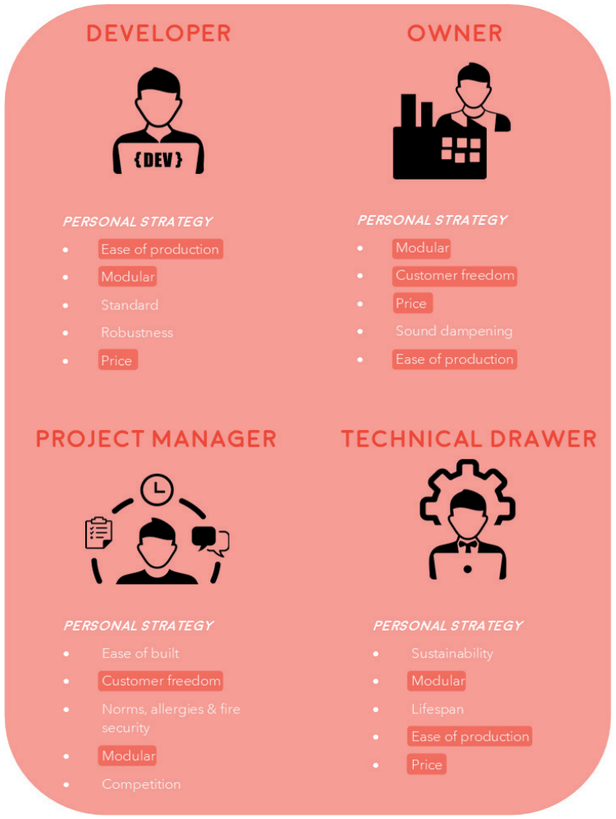

Figure 31. The stakeholders and their strategies

VAN KEULEN INTERIEURBOUW

ALIGNMENT OF THE CONCEPT DESIGNS

The concepts were created with a specific strategy, as shown in Figure B. Normally, a design process would have been executed prior to evaluation, including a research phase and requirements determination for these concepts. However, in this case, such a design process was not executed. The only requirement was that the box should be modular, as this was the initial requirement for the project. These concepts were developed for research purposes. They were created without undergoing a design process but with a clear strategy in mind. For research purposes, only these specific strategies and one requirement were necessary.
The objective of this analysis is the demonstration of the potential impact of a change in strategy. It shows the influence of stakeholders and VKI's strategy, even during the early stages of the design process.

ALIGNMENT WITH THE BOX STRATEGY

The Greenbox shows the lowest correlation with the strategy. In Figure 32, the Multibox has 3 points, indicating strong correlation with the identified strategy. The Flatpacker only corresponds with one point. Therefore, only the Multibox would be suitable for VKI's strategy with some modifications.

ALIGNMENT WITH THE SCORES AND STRATEGY

The boxes were analyzed using a radar plot built-up method that is previously mentioned. The examination is subjective due to the lack of existing data. The Multibox outperforms all other boxes on all four key points and thus fits the business strategy best. Despite its poor score, the Greenbox still performs okay. It scores poorly on price and customer freedom, but this is intentional to improve sustainability. The emphasis on circularity and sustainability has hindered customer freedom in regards to the box. The green wall idea would make the selling price expectedly high. However, implementing a PSS strategy could allow the box to be rented at a lower price. But, this is not aligned with the current business strategy of VKI. Moreover, the Flatpacker performs sufficient in all aspects, with no low or high points. While it can fit VKI, modifications are necessary for optimal adaptation.

ALIGNMENT WITH THE BRAND IDENTITY

While the Greenbox does not align with the business strategy, it does partially align with the brand identity. The box is flexible, robust, of high quality, and unique. This is a situation where the business strategy and brand identity are misaligned, yet the box still works. The Multibox is the best fit for VKI's identified strategy, particularly its brand identity. The box precisely represents VKI, with only the box aesthetic requiring improvement based on the interview comments. The Flatpacker does not align with the brand's identity. The wooden construction of the box is expected to result in a lack of durability and sturdiness, contradicting VKI's main vision and compromising their trustworthiness.

Figure 32. The concept designs and their strategy

ALIGNMENT OF CURRENT BOX DESIGNS

The current designs also incorporate a design strategy, whether intentional or not. However, some of the boxes were designed prior to the author's project at VKI, resulting in the tracing back of certain strategies. Figure 33 shows what strategies were suspected to be employed.

ALIGNMENT WITH THE BOX STRATEGY

The key points in table 3 correspond to the identified strategy. Box 3 receives the highest score. While Box 1 was designed for a specific customer and is therefore not compatible with the strategy, Box 2 is partially compatible with the strategy, but its follow-up process falls short. The box lacks robustness and fails to meet VKI's quality standards. Insufficient time allocated for designing the box is a major contributing factor to the rough follow-up process. Moreover, the lack of emphasis on customer freedom contradicts one of VKI's main focuses. Even though Box 1 is not one of the box's strategic points, it does align with the customer freedom aspect. During the design phase, it was created with the customer in mind, which allowed for significant customer freedom. However, the final product does not offer much freedom to VKI's client's customers. Consequently, the design lacks customer freedom, while the design process itself did prioritize it.

ALIGNMENT WITH THE BRAND IDENTITY

Not all types of boxes are aligned with the established brand identity. Box 1 and 3 are most suitable due to their flexibility and modular design, offering customers some degree of freedom. However, customer freedom can be further enhanced in both box types to better align with the brand identity. This can be achieved by incorporating accessories. For Box 3, which is currently in the early stages of development, the available options have not yet been fully designed and thought out due to time constraints. However, there is a desire to include them in the future. Box 2 is not in line with the brand identity as it is inflexible and of lower quality than desired. This is mainly due to the fact that it was designed with a cost constraint, which should be kept low. Nonetheless, this box does not align with VKI's desired image, product portfolio and brand identity.

ALIGNMENT OF SCORES AND STRATEGY

When analyzing the scoring of the boxes shown in Figure 25 of chapter 'Concepts' and considering the discovered strategy, it is evident that Box 1 performs better. However, Box 3 remains the best fit for VKI as it was designed specifically for themselves at a later time and incorporates the previously identified strategy. Additionally, the designers were able to learn from previous mistakes and avoid them in this new design. Unfortunately, Box 2 still has poor scores and does not align with VKI's strategy.

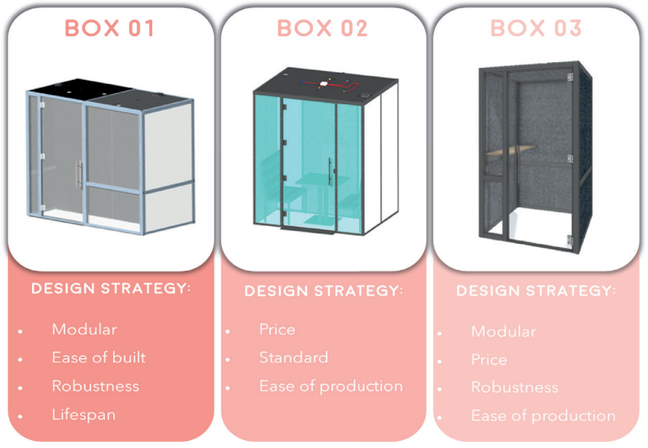

Figure 33. The current box designs and their strategy

ALIGNMENT OF THE PERSONAL STRATEGIES' EFFECTS

As mentioned previously, the individual strategies do not entirely align with the identified strategy, which is expected given their personal nature. To assess the impact these strategies may have on the boxes and subsequently on VKI, a few final clusters of key points (like the chapter 'Clustering the map') using the previously utilized Gephi tool have been generated. The personal strategy key points are settled, and the algorithm is run again. The key points closest to the settled nodes are now the closest key points to focus on, and will therefore be the next focus point. There are the 'effect key points'. Table 3 displays the resulting data.

The project manager has different strategies than the other three team members, which affect their impacts. These effects can be applied to Boxes 1, 2, and 3. In Appendix 8, all boxes and associated personal effects are described. Two effects were singled out due to the fact that the analysis revealed their consistent negative or positive impact, independent of the type of box. Below, an example is given of a positive impact.

In this example, the project manager's impact and Box 1 were utilized. The manager's strategy can influence the selected material in combination with the emphasis on standards. The packaging type is also well-suited for a Product-Service System (PSS), requiring no modifications. This relates to the increased focus on sustainability and circularity. When used in combination with the VKI strategy and the brand identity, this personalized effect has the potential to enhance the product portfolio and align perfectly with the brand identity. Therefore, it can be concluded that this effect is positive.

But, there is also an example with a negative effect. Negative means that the effect does not align with the current business strategy and brand identity. This does not mean that it is a bad effect, it is just different from the identity and strategy.

Here, the effect of the technical drawer on the design of Box 1 is examined. Between ease of assembly and ease of production a trade-off is observed. While these factors do not directly affect each other, they may have an impact on each other. On the positive side, Box 1's robustness will increase as the technical drawer prioritizes a longer lifespan. Additionally, the Product Service System (PSS) will help to promote sustainability, so this will be implemented as well. The selection of materials is affected by factors such as regulations and fire safety, along with sustainability considerations. And thus, different materials will be used in the new design. If this personal strategy were to be implemented, it would result in a very different product from what exists today. However, this approach would not align with current branding and strategy, making it a negative effect.

Table 3. The effect key points per personal strategy

Project manager	Developer	Technical drawer	Owner
VKI freedom	Ventilation	Ventilation	Competition
Accessories	Sound proofing	Sound proofing	Use oriented PSS
Sustainability/circularity	Competition	Competition	Norms
Use oriented PSS	Material	Use oriented PSS	Fire security
		Norms	
		Fire security	

CONCLUSION

To conclude, the business strategy is an area of improvement. The personal strategies can have varying impacts on the design outcome, resulting in the product not aligning with VKI's standards. This depends on the individual. However, this gap can be filled by implementing a more explicit business strategy with more focus. If this general approach is insufficient, specific project priorities can be defined with the stakeholders at the beginning of the project to ensure that the product is in line with the business strategy as well as with the customer's needs. The more explicit business strategy enables a more explicit design strategy, aligning the newly designed product with VKI's strategy and brand identity.

PUZZLE PIECE 7:
The designs are evaluated based on their alignment with the business strategy and brand identity. This evaluation discovers whether the new design fits into the business before launch, to enable for adjustment if necessary.

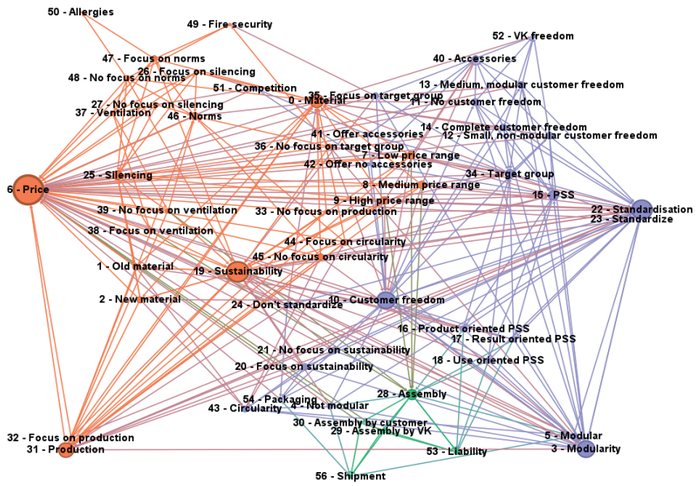

Figure 34. The Gephi map of the developers strategy, before rerunning

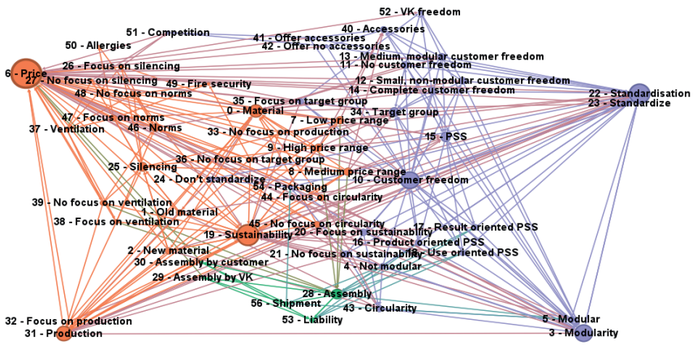

Figure 35. The Gephi map of the developers strategy, after rerunning

7. FRAMEWORK

A FRAMEWORK

During the course of the project, several pieces of the puzzle were discovered. These pieces can be assembled to form a comprehensive framework, depicted in Figure X. The framework, along with its corresponding step-by-step plan, presents a clear overview of the project process. It includes all the essential steps and inputs needed to translate the business strategy into a design strategy. The resulting guideline is not only useful for VKI, but also for other companies. With this framework, translating the business strategy into a design strategy becomes more efficient. It includes only essential steps to enable the translation. While not all steps are necessary for every translation, their exclusion from this framework doesn't diminish their value. All steps in this process contribute to the final result of this framework. Without the other steps that are not necessary to the framework, this work may have yielded different results. In this chapter, the framework will be explained.

The found puzzle pieces:

1. A relationship has been discovered between the functions of the box.
2. Several key points were identified.
3. Interconnections between the key points were discovered.
4. All key points have bene identified.
5. The underlying effects resulting from the interrelationships of the key points have been uncovered.
6. The business strategy of VKI has been established.
7. The last step of the framework has been completed: the evaluation of the design

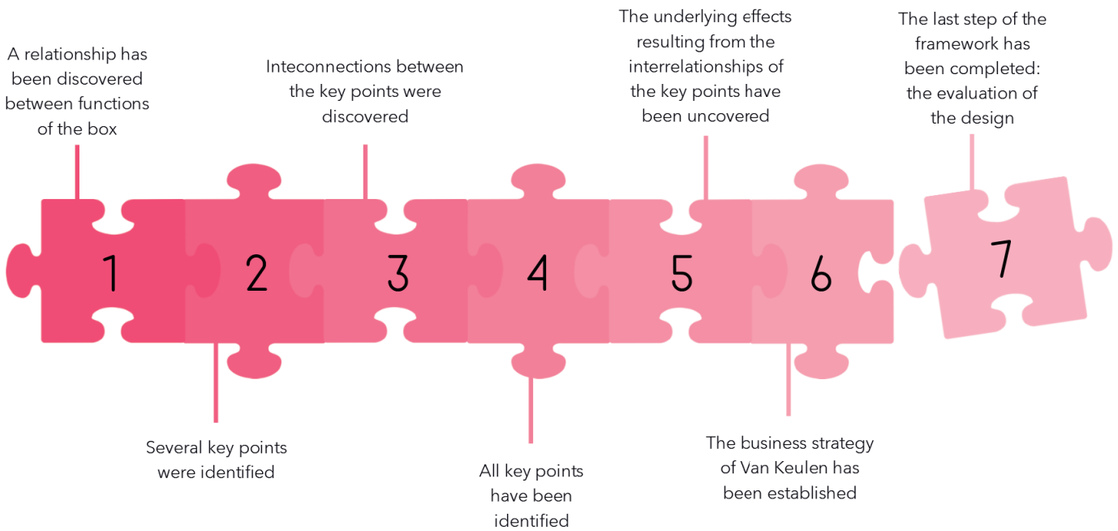

Figure 36. The puzzle pieces found throughout the project

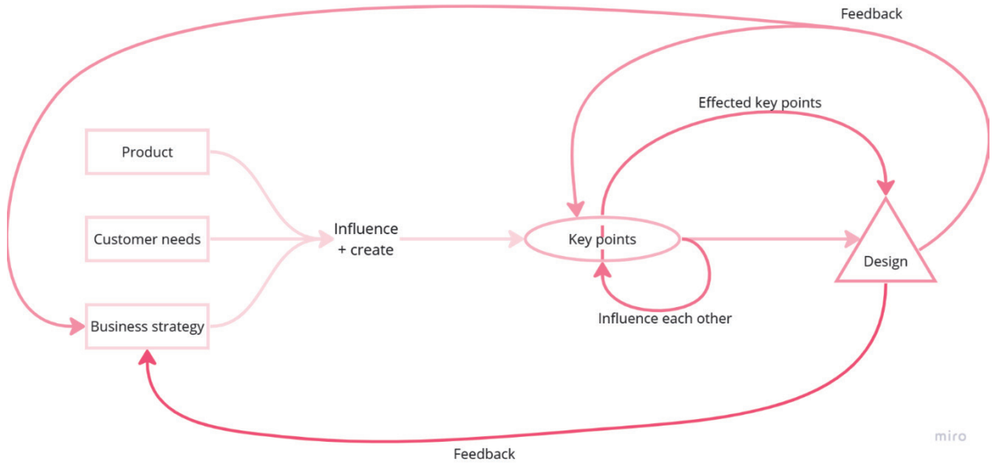

Figure 37. The established framework

The puzzle pieces represent inputs, observations or steps that all contribute to the translation of the business strategy into the design strategy. These are combined together in the framework (Figure 37), and have a certain flow (Step-by-step plan Figure 38).

The first step in the process depicted in this framework begins with identifying the product and its type. Is it a stand-alone product or a complete product family, such as a modular soundproof box? This determination will influence the importance of certain key points. For instance, if it is a product family, standardization or modularity might be more important than other aspects. These key points may become less important if only one product is being created. This step in the framework is completed during the product analysis phase of the project. This steps belongs to the block 'Product' in the framework.

Secondly, it is important to have an understanding of customer needs, which can be in the form of requirements. These requirements determine other key points, for example, the target group wants accessories, so this becomes a key point. However, they have to be evaluated together with another, final factor: the business strategy. In the case of this project, this comes together in the concepts, where the needs and strategies of the stakeholders are fully identified. The customer needs fit into the 'Customer needs' block of the framework.

The three blocks 'Product', 'Customer needs', and 'Business strategy', together form the necessary input for the translation. Retrieving these three information blocks are step one in the step-by-step plan of Figure 38.

Some of the company's key points are outlined in the business strategy, and must be translated into the design to produce a quality product suitable for the target market. How does the company define a "good product"? These factors are crucial considerations in the business strategy. The business strategy fits into the 'Business strategy' block of the framework. The research phase of a design project collects these three (Product, Customer needs, and Business strategy) inputs.

The research phase can be used to highlight key points about the product, as in this project. Furthermore, a mind map can be used to brainstorm all relevant factors related to the product. These points can be further narrowed down to the most important key points while keeping in mind the customer's needs and the business strategy. So, the three input blocks (Product, Customer needs, and Business strategy) together also determine the key points. They are the input of which the key points are discovered. This corresponds with step two of the plan in Figure 38.

An example: for the silence box, the mind map indicates a price range. This raises the question whether the product should be priced high, medium, or low, which can be determined by considering the company's business strategy. What price range does the company typically operate within and what message do they want to convey to their customers? Do they want to be a high-end company that provides products of superior quality, or do they want to provide lower-priced products that are very good value? Is their goal to become an A-brand or a private (B) label of the supermarket?

These inputs shape the key points, but as seen in the example above, also influence the key points. The three inputs act as a preliminary filter for important key points. The next step is to identify the most critical key points to develop a clear strategy and prioritize them accordingly (step 3 and 4 in Figure 38). The justification for prioritization will be examined later. So it is essential to prioritize a key point while keeping the business strategy and customers' needs in mind.

Priority is important to keep a strategy. Because all points are intertwined with relationships and effect, as seen in the Gephi map (Figure 16) an order is required, otherwise the process will just go back and forth. For example, looking at the key points material and sustainability. To become more sustainable, other materials can be used. But, buying bulk and creating other products from the material that may be less sustainable but creates less waste is also an option and has an positive effect on the sustainability. Which of the two is more important? Keeping the same material and a bulk advantage or go all-in for sustainability? This can even go further by making the size of the box dependent on the base material. As shown in the example, a lot of effects are created by selecting one key point. To prioritize these effects, the first level should be examined. This first level includes the direct and logical effects of the key points on others. This is a condensed step of the clustering process covered in the 'Clustering the Map' chapter. The impacts mentioned are illustrated in the framework through the loops called 'Influence each other' and 'Affected key points'.

For example, by prioritizing sound proofing, it becomes logical that the selection of material becomes more important. Additionally, a requirement can be established for the material: The material should be at least (e.g.) 15 dB sound insulating. Although, soundproofing has additional relations, such as norms that may be applicable, but these are not as closely related as material.

Focusing on key points and their effects enables the creation of requirements that translate the business strategy into a design strategy. The key points themselves also generate certain requirements. In addition, it is important to consider the effects that key points have on each other during the design phase. This is investigated in step 5 of the step-by-step plan in Figure 38.

Step six and seven are not specifically shown in the framework of Figure 37. This is all implemented into the design, depicted in the triangle with 'Design' in Figure 37.

Lastly, there are two feedback loops integrated into the process (step eight in Figure 38). The first feedback loop can be obtained after the completion of the design phase, which is indicated by the bottom arrow. The bottom arrow represents the feedback on the company's applied business strategy. This step was partially performed by the test cases in this project. This feedback assesses whether the design is suitable for the brand identity and the company's requirements, or whether any adjustments are needed. This can be carried out prior to product launch to enable for changes if it doesn't align with the company's strategy. The second review is conducted after the product is positioned in the market. Is the product suitable for the market? Does the strategy align with the market? Has the focus been on the appropriate key points, or should there be some alterations?

So, a business strategy can be translated to a design strategy with the framework presented in Figure 37. Furthermore, a small overview of the required steps can be created, as seen in Figure 38.

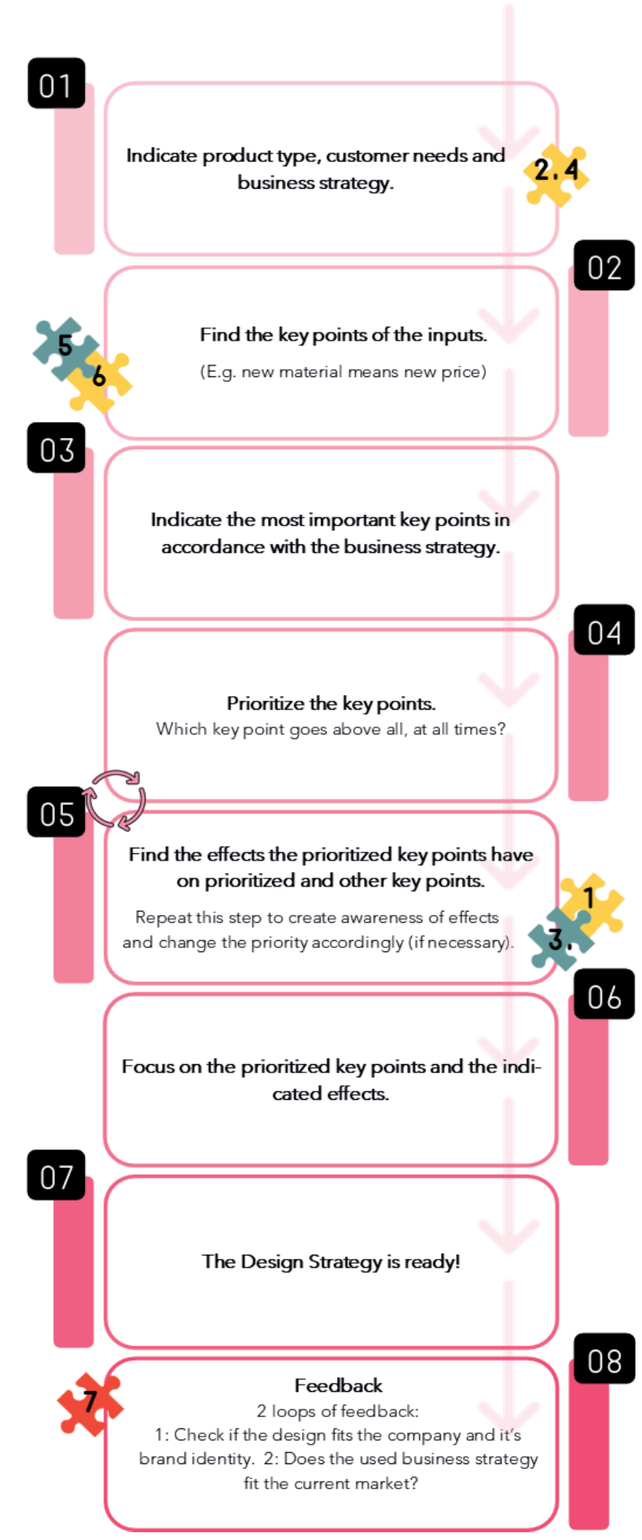

Figure 38. The step-by-step plan to translate the business strategy into the design strategy

8. CONCLUSION

This thesis is conducted to answer the question: ‘how to translate a business strategy into a design strategy?’ However, the initial aim of this thesis was to create a redesign of the silence box. The first step of this project was a research phase. Through the research process, the relationships between box functions and project focus were identified. However, as the initial design decisions in the ‘Strategy’ chapter were considered, these relationships became more important and indicated the complexity within this project. Several focus areas were found to be interrelated, requiring more research than originally anticipated.

One approach to organizing the complexity is by implementing a design strategy, which serves as a foundation and guide throughout the development process, and ensures alignment with business objectives. This approach focuses the project. However, it is crucial to investigate the relationships among key elements before determining that focus and understanding what impact it could have.

The exploration of key points is done using a mind map. A main key point is surrounded by other key points that are related to it. The relationships, whether positive or negative, are also determined at this stage. Additionally, a third effect is identified: the relationship among the key points that are not the main key point but have an impact on each other in conjunction with the central key point. All of these interrelationships are brought together in a single map, which demonstrates the true complexity of the project. Consequently, the project’s aim has shifted from redesigning a silence box to formulating a design strategy. To determine the most appropriate design strategy, the business strategy can be used along with this map. The business strategy provides both a purposeful direction and a foundation for the design project.

Before implementing the business strategy to focus the project, a deeper dive into the key points and their relationships is done in the “Clustering the Map” chapter. This step involves clustering the key points and utilizing Gephi software to identify the most significant key point. These requirements were still focused on a lot of key points. Subsequently, the business strategy’s focus is applied to develop a design strategy and determine the most important requirements. At this stage of the thesis, the goal has developed into its final objective: How to convert a business strategy into a design strategy?

However, during the research conducted on the business strategy of Van Keulen Interieurbouw, it was discovered that there was a lack of explicit strategy. This absence of an explicit strategy was identified as the root cause of the complexity of the project and why reducing this complexity was challenging. An attempt was made to address this issue by investigating underlying strategies. It was hypothesized that the employees might have been using the same strategy while making decisions, but it was not explicitly communicated. New concepts of silence boxes were created and presented to interviewees, resulting in the discovery of an underlying strategy.

These unspoken and personal strategies were applied to both the current box designs and new concept designs discussed in the ‘Test Cases’ chapter. The purpose was to demonstrate the impact of each strategy on the design and VKI’s brand image. In conclusion, these personal strategies significantly influence the design’s outcome, affecting VKI’s brand image both positively and negatively. Therefore, implementing an explicit design strategy is necessary to avoid this issue, and one way to achieve it is by making VKI’s business strategy more explicit.

The steps taken in the project can be incorporated into a framework to guide VKI in new product development, together with developed the step-by-step plan. The tools help create a well-supported foundation for the project. It addresses the necessary focus key points from which requirements are formulated. However, in order for these tools to be most effective for VKI, it is necessary for them to clarify their business strategy. Once their business strategy is made explicit, it will serve as a foundation not just for one project but for all future projects. In addition, other companies can use these tools to translate their own business strategy into a design strategy, ultimately saving time in the development of new products or redesigns.

9. DISCUSSION & EVALUATION

A DISCUSSION

During the research conducted in the ‘Strategy’ chapter, assumptions were made about the potential effects of certain key points. These assumptions were necessary to provide a starting point for examining the impacts, as time constraints did not allow for an in-depth examination of each effect.

In the ‘Clustering the Map’ chapter, not all scenarios are explored. Only logical and well-known scenarios are explored, primarily due to time constraints. Ultimately, investigating these scenarios further is expected to provide little to no value, as the primary objective shifted away from redesigning and the development of requirements became less important. However, this step still provided value to the project. It served as a means to translate the business strategy into necessary requirements and analyze their impact, ultimately contributing to the final framework.

Thirdly, the framework has only undergone partial theoretical testing in the chapter “test cases”. Ideally, a redesign would be developed using the framework to observe the practical implementation of the tool and to identify potential improvements. However, this was not possible due to time constraints.

One aspect to be taken into account with regard to the analysis is the subjectivity of the analysis. Certain aspects were subjective because the author performed the analysis. For instance, the scoring of the FMEA was not determined objectively since it was not derived from practical data. In addition to the FMEA, the author also determined the scores on the radar plots for the new concept designs and existing boxes. No data has been collected on this matter, although the author established a standard, as demonstrated in Appendix 7. However, since the new designs are non-existent concepts, measuring them is challenging. Subjectivity may lead to different scores among developers. It would be beneficial to have other developers review and create scores to provide a more objective total score. However, this result was considered inconsequential because no changes in personal or underlying strategies are expected due to a change concept scoring. Moreover, the author comprehends the logic behind the underlying strategy through observations during her time at VKI.

However, there is a need for further research to refine the underlying strategy. Only four VKI staff members were interviewed for this project, all of whom were stakeholders in the silence box project. As a result, their personal strategy may have already been aligned with the personal strategies of other stakeholders, potentially biasing their wants and needs. It is possible that these individuals may have already discussed certain design choices due to their involvement in the development of Box 3. In addition, the potential for bias may be increased by the other two box projects (Boxes 1 and 2). Therefore, it may be necessary to conduct additional employee interviews to ensure that no bias has influenced the underlying strategy found.

Finally, time has significantly affected the designs of Boxes 1 and 2. This makes it difficult to determine the strategy used and the reasoning behind the design choices. Therefore, test cases are subjective. Interviews were conducted with project stakeholders, but since some time has passed, they cannot recall all the reasons behind certain design decisions. Consequently, the strategy employed was estimated.

B RECOMMENDATIONS

The first recommendation to VKI is to use the proposed framework and step-by-step plan when designing a new product. This will establish a solid foundation for creating new products and serve as a valuable reference for future redesigns. It should be noted that adopting this approach may require additional preparation time, particularly if the base is not strong enough (or if there is no base at all). In addition to recommending the use of this approach for the project's design strategy, it is suggested that a general design strategy be created. This general strategy can serve as a foundation for developing a specific strategy for the project. With a general strategy in place, the same tools (framework and step-by-step plan) can be used to create a project-specific strategy more quickly and easily. Creating a general design strategy requires an initial investment of time, but ultimately reduces the time taken to develop a project-specific strategy. However, it is essential to establish a clear business strategy before undertaking this general design strategy.

The absence of a clear business strategy was ultimately the primary issue and conclusion of this project. As a result, it is recommended that VKI formulate a more explicit strategy and, most importantly, communicate it effectively to all employees. It is crucial that everyone is aware of and well-informed about a specific business strategy, allowing them to make informed decisions. A non-communicated business strategy can not be implemented. Additionally, implementing an explicit strategy can foster innovation within VKI and facilitate the ongoing development of its existing product lines. This approach can be especially beneficial for projects that have experienced stagnation and contain errors. For example, Box 2 could have been developed and innovated into a product that is a standard and "easy money" because it is already in the system and only needs a production order. Furthermore, this foundation is crucial in the creation of a new product line to ensure it aligns with the portfolio, market, and brand image, resulting in a cohesive and aesthetic interior. VKI has the necessary aspirations and opportunities to achieve this goal, and this approach could make this ambition possible. Lastly, the utilization of these tools is essential during the redesign of the box, since the redesign initiated this research that is concluded in a framework and step-by-step plan.

Finally, more research should be done on the framework. It has not yet been tested, as mentioned above. This testing should be conducted at VKI and other companies to determine the method's effectiveness across VKI as well as other companies and its impact on the design process. Feedback loops, which are already integrated into the framework, can be utilized to measure its impact.

C EVALUATION & REFECTION

As previously mentioned, significant changes occurred during the course of this project. Midway through, the initial objective shifted, a new developer took over, and time constraints were added. In the end, these changes resulted in a more impactful and intriguing thesis. However, it is unfortunately true that certain steps taken earlier were not of value.

The first change that took place was in connection with a point of stagnation. The initial challenge arose at a stagnation point in the 'strategy' chapter, where the project was found to be more complex than anticipated. The point was overcome with the help of my supervisor and friends. Preferably, as with the original goal, I would have designed a new box and tested it with a prototype. However, for academic purposes, the change in objective was preferable and ultimately more engaging. Moreover, the project's objective was transferred to a different developer during the transition. The owner made this decision, unaware of my involvement in the same project. The owner wanted to create a new box as soon as possible, due to a situation that occurred. The developer was aware of the my involvement and addressed the issue. Eventually, it was decided that I would continue with my thesis as planned and collaborate with him whenever possible. The time pressure was on his shoulders, not on mine. Initially, I felt disappointed to develop a design alongside his design since the likelihood of my design being produced decreased. However, I was well aware that it would have been nearly impossible to complete my thesis and design a new project in a few weeks, so the change in goal was a positive change that gave my thesis value to VKI in a different way.

However, there were some limitations to this mid-course objective change. The main reason for these limitations was time. For example, I could have done more research on the underlying strategy and where it came from, or a deeper dive into their development process and how the framework could be better tailored to that process. Furthermore, I would have liked to apply the framework and step-by-step plan in practice by redesigning a box to evaluate its effectiveness as a guide and foundation. In addition, other tools could be integrated with this tool to establish a standard foundation for VKI's development process.

If the objective had originally been to translate the business strategy to a design strategy, the approach would have differed. The first conclusion would have indicated the absence of an explicit business strategy. Subsequently, a more in-depth investigation would have been conducted on the underlying strategy. Also, the concepts used for the presentations could have been developed further and measuring the scores in the radar plots, or asking more developers what they thought to get a more objective view of my own designs. I would still have applied this process to a product, also to make it less abstract for myself and the reader, as well as to actually implement and test the results of this thesis.

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11. APPENDIX

1. FLOWCHARTS

Some terminology is used in the flowcharts. For better understanding, the terms are defined:

Door draught excluder aluminum profile - Tochtprofiel deur
: A rubber with an aluminum profile to close the gaps of a door.

Weather strip P profile - Tochtband of tochtrubber
: A rubber p-shaped profile to close gaps.

Rebate - Sponning (koker waar het tochtprofiel is opgelast en samen gelast is met de stijl)
: Tube where the door draught excluder aluminum profile is mounted to, together with the window pillar.

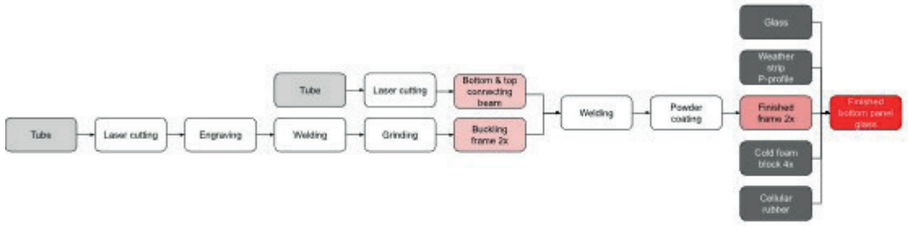
Shim magnet - Vulplaat magneet
: A plate where the magnet is attached to.

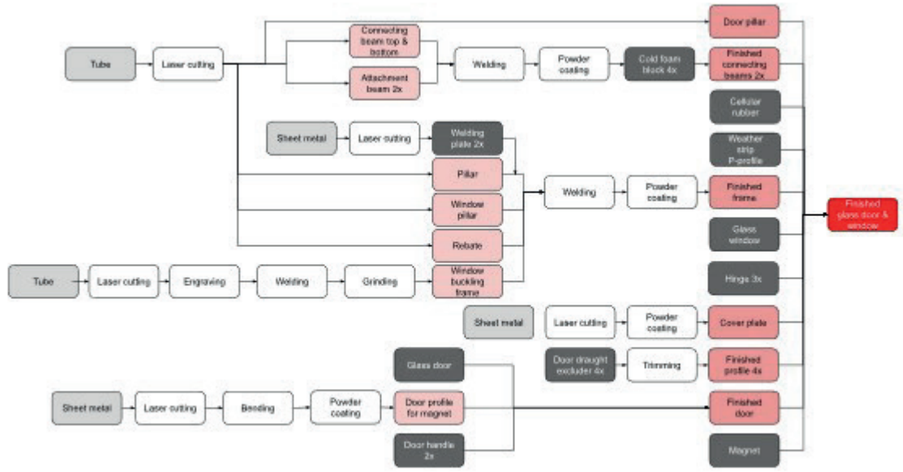
Door pillar - Aanslag deur
: Pillar to accommodate the door.

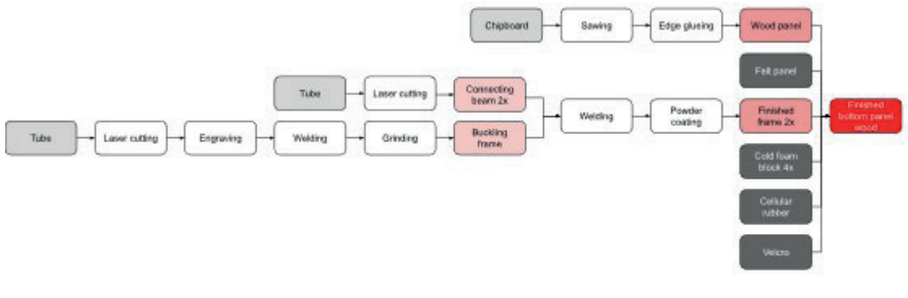
Connecting beam top – Bovenbalk
: Beam to connect pillars, at the top of the box.

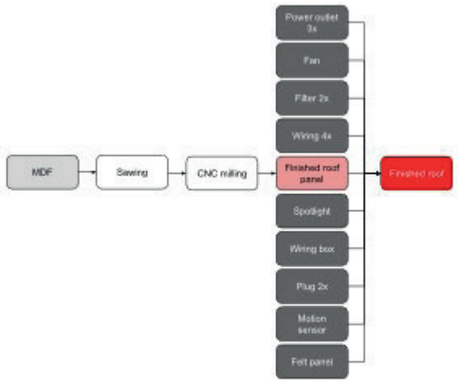
Connecting beam bottom - Dorpel koppelbalk
: Part of the doorframe is a small beam on the floor, which results in a threshold at the bottom of the door opening.

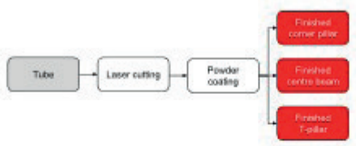
Window pillar - Stijl
: A tube acting as one of the pillars in the box.

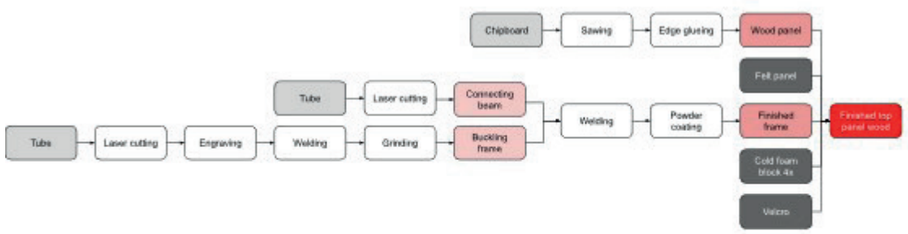

Tube
Laser cutting
Engraving
Welding
Grinding
Bottom & top connecting beam
Buckling frame 2x
Welding
Powder coating
Finished frame 2x
Glass
Weather strip P-profile
Cold foam block 4x
Cellular rubber
Finished bottom panel glass

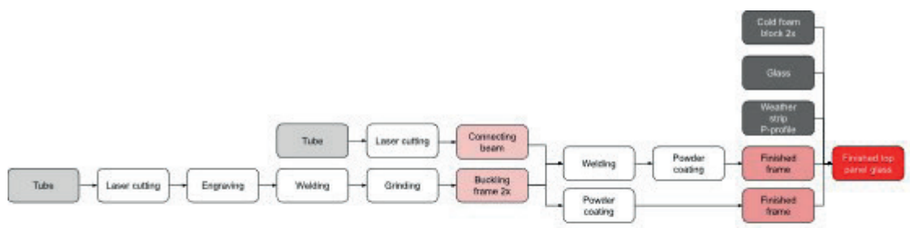

Tube
Laser cutting
Connecting beam top & bottom
Attachment beam 2x
Welding
Powder coating
Cold foam block 4x
Door pillar
Finished connecting beams 2x
Cellular rubber
Weather strip P-profile
Sheet metal
Laser cutting
Welding plate 2x
Pillar
Window pillar
Rebate
Welding
Powder coating
Finished frame
Glass window
Hinge 3x
Tube
Laser cutting
Engraving
Welding
Grinding
Window buckling frame
Finished glass door & window
Sheet metal
Laser cutting
Powder coating
Cover plate
Door draught excluder 4x
Trimming
Finished profile 4x
Glass door
Sheet metal
Laser cutting
Bending
Powder coating
Door profile for magnet
Door handle 2x
Finished door
Magnet

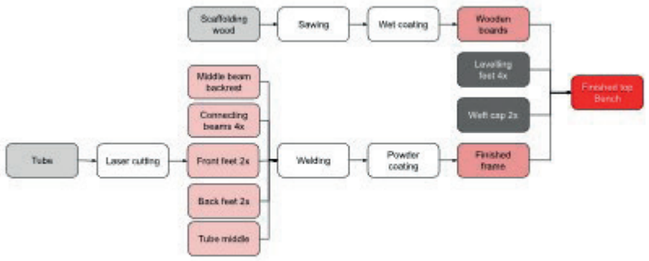

Chipboard
Sawing
Edge gluing
Wood panel
Felt panel
Tube
Laser cutting
Connecting beam 2x
Tube
Laser cutting
Engraving
Welding
Grinding
Buckling frame
Welding
Powder coating
Finished frame 2x
Finished bottom panel wood
Cold foam block 4x
Cellular rubber
Velcro

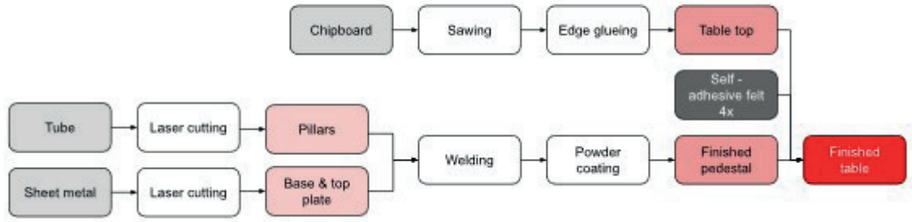

MDF
Sawing
CNC milling
Power outlet 3x
Fan
Filter 2x
Wiring 4x
Finished roof panel
Finished roof
Spotlight
Wiring box
Plug 2x
Motion sensor
Felt panel

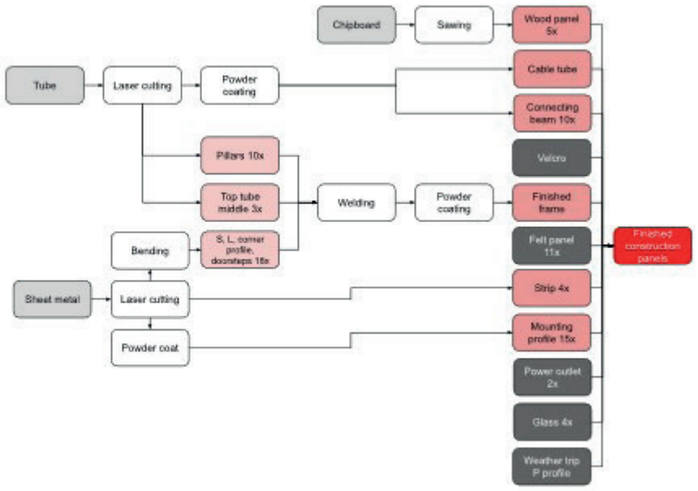

Tube
Laser cutting
Powder coating
Finished corner piller
Finished centre beam
Finished T-piller

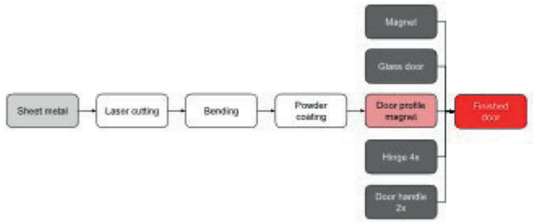

Chipboard
Sawing
Edge gluing
Wood panel
Felt panel
Tube
Laser cutting
Connecting beam
Tube
Laser cutting
Engraving
Welding
Grinding
Buckling frame
Welding
Powder coating
Finished frame
Finished top panel wood
Cold foam block 4x
Velcro

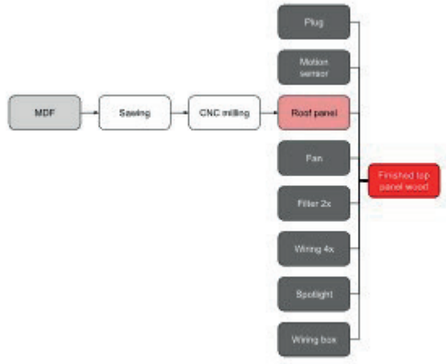

Tube
Laser cutting
Engraving
Tube
Laser cutting
Connecting beam
Welding
Grinding
Buckling frame 2x
Welding
Powder coating
Powder coating
Cold foam block 2x
Glass
Weather strip P-profile
Finished frame
Finished frame
Finished top panel glass

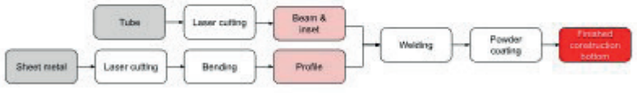

Scaffolding wood
Sawing
Wet coating
Wooden boards
Levelling feet 4x
Weft cap 2x
Finished top Bench
Middle beam backrest
Connecting beams 4x
Front feet 2x
Back feet 2x
Tube middle
Tube
Laser cutting
Welding
Powder coating
Finished frame


Chipboard
Sawing
Edge glueing
Table top
Self - adhesive felt 4x
Tube
Laser cutting
Pillars
Welding
Powder coating
Finished pedestal
Finished table
Sheet metal
Laser cutting
Base & top plate


Chipboard
Sawing
Wood panel 5x
Cable tube
Connecting beam 10x
Velcro
Tube
Laser cutting
Powder coating
Pillars 10x
Top tube middle 3x
Welding
Powder coating
Finished frame
Bending
S, L, corner profile, doorsteps 18x
Felt panel 11x
Finished construction panels
Sheet metal
Laser cutting
Strip 4x
Mounting profile 15x
Powder coat
Power outlet 2x
Glass 4x
Weather trip P profile


Magnet
Glass door
Sheet metal
Laser cutting
Bending
Powder coating
Door profile magnet
Finished door
Hinge 4x
Door handle 2x


Plug
Motion sensor
MDF
Sawing
CNC milling
Roof panel
Fan
Finished top panel wood
Filter 2x
Wiring 4x
Spotlight
Wiring box


Tube
Laser cutting
Beam & inset
Sheet metal
Laser cutting
Bending
Profile
Welding
Powder coating
Finished construction bottom

2. RAMSSHEEP ANALYSIS

2.1 PARAMETERS

Reliability

According to ISO 8402, reliability is 'the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs' (Ireland, 1990). With this is meant the time that the product can perform its function without breaking down.

Availability

Availability is not to confuse with reliability. Availability means how much of the time the product is available; How much of the time the product is able to deliver its job.

Maintainability

With maintainability is meant the down time of a product and the time it takes to repair or maintain the product and the safety of the maintenance operations.

Supportability

This parameter is about the ability to maintain the inbuilt reliability and to perform scheduled and unscheduled maintenance according to the plan with minimum costs and time.

Safety, Health and Environment

Implements solutions of environmental and safety at work prevention and protection; that what should be done to make sure that activities do not cause harm to anyone. In this parameter, safety means injury, health means disease and environment means disaster.

Economics

A perspective concerned with the financial aspect of the asset and its operation. These are often the drive of the main direction and investment within the whole life cycle.

Politics

The aspect of politics is about regulations and legislation, but also about emission reduction, societal impact, circularity and societal needs.

Many of these aspects have measurements such as failure rate and mean time between failure. These are not interesting in this analysis, since these are based on too many assumptions. Box 1 is not completely assembled by VKI, as well as the feedback from customers is not received by VKI.

2.2 BOX 1

Reliability:

- Not many moving parts: only a door and ventilation which is quite necessary. Shelf can be moved when it is taken out, but that is only for assembly and disassembly.

Avoid unnecessary parts: there are many parts, especially with the double buckling frames. Furthermore the panels are separated to make it easier to move, but it does create a product made out of more parts.

- The box itself is quite rigid; due to welds and all the steel it is not really 'moveable'. But in this case it is a box just standing there. So nothing can really break or injure someone if it is this rigid. Only maybe with earthquakes it is interesting to create a less rigid box. The shelf is quite rigid as well, but still a bit moveable.
- No back up system is implemented but there is not really a use for it. Mainly only for the lights and ventilation.
- Overdesign is done with the double buckling frame and double ears in the connection between beams.
- Sturdy design for the door with big strong hinges. Only the shelf is a bit flimsy.
- Very similar, standard parts are used for different components .

Availability

- To be in state of operation, the door need to be able to be opened and the light and ventilation should work. But only the door is crucial for the availability. The light is inconvenient, but incase of having a lot of glass the environmental light can be enough for the user. For the ventilation, if it does not work, in the first few minutes it is not that important. After a longer period of time this becomes uncomfortable and will make the box less available, but not unavailable.

- The spare parts are quite available; the product is modular and most of these products are in stock at VKI for a buffer inventory. Therefore, if necessary, the part can be delivered in one, maybe two days.

Maintainability

- Some standard screws are used, but these are not specified in the drawings or orders that the assemblers receive. So from time to time they use different screws for different components which will take more time to put it together.
- The screws are simple cross screws making these prone to wear and tear. This can cause that it is impossible to screw the screw out and requires more time to be removed.
- Fast fasteners are used in the form of ears and slit holes where the ears fit into. Furthermore, some extra ears are created at the bottom of the top panels to help the panel to go easily in the right place when assembling the box. Also, the magnet for the door can be seen as a fast fastener for the door.
- Almost no maintenance is required for this box. Probably only when a part needs replacing. These are in general big parts that should be carried with at least two persons and preferable with suction caps. The panel is quite heavy and could hurt someone easily.
- There is enough space for maintenance, except for the door. While assembling it is quite hard to get the door in place correctly. It is hard to mount and very heavy to hold while screws have to be screwed in and there is almost no space for the screwdriver.
- The design could be more unambiguous when assembling the parts into components. But not important for the rest of the assembly; it can not be done wrong, only a wrong middle beam on the roof (which happened in the field research).
- Since this box is not assembled by VKI anymore, not much is known about this. But, logically thinking, the panels do not need replacing often, or maybe not at all until the end of its lifetime. But if it needs replacing most parts are very heavy. The ventilation and light is not heavy, but harder to reach because it is on top of the box. Furthermore, it now looks like that the whole spotlight needs to be replaced when it does not work anymore. The location is also hard to reach for the parts that needs maintenance the most often.
- The design is modular, which is a very good characteristic for maintainability.

Supportability

- It is a good thing that fairly generic parts are used. Maybe except for the door but also pretty generic. Also not very expensive spare parts are used in the product.
- Not many fasteners but quite different in every box every time.
- Not very hazardous materials are used, only the felt foam that is used.
- No monitoring systems are used for the product. However, it could be important for the ventilation. If the light does not work anymore or the sensor that detects if people are in the box, the light will not work anymore. But, this problem will be noticed very fast, since the light will not turn on anymore. Furthermore, it is know that the pir does not work anymore because a little red light in the sensor is not seen anymore. But, for ventilation costs a bit more time before it gets noticed. Especially when users are in the box for a small amount of time they will not immediately notice this.

Safety & health

- FMEA for hazard identification, risk analysis and assessment.
- The design is minimized; as less as possible different parts and hazardous materials are used. Also, the system is as small as possible and an existing ventilation system is used so experiences from the past ensures that it works and does not have many problems.
- Wiring is a very important aspect; no clear instructions are available and they just know how to do it. If someone confuses one thread with another it is not correct anymore.

Environment

- The processes and materials used are not the most environmental friendly, such as powder coating and the foam walls. This can be further analyzed in a LCA.
- Though, high quality materials are used to ensure a long life time.
- Due to the modularity, repair is made easy and prolongs the product life time because it can grow with the customer.
- A minimum energy consumption is achieved in the use phase due to the fact that the box is powered with just one plug. It can be unplugged when not used and the light and ventilation is based on a sensor to determine if someone is in there and if these two features need to be turned on or off.

Economics
This box is within the medium price range, between €6000 and €10000.

Politics
In politics the ISO standards and certifications are interesting. For now no ISO standards are complied to and only one certification of the dB reduction that is tested. For environmental politics, it is know where the used material comes from, but that is it. Therefore, an LCA could be executed to determine the environmental impact and how well this product can comply to environmental regulations.

Conclusion
Opportunities:
- There are many unnecessary parts, so the amount of parts can be reduced.
- An indication of what is broken can help for faster repair and a lower down time.
- An alternative for the felt foam is recommended, because it is not environmental friendly.
- Standardize used screws; these are not specified in drawings so they can change over time. Therefore other tools may be necessary.
- Better assembly manual; not for the mechanic on location but for the assembler at VKI. They do not always know what they are doing (conclusion of field research) and may cause the mechanic on site more problems instead of helping them.
- Comply to norms and differentiate the box from competition.

Strong points:
- Modular.
- Very sturdy, rigid.
- High quality, long lifetime materials.
- Not much maintenance is required next to cleaning.

2.3 BOX 2
Reliability
- Not many moving parts like the first box. Only ventilation and door. These are unavoidable. Also the shelf can be moved, just like Box 1.
- All the profiles are an extra component. These are also all loose parts and can only come together when the complete box is assembled. Also extra profiles around the roof can be eliminated, these are mainly to make the whole design nicer, but if small faults are solved, these are not necessary anymore.
- Rigidity is necessary in this box.
- No use for back up system, only for lights and ventilation (it is the same as for Box 1).
- Not much overdesign, some extra parts are added to the bottom frame and top but nothing is designed to be way too rigid and the door has 4 hinges but the same door only needs 3 in Box 1.
- Very sturdy design; the door has 4 hinges.
- There is symmetry, where the same parts are used. Only for the door and roof the parts are different.

Availability
- To be in state of operation the same requirements and points hold for Box 1.
- Spare parts are quite easy to make. Especially because every step of the production is at VKI. Therefore the part that is required can be delivered quite fast. Also because it uses the same ventilation and light as Box 1 is used, which are always in stock and can be replaced quite easy if necessary. But since this product is not modular, a lot of parts have to be taken out to repair one part. This may be harder than it is in Box 1. But, not the complete box has to be replaced to repair one part. Even though the box is not modular, just 1 part can be replaced, not the whole module (component) or box.

Maintainability
- The screws are simple cross screws making these prone to wear and tear. This can cause that it is impossible to screw the screw out and requires more time to be removed.
- Here are also fast fasteners used for the door closing and also for the spotlight in the roof.
- The maintenance will probably be just repairs; the box requires no maintenance next to cleaning. This clean can be done by the user such as cleaning the windows or removing dust/dirt form the panels and shelf. If something requires a repair, it can be done by the user, but it should be understood how the box is built up. Furthermore, it requires that the roof is dismounted and thus all electricity. The ventilation, light and light sensor are quite easy to replace.
- It is a bit unambiguous; more than Box 1. For example, the screws are not all on the same spot, not all profiles can be put on the same spot due to this but at first assembly this is possible.
- The parts are not as heavy as those of Box 1. The glass is the heaviest. The rest is quite manageable. The only downside is that some panels may be hard to get to location because of its length. The panels are taller than those of Box 1. Furthermore, there are a lot more parts than Box 1.
- Some standard interfaces are used; like a plug and USB.
- All parts are easily accessible: only the parts on the roof are harder to reach, like the light, light sensor and the ventilation.

Supportability
- Self-tapping screws are used; these are standard but not as standard as just regular screws. Also here are cross shaped screws used but these can wear out quite easy.
- Due to only one type of screw, only one specific tool is required which is generally a very common tool.
- No monitoring system; same as Box 1.

Safety & health
- FMEA for hazard identification, risk analysis and assessment.
- The wiring is important to do correctly, just as mentioned above with Box 1.

Environment
- The processes and materials used are not the most environmental friendly, such as powder coating and the foam walls. This can be further analyzed in a LCA.
- Though, high quality materials are used to ensure a long life time.
- A minimum energy consumption is achieved in the use phase due to just one plug. It can be unplugged when not used and the light and ventilation is based on a sensor to determine if someone is in there and if these two features need to be turned on or off.
- In this development, the box is not modular. The parts can be easily replaced but requires some effort such as removing the roof in order to replace panel or a pillar. But, because it is not modular just one part can be replaced instead of the whole module.

Economics
This box is in the low price range, below €6000.

Politics
In this aspect has become more important over time, which includes, as mentioned above, ISO standards and NEN norms. These are not yet applied to this box. But these can be of added value in terms of dB reduction and maybe for fire safety. Furthermore, for some of the materials a certificate of where these came from is not available or not known. With some more focus on sustainability, these become more important as well, this is an opportunity for the new redesign.

Conclusion

Opportunities:

- Reduce the amount of parts that have to be transported from VKI to the customer's location, like Box 1.
- An indication of what is broken can help for faster repair and a lower down time.
- Due to more parts and non-modular parts the repair time is higher than with modular components. This also means that the down time is higher.
- Self-tapping screws cannot be used over and over again, not ideal for disassembly. Furthermore, these leave steel chip on site of the assembly. That has to be cleaned and can damage the rest of the parts during assembly.
- An alternative for the felt foam is preferable because it is not environmental friendly.
- Redesign the box in such a way that it is modular.
- Comply to norms and differentiate the box from competition.
- Overall construction could be better.

Strong points:

- Not much maintenance is required next to cleaning.
- Standard screws and tools can be used to assemble and disassemble the box.
- High quality, long life time materials.
- Lighter parts.
- Overall the design is basically very simple.

3. FMEA

Legend:

S = severity.
O = probability of occurrence.
D = probability of detection.
High risk priority > 80 = Red.
Medium risk priority > 40, < 80 = Yellow.
Low risk priority <40 = Green.

3.1 BOX 1

Table 4. FMEA Box 2

(1) Component, life-cycle stage	(2) Potential failure mode	(3) Potential failure effects	(5) Potential causes	(S) Severity	(O) O	(D) D	(R) RPN
Door	Door doesn't work	The box can not be used; main function of the box can not be performed	The metal part on the door to connect to the magnet came loose. Hinges are stuck or there is something in front of the door	3	1	1	3
	Door breaks	Door breaks and glass goes everywhere, including hurting the user. Or the door breaks in pieces but remains as a whole	Somebody walked into it, smashed it close or open to hard or let the door smash into the side of the box	10	2	1	20
	Door comes loose	The door falls on top of the user, smashing into pieces hurting he/she significantly. Or falls to the ground smashing into pieces and disperse the glass everywhere potentially hurting the user	Screws of the hinges where not tightly screwed into place and came loose, or the hinge just breaks because of the load	10	1	8	80
	Door rubber comes loose	The door will not close correctly anymore, making it less sound proof/dampening	Bad stickers behind the rubber or somebody pulled it. Or the door pushes the rubber out of place when opened/closed	3	4	6	72
Electrics	Ventilation doesn't work	The main function of the box can not be performed; it is too hot, it smells and it is uncomfortable in the box.	Something is stuck in the ventilation, the power cable is disconnected or a fuse burned.	4	4	5	80
	Ventilation doesn't work enough	The main function of the box can not be performed; it is too hot, it smells and it is uncomfortable in the box. (less fast compared to a non-working ventilation)	Something is stuck in the ventilation, or some part of the ventilation came loose and now holds back the ventilation. Or the foam has not been placed in the right place and now the airflow is blocked	4	4	6	96
	Light doesn't work	There is no light making it harder to perform its main function. There is not enough light for the user to be able to work or sit there comfortably	The light sensor does not work or the LED broke (which is very unlikely). Or a power cable came loose from the light or light sensor	3	1	3	9
	Light sensor doesn't work	There is no light making it harder to perform its main function. There is not enough light for the user to be able to work or sit there comfortably. Or the light just stays on even though the box is not used	The sensor is broken, something is in front of its range blocking it to see movements or the power cable came loose	3	2	3	18
	The box emits electricity to the user's touch	The user gets electrocuted. Dependent on what voltage level is going through the box (not more than 230V) the user is hurt a bit or very severe	Power cable came loose and 'leaks' and electrical current through the metal frame of the box. Or the wiring is done incorrectly causing a power leakage	9	1	8	72
	Short circuit	The box no longer has power to ventilate and light up the box. So it becomes harder to perform its main function. Maybe it even catches fire	Wrong wiring, bad wiring, cheap modules (light, light sensor or ventilation) or a lightning strike blows through the buildings power circuit	7	4	8	224
Panels	Gaps between panels	Unhappy customer; the user can look from the inside to the outside. It leaks sound as well	Bending of the metal tubes due to heat of the welding. Bending because of transportation. The wood has shrunk because of temperature differences	3	5	1	15
	Wood falls out	Falls on to a user causing small to severe injury. Or just falling to the ground.	Screws are not placed in the middle of the panel, breaking out on one of the sides. Or the wood has shrunk due to the big shift in temperature. Or somebody smashed it	10	2	1	20
	Glass falls out	Falls on to a user smashing into pieces seriously hurting he/she. Or stays in one piece still hurting the user. Or falls onto the ground in one piece or in many pieces which can damage the rest of the room as well as the user who is nearby maybe	The welds in the buckling frame were not done correctly. Second buckling frame is not screwed into place correctly. Someone smashes the glass.	10	3	1	30
	Panels are not correctly placed in position	The whole box eventually falls apart with maybe damaging the user. Or just nothing happens. A weak part has been created due to this.	It just does not fit because the floor is not square and the box can not be levelled. So it is hammered into place. Or during transport something bended causing it not to fit anymore	2	5	3	30
	Acoustic foam comes loose	The foam falls onto the user or just falls onto the ground.	The velcro does not stick to the panel anymore, or the velcro is dirty so the two types of velcro does not stick together anymore	3	2	1	6
	Glas breaks	The glass falls on top of the user, smashing into pieces hurting he/she significantly. Or falls to the ground smashing into pieces and disperse the glass everywhere potentially hurting the user. Or it just breaks into pieces but stays as a whole	Tension in the buckling frames it is placed into. The se put too much tension on the glass causing it to break. Or the user smashed through it	10	1	6	60
Assembly	Components do not fit into eachother	The box can not be assembled at the location. Unhappy customer. Or it is just smashed into place damaging components making sure it can not be used again and/or it is hard to take apart	It is the wrong component. Or assembly at Van Keulen made a mistake that the component is wrongly made so it does not fit anyway. Or the component is damaged during transport	2	5	5	50
	Ears of components are bended	The component can not fit into the whole assembly anymore or makes the whole assembly weak. Or it can not be disassembled and reused anymore	Damage during transport or while assembling the components. Or the box is not level making it hard to assemble the components which requires a hammer. Then with the hammer the ears are bended (manual force)	4	6	1	24
	Component is in the wrong place	The box falls apart before the mistake is detected by the assemblers. Damage to the assemblers or to the components is possible. Or the box just stays in place and nothing happens	The assemblers are inexperienced or the drawing is unclear	2	4	5	40
	Box is not level	The box has gaps which will cause an unhappy customer. Or the box becomes unstable with all effects that belong to that; parts fall apart or so with possibly injuring the user/assembler	The floor is not level and the box has no possibility to make it more level with e.g. levelling feet. It is a very rigid product	3	5	6	90
Use	Somebody falls into the glass	The glass smashes into pieces cutting the user and severily hurting him/her. Or the glass just stays in place and nothing happens (depends on glass)	Somebody trips because of the little door step or somebody just trips/looses their balance	10	2	1	20
	Fingers come between the door and the pillar	Severily injuring the user	The user was not aware that his/her fingers where in between and somebody else closed the door.	5	3	1	15
	Shelf comes down	Severily injuring the user or just a bit. Or nobody is hurt but only this component or the holes where the component go are damaged that is needs to be replaced	Not strong enough for the weight that is applied to it (more than that was set as requirement; the user is e.g. standing on it. For that kind of use the shelf is not made). Or the material faulty, or there is a production error	4	1	1	4
	Shelf breaks in two peaces	Severily injuring the user or just a bit. Or nobody is hurt but only this component or the holes where the component go are damaged that is needs to be replaced	Not strong enough for the weight that is applied to it (more than that was set as requirement; the user is e.g. standing on it. For that kind of use the shelf is not made). Or the material faulty, or there is a production error. Or the user tried to break it themselves on purpose.	4	1	1	4

3.2 BOX 2

Table 5. FMEA Box 2

(1) Components, life-cycle stage	(2) Potential failure mode	(3) Potential failure effects	(5) Potential causes	(S) Severity	(O) O	(D) D	(R) RPN
Door	Door doesn't work	The box can not be used; main function of the box can not be performed	The metal part on the door to connect to the magnet came loose. Hinges are stuck or there is something in front of the door.	3	1	1	3
	Door breaks	Door breaks and glass goes everywhere, including hurting the user. Or the door breaks in pieces but remains as a whole	Somebody walked into it, smashed it close or open to hard or let the door smash into the side of the box	10	2	1	20
	Door comes loose	The door falls on top of the user, smashing into pieces hurting he/she significantly. Or falls to the ground smashing into pieces and disperse the glas everywhere potentially hurting the user	Screws of the hinges where not tightly screwed into place and came loose, or the hinge just breaks because of the load	10	1	8	80
	Door rubber comes loose	The door will not close correctly anymore, making it less sound proof/dampening	Bad stickers behind the rubber or somebody pulled it. Or the door pushes the rubber out of place when opened/closed	3	4	6	72
Electrics	Ventilation doesn't work	The main function of the box can not be performed; it is too hot, it smells and it is uncomfortable in the box.	Something is stuck in the ventilation, the power cable is disconnected or a fuse burned.	4	4	5	80
	Ventilation doesn't work enough	The main function of the box can not be performed; it is too hot, it smells and it is uncomfortable in the box. (less fast compared to a non-working ventilation)	Something is stuck in the ventilation, or some part of the ventilation came loose and now holds back the ventilation. Or the foam has not been placed in the right place and now the airflow is blocked	4	4	6	96
	Light doesn't work	There is no light making it harder to perform its main function. There is not enough light for the user to be able to work or sit there comfortably	The light sensor does not work or the LED broke (which is very unlikely). Or a power cable came loose from the light or light sensor	3	1	3	9
	Light sensor doesn't work	There is no light making it harder to perform its main function. There is not enough light for the user to be able to work or sit there comfortably. Or the light just stays on even though the box is not used	The sensor is broken, something is in front of its range blocking it to see movements or the power cable came loose	3	2	3	18
	The box emits electricity to the user's touch	The user gets electrocuted. Dependent on what voltage level is going through the box (not more than 230V) the user is hurt a bit or very severe	Power cable came loose and 'leaks' and electrical current through the metal frame of the box. Or the wiring is done incorrectly causing a power leakage	9	1	8	72
	Short circuit	The box no longer has power to ventilate and light up the box. So it becomes harder to perform its main function. Maybe it even catches fire	Wrong wiring, bad wiring, cheap modules (light, light sensor or ventilation) or a lightning strike blows through the buildings power circuit	7	4	8	224
Panels	Wood falls out	Falls on to a user causing small to severe injury. Or just falling to the ground.	The screws are not correct. They are too small so it does not go through the tube. Or a screw broke.	10	4	4	160
	Glass falls out	Falls on to a user smashing into pieces seriously hurting he/she. Or stays in one piece still hurting the user. Or falls onto the ground in one piece or in many pieces which can damage the rest of the room as well as the user who is nearby maybe	The screws are not correct. They are too small so it does not go through the tube. Or a screw broke.	10	4	4	160
	Panels are not correctly placed in position	The whole box eventually falls apart with maybe damaging the user. Or just nothing happens. A weak part has been created due to this.	It just does not fit because the floor is not square and the box can not be levelled. So it is hammered into place. Or during transport something bended causing it not to fit anymore	2	5	3	30
	Acoustic foam comes loose	The foam falls onto the user or just falls onto the ground..	The velcro does not stick to the panel anymore, or the velcro is dirty so the two types of velcro does not stick together anymore	3	2	1	6
	Glas breaks	The glass falls on top of the user, smashing into pieces hurting he/she significantly. Or falls to the ground smashing into pieces and disperse the glas everywhere potentially hurting the user. Or it just breaks into pieces but stays as a whole	The rubber is not placed in the bottom beam so there is tension in the glass that can cause it to break. Or someone smashes into the glass	10	1	7	70
Assembly	Components do not fit into eachother	The box can not be assembled at the location. Unhappy customer. Or it is just smashed into place damaging components making sure it can not be used again and/or it is hard to take apart	It is the wrong component. Or assembly at Van Keulen made a mistake that the component is wrongly made so it does not fit anyway. Or the component is damaged during transport	2	5	5	50
	Ears of components are bended	The component can not fit into the whole assembly anymore or makes the whole assembly weak. Or it can not be disassembled and reused anymore	Damage during transport or while assembling the components. Or the box is not level making it hard to assemble the components which requires a hammer. Then with the hammer the ears are bended (manual force)	4	6	1	24
	Component is in the wrong place	The box falls apart before the mistake is detected by the assemblers. Damage to the assemblers or to the components is possible. Or the box just stays in place and nothing happens	The assemblers are inexperienced or the drawing is unclear	2	4	5	40
	Box is not level	The box has gaps which will cause an unhappy customer. Or the box becomes unstable with all effects that belong to that; parts fall apart or so with possibly injuring the user/assembler	The floor is not level and the box has no possibility to make it more level with e.g. levelling feet. It is a very rigid product	3	5	6	90
Use	Somebody falls into the glass	The glass smashes into pieces cutting the user and severily hurting him/her. Or the glass just stays in place and nothing happens (depends on glass)	Somebody trips because of the little door step or somebody just trips/looses their balance	10	2	1	20
	Fingers come between the door and the pillar	Severily injuring the user	The user was not aware that his/her fingers where in between and somebody else closed the door.	5	3	1	15
	Shelf comes down	Severily injuring the user or just a bit. Or nobody is hurt but only this component or the holes where the component go are damaged that is needs to be replaced	Not strong enough for the weight that is applied to it (more than that was set as requirement; the user is e.g. standing on it. For that kind of use the shelf is not made). Or the material faulty, or there is a production error	4	1	1	4
	Shelf breaks in two peaces	Severily injuring the user or just a bit. Or nobody is hurt but only this component or the holes where the component go are damaged that is needs to be replaced	Not strong enough for the weight that is applied to it (more than that was set as requirement; the user is e.g. standing on it. For that kind of use the shelf is not made). Or the material faulty, or there is a production error. Or the user tried to break it themselves on purpose.	4	1	1	4
Furniture	The bench sags	Severily injuring the user or just a bit. Or nobody is hurt but only the component or parts of it need to be replaced	The bench can not handle the load or the user is doing the wrong things with the product. Or it is not assembled correctly which causes a part to be loose	7	2	1	14
	The bench falls over	Severily injuring the user or just a bit. Or nobody is hurt but only the component or parts of it need to be replaced or the product is not damaged or a bit	Some part is loose (not seen by the assembler) or the user pushes the component over	5	5	1	25
	The table breaks down	Severily injuring the user or just a bit. Or nobody is hurt but only the component or parts of it need to be replaced	The table can not handle the load or the user is doing the wrong things with the product. Or it is not assembled correctly which causes a part to be loose	7	2	1	14
	The table falls over	Severily injuring the user or just a bit. Or nobody is hurt but only the component or parts of it need to be replaced or the product is not damaged or a bit	Some part is loose (not seen by the assembler) or the user pushes the component over	5	5	1	25

4. STRATEGIC CONSIDERATIONS

In order to create a set of requirements, a few things needed to be determined. This could be done in different ways. For example, in a design project, a target audience is initially identified before the requirements are created. But in this case, target group will push the project into a certain corner. The target group can also be defined differently, so that no specific target group is defined and thus the path of the project is not specific yet. This way of thinking is used this to define the boundaries of the project which are necessary to form a set of requirements, opportunities and wishes. In this chapter several strategies are proposed for several aspects of the design (design decisions). An advice is given but the eventual choice is in the hands of the stakeholders of VKI.

PRICE RANGE

In Chapter 'Market analysis' the competitors of VKI for this product are categorized in 3 different price levels.
For the redesign of the silence box, it is important that the price range is determined to know which wishes and opportunities can be achieved and what not. If there is a desire for a luxe product, but the budget is very low, it is probably not possible to produce the product in this budget. Of course, this decision may not limit the out-of-the-box thinking in the ideation and conceptualization phases, but is set a bar for a maximum or a minimum which should be complied to. This decision is also important to make sure that the designer and VKI are on the same page regarding the redesign.

CUSTOMER FREEDOM

For customer freedom, four different strategies can be defined. One completely free, one without any freedom, and the other two strategies fall in between. Customer freedom can be defined as "the ability and autonomy of the individual to perform an action selected from at least two available options, unconstrained by external parties" (Bavetta & Navarra, 2011). Customer freedom is the opportunity to choose. Four strategies are proposed:

1. Complete freedom: there are some standards boxes available (as a base), but most of the them are custom made. This strategy is the same strategy that currently is used for Box 2. The customer determines the furniture, colors and more. This type of freedom requires a redraw of every box that is or will be sold, due to these customer changes. This requires more time and therefore costs. Furthermore, since parts and colors are not, or can not be standardized, an incorrect part can not be easily reused and becomes scrap. In addition to this, other standardizing benefits such as bulk material, consistent quality and predictability in the process will not be achieved with this strategy.
2. Modular & partial freedom: all parts can be used for different configurations. This strategy is currently applied to Box 1 with different cartons with components that can be ordered. The carton includes, for example, one top glass pane. Furthermore, colors and customizing orders is possible. Due to the modularization, some standardization can be applied. Especially because several lengths and widths for the box can be created from the same pillars and beams. Some boundaries in freedom have to be determined, which can be done by VKI. For example, materials or the different colors that can be chosen. Here, some of the benefits of standardization are achieved such as predictability, flexibility and consistent quality.
3. Nonmodular & partial freedom: a few different boxes with a few different color options and configurations. With extra billing, the box can be personalized. Here, less standardization can be done due to the different sizes. Different beams are required but maybe some of the pillars can be used in several sizes (like the four pillars on the corners), but not as much and as easy as the second strategy.
4. No freedom: a few different boxes can be ordered. No customizations are done. In this case, standardization can be quite easy and most of the benefits can be achieved. Especially the reduction of waste and flexibility have a positive effect of the sustainability and thus the carbon footprint of the products.

To determine the right strategy VKI would like to apply, different perspectives can be considered. This perspective can determine the amount of customer freedom VKI wants to provide to their customer.

BUSINESS STRATEGY & SERVICES

Lastly, a strategy can be established as to selling and services that is offered by VKI. These also affect the requirements. For example, if the customer were to build the box themselves, the box should include Ikea-like instructions to build this box. With building is meant the on-site assembly of the already assembled components. According to Vlaanderen-circulair.be (n.d.), there are three different strategies. The main difference is the product ownership, and the deal with the customer:

1. Product based value: The customer will own the product. VKI just sells the box to the end user.
2. Integrated product-service system: This can have different forms, from customer owned product to completely company owned products providing full service.
3. Service based value: Only a service is offered, no product.

Integrated Product Service Offering (IPSO) types:

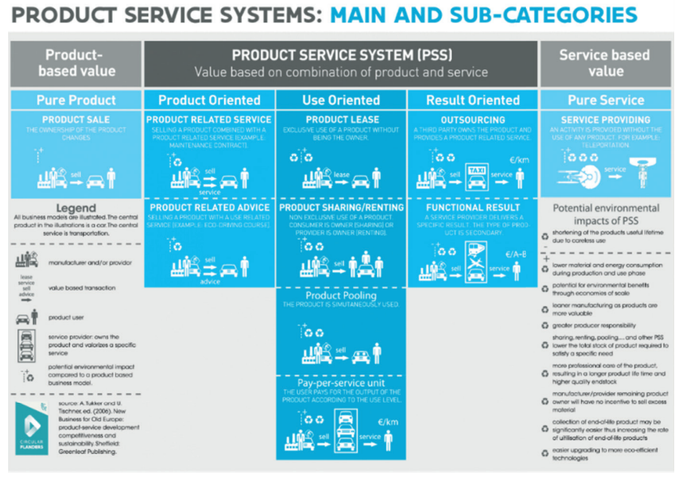


Figure 39. An overview of business models (https://vlaanderen-circulair.be, n.d.)

There are 3 different main categories of PSS. A product oriented PSS is the product with some extra added services, but has focus on product sales. Use-oriented PSS the focus shifts away from selling the product. The product is still the main aspect of the PSS, but instead shifting from owner, the product now stays in the providers ownership. The last category, result oriented PSS, the result is the base of the agreement, where the product is yet to be determined. There is complete freedom for the provider on how to deliver the agreed upon result.
Looking at Box 2, there is product-based value (pure product). The customer owns the product. By focusing on the product, the competitive aspect of the product is maintained and keeps the product up to date with changing trends. By focusing on the product, VKI does what they do best. But, it is also required to keep the product up to date, otherwise it may loose its competitive advantage and may even become obsolete. Furthermore, by narrowing the focus to only the product, a higher uncertainty and risk is created. But since VKI has many more products next to this, these are relatively not high, in this case.

In this project, one of the strategies could be chosen. Currently, VKI uses the pure product strategy. A product oriented PSS can have some advantages: 'lower client barriers, higher client loyalty and due to better client contacts, some increase in the speed of innovation' (Tukker, 2004). But in practice, 'these benefits may not be achieved where impact may not be reduced, but be more likely to be incremental at best', according to Tukker (2004). Furthermore, in the case of the silent box, advice and maintenance are not that value adding. Advice may be helpful for the customer in the aspect of size and quantity (what to buy), but not for the use. The product is fairly straight forward and easy to understand.

Therefore, a use oriented PSS would be more interesting. Here, the use of the product can be maximized as well as extending the products life. Furthermore, since the company still owns the product, there is more end-of-life potential since this now lies in the hands of the company instead of the customer. For example, the recycling of the product is done correctly by VKI, while the customer would just throw it away because it will take time to recycle the product. In addition to this benefit of keeping the product in the providers ownership, using this strategy, some of the costs and activities are shifted away from the customer to the provider, making the product more attractive and creates a lower barrier for new customers. But some downsides are that the provider has relative higher risks (more capital invested) and has to take careless behavior of the customer into account. This will shorten the initial lifetime of the product. The product can be redesigned to be more resistant to this careless behavior of customers. Furthermore, the loyalty and relationship with the customer is improved but it is fairly easy to switch to another provider (if available). All these advantages and disadvantages apply to product lease, sharing & renting, pooling and pay per unit use.

For renting & sharing an additional advantage is that relatively to leasing, the overall capital need is lower due to the shared use between customers. But, this also means that the provider needs 'more human resources to be able to provide the service. Furthermore, the customer needs to put more time and effort into getting access to the product' (Tukker, 2004).

This discourages the customer to use the product, which can lead to additional positive environmental impacts. In addition to this, according to Tukker (2004), 'renting and sharing can have high impact reductions due to the fact that most of the life-cycle impacts are in the manufacture of the product, which stimulates to innovate the product'.

For pay per unit use, Tukker (2004) mentioned a high potential for impact reduction, relatively more than the mentioned strategies above. Here, the provider is responsible for most life cycle costs, which motivates the provider to design a product with a long life time and better end of life properties, optimizing the products environmental impact. There is a constant drive for continuous improvement.

Lease would be the most interesting use oriented PSS in the case of the silence box, since sharing and pooling have a less broad target audience. This is because sharing and pooling can be applied in, for example, a collective building for companies where several companies have an office space. But where companies have their own building, it is harder to share the same box (with others than the employees within that company) at the same time. Pay per unit use has the same advantages as lease and even some additional advantages, but it is harder to design this into the box. How will the time that the service is provided be measured, and since the product is not very mobile (yet) there is a lot of wasted time when it is not in use. The big question is therefore how to bill the client for the use and still earn money when the product is not that much in use.

Lastly, the result oriented services can be interesting as well, but here there would be a lot of wasted time as well. Since there is only paid for the result, for example the availability of a silent space, the provider has the freedom to provide this in any way they want; no specific product is connected to this result. But, since this project is focused on the redesign of a silence box, the silence box is the product that will be used to achieve this goal. Therefore, this will look like the pay per unit use, where the box is standing in the office and waiting to be used. But there is only paid for the result. Outsourcing is not that interesting, since this was happening with Box 1. Now, this has switched to just selling to the company. But before, VKI did the service in terms of delivering and assembling the box on site. So this is an nonpreferred option since they have already done that but not doing this anymore. But, on the other hand with outsourcing longer contracts are arranged creating less uncertainty in customer loyalty. Furthermore, outsourcing demands for efficient use of financial resources and materials in order to make (more) profit. Hereby, some impact reduction is achieved as well, but is relatively low.

The functional result is the model with the highest degree of freedom, especially in regard to innovation, it has low capital costs but high transition costs and has the highest potential for impact reduction due to the abstraction of the result (no specific product e.g.), according to Tukker (2004). But, as mentioned above, this may be harder to achieve in this project because of the predefined product.

As a conclusion, it is interesting to still own the product as a company, because there is a lot more end-of-life potential and the product's lifetime can be increased by reusing and remanufacturing used parts. Furthermore, since these products already have a relative long life time (theoretically), a IPSO can be an opportunity to keep a closer relationship with the customer and gain more profit because of a subscription. Additionally, it is easier for a customer to switch the size of the product without having a modular product. So this changes the requirements for the redesign as well.
For both types of business models, company owned or customer owned, two different services can be provided or not:
1. Customer builds the box: No extra profit can be made, since no mechanics are required. But because no mechanics are required, the delivery time is shorter. This raises the question of who will be held responsible in case something happens. Ikea is a good example of this, but their terms only states that if a customer has a complaint, one of the conditions is that it may not be a consequence of bad assembly by the customer, (Algemene Verkoopvoorwaarden Ikea, 2023) It is unknown how this is checked. To be sure in legal terms, this should be further researched. Furthermore, the product should be designed differently; it can not be as complicated as it can be with experienced mechanics. In addition, a very thorough manual has to be created to guide anyone with building this box. This will cost extra time and therefore money.
2. VKI builds the box: additional profit can be achieved through this service. Furthermore, there is less uncertainty as to whether the box is built correctly since experienced mechanics or at least employees with some technical background built it. In addition, there is more security with the guarantee. It is know that it is built correctly and not halfway. Therefore, depending on the design, a guarantee can be given for certain years.

5. CLUSTERING OF THE GEPHI MAP

In order to be able to derive the requirements out of this Gephi map of chaos, sets of subjects are pulled out of the whole network and are settled. By then starting the algorithm again, it can be seen which nodes are more important of that cluster. Hereby, a focus can be derived and thus a requirement. This also means that if the focus does not lie on the most important node, this choice has a big effect on the most important node. The sets are determined by current designs, stakeholders and logical influences. For example, the material choice will have an effect on the silencing of the box, which can have an effect on the price. Clusters with no underlying relationships between the key words are not that interesting since these will probably create separate requirements per keyword, not combining them in a requirement or influencing each other.

Set 1: The current situation of Box 1, with conclusions of the FMEA. 2 points that is already focused on and 2 points of improvement opportunities. Modular, high customer freedom, standardize (improve), focus on ventilation (improve).

Conclusion: the network shifts towards modular the most. Then also to customer freedom. These two nodes are the most important. Information missing: not known how much ventilation is required. This is dependent on size. Missing information: the business strategy of VKI.

Requirement: Modularity and customer freedom have a direct relationship. If the box is modular, the customer freedom gets limited, but can still be quite high. The box can be easily changed in terms of size and dependent on the different modules in accessories, materials etc. But, these two keywords also have an effect on the possibility of standardization. Because of the different modules, which are parts that are pre-configured, the box can be adjusted to preferences, within the designed modules. Or, new modules can be designed if demanded. But, the more customer freedom, the less standardization. So, VKI has to decide what is more important to them and their company. For example, VKI could also focus on modular and customer freedom which will affect the standardization. So, with the business strategy of VKI, it can be determined which point is more important and what requirements is retrieved from this focus.

For example, if VKI wants to standardize, a requirements should be made that is about the customer freedom, not about the standardization itself:
Final requirement: The box should be modular and provide for customer freedom.
The degree of freedom is dependent on the business strategy that VKI is currently applying. The effect of this means that the standardization is dependent on the 'amount' of freedom.

Set 2: The current situation of box 2, with conclusions of the FMEA. 2 points that is already focused on and 2 points of improvement opportunities. Not modular, high customer freedom, focus on ventilation (improve), focus on silencing (improve).

Conclusions: Almost equal attraction to not modular and complete customer freedom. Information missing: one directed edge between silencing and ventilation. The ventilation should not make too much noise, but how much noise is too much? Furthermore, how silent should the box be?

Requirement: At VKI, the choice have been made that the box should be modular. Furthermore, this is also the main result from the web, what can be seen in set 1 as well. Of course, no borders should be placed yet but to create effective requirements, the modularity should be taken into account. High customer freedom and non modular are again the most important key points, just like set 1. But, in this case, it is not modular. This means that the customer decides everything. Frtuehrmore, this causes that for every new box (for each customer) the ventilation and sound proofing should be determined again. So, due to high customer freedom, there is less grip on the ventilation and sound proofing. Therefore, to retrieve a bit more grip on sound proofing, the following requirement can be created: The choices that the customer can make in terms of product features and attributes, are limited in such a way that the box can still be modular and comply to specified ventilation and sound reduction requirements.

Exception: the author has seen within VKI that customers are king. VKI creates a lot of custom products and there could be a situation where a custom box will be designed. This causes again less grip on the requirements about ventilation and sound proofing, which is not necessarily a bad thing, but VKI should be aware of this.

Set 3: These are preliminary requirements of the owner of VKI, who is involved in the project. He wants to put extra focus to the ventilation and modularity of the box and wants to reuse the old material that they use for the current designs. Modular, focus on ventilation, old material.

Conclusions: modular is most important since the network pulls the most towards this node. No direct edge between any of the points.

Requirement: This sets resembles set 1 and 2 as well, only without the customer freedom. Here, again, modularity is most important. Next to this, no specific requirement pops up. Here, mainly single requirements for the box can be found, with no connecting relationships. The only relationship found is between the ventilation and modularity. Here, the priority of key points are key: The amount of ventilation required is dependent on the size of the modules of the box. Or, the modules may not be bigger than that the ventilation can handle. In this case, it is known that modularity is priority number one, since this is the only initial requirement of the project. Therefore, the following requirement is found:
The ventilation should ventilate so much m2 per hour for good air quality, dependent on the size of the box.

Set 4: material, focus on silencing, price
Conclusions: The whole network pulls towards price. This makes sense because it is the biggest node in the network looking at paths going through this node. The same information as at set 2 is missing; how silent should the box be? So if there is a focus on silencing, this should be determined first. But, if silencing is not that important, this will just become an effect of the material choice. Also, if the silencing will become a focus, it should be determined how much this added value is worth; it can be a characteristic that differentiates the product from competition and that can also be shown in the price, but how much can that difference be?

Requirement: 2 clear requirements can be formulated: The box should mute outside noise for at least x dB and should mute inside noise at least y dB. Or: The price of the box should not exceed € X. The latter requirement has an effect on the maximum result of the sound proofing. If there is a requirement that determines which type of material should be used, it will create less grip on the sound proofing and price. So again, the focus determines the amount of grip on certain key points. One thing that is known, is that these requirements should state that it should be at least performing as well as Box 1 and Box 2.

Set 5: modular, price, standardize, focus on production
Conclusion: The network pulls most to price which again makes sense because it is the biggest node. Without price, because this is logical and predictable, the network pulls towards standardization and a bit towards modularity.

Requirement: standardization and production have a direct relationship. By standardizing the design, the product will be easier to produce, due the standard parts. This could be an effect that is reached later in the process, because first the production process should be learned, but by standardizing, it can be made more efficient and faster, and eventually easier. Next to this relationship, modularity and standardization have a direct relationship as well (as mentioned above). By making the product modular, it is automatically standardized, without loosing too much customer freedom. These three key points have a combined effect on price: by standardizing the product, the cost price is reduced and a modular product increases this. But, the main key point in this set is standarizing, which formulates the following requirement:
The modules of the box should be standardized as much as possible. Preferably that many different modules can be made with the same base components.

No other requirements can be created out of this set, because they are almost all direct effects of standardization. Only if the price may be high, the standardization becomes less important. In that case, this requirements could be turned into a wish.

Set 6: competition, accessories, silencing.
Conclusion: The network pulls towards both accessories and silencing. Here the competition is the connecting node to accessories and silencing, since they are not directly connected. This means that it is not important to focus on the competition but one of these components. This will influence the competitive advantage of the box. Accessories and silencing pull both evenly strong, so choosing one means directly a lot less focus for the other one. Missing information: It is not known how important both accessories and silencing is to differentiate from competition. This is more dependent on the customer and their requirements, which is not completely dependent on the target group. This is because different customers within the same target group may have different expectations and desires. Here VKI has the freedom to choose what they want to focus on and how they can make money with it.

Requirement: Both accessories and sound proofing have effect on the competition. These key points will make them stand out above the other available boxes. Accessories are important to take into account at the modularity key point. The accessories should fit into the modules, or the modules should be designed in such a way that they can be adjusted to fit the accessories. For sound proofing, this is not necessary. The sound proofing performance is more dependent on the construction of the box, the used materials and the ventilation used. Or, these parts are all dependent on the desired performance of sound proofing (if sound proofing is of higher priority). Therefore, two requirements can be created, of which one is already mentioned before:
The modules should be designed in such a way, that if new, extra modules are developed later on, as little as possible components in modules should be replaced to be able to add the extra module.

The box should mute ouside noise for at least x dB and should mute inside noise at least y dB.

Set 7: PSS, price, customer freedom.
Conclusion: price is most important. PSS is also a bit more important than customer freedom. Probably because the PSS determines the amount of customer freedom, but customer freedom does not precisely determine the type of PSS.

Requirement: This set also resembles the above discussed sets. Here, price is again the most important node. Next to price, PSS is also important. This is logical because a PSS can enable a low sales price (price that the customer pays), but this could mean a higher cost price for VKI. Customer freedom is less important. But, by using the PSS strategy, the customer freedom can be increased. The customer can easily switch to different boxes dependent on their situation and which size fits them the best at that moment. Due to the PSS strategy, the customer can change their subscription any minute. A requirements that can be formulated out of this:
If a low selling price is desired, the box should be designed in such a way that it should enable a use or result oriented PSS.

This requirement is dependent on the strategy at VKI. Where do they want to go? Do they want to enable everyone to have a silence box or do they want to create a luxury product?

Set 8: PSS, circularity, standardize, price.
Conclusion: When price is included, price is the most important node. But if not, standardization and PSS are equally drawing nodes towards them.

Requirement: Here, a price requirements can be created: The box should not cost more than €x for the customer. This affects the amount of focus on other key points and what is possible with this focus. The PSS strategy is an enabler in this case: by utilizing the PSS strategy, the price for the customer is decreased and eventually long term, also for VKI. A PSS is also an enabler of circularity, because the products stay in ownership of VKI (in most of the PSS types). Therefore, it comes back to VKI, which enables VKI to close the loop. Furthermore, a PSS encourages standardization as well. Because of standardization, it is easier to produce parts, but also to replace or repair broken parts. Furthermore, the parts are applicable to more customers and different boxes, enabling reuse of parts. So the following requirement is formulated:

The box should be designed in such a way that it can be used for a use or result oriented PSS. This means that the product should be:
- Robust
- Rigid
- Mobile (through disassembly)
- Easy to disassemble
- Easy to assemble
- Have a life time for at least x years
- Easy to clean

This is partially summarized by the requirement that the box should be modular. Because, in that case it is important that it should be easy to assemble and disassemble to enable modularity and male changes easier. Easy to clean is anyway important. Also, because of easy assembly and disassembly, the box is more mobile than creating a room, which is the key point for these boxes for selling.

Next to this requirement, two other requirements for material and production can be created:
The material should have a life time of x years to enable reuse of the box.
The production method should enable modules to be easily assembled and disassembled for relocation, reuse and recycling (focus on circularity).

Set 9: customer freedom, norms, sustainability, modular
Conclusion: Modular and sustainability are the most important node and are equally important. But in this set the customer freedom and norms are not that important. Missing information: it is not know which norms are important. There are many norms for sustainability but which are interesting for the customer and thus for VKI and what will be the requirements for the box when these are determined.

Requirement: Modularity is important to VKI, but according to this set sustainability is just as important. Making the product modular helps with increasing its sustainability: more parts can be reused when a different configuration is desired. Less parts needs to be replaced. Norms could be applied, but it is unknown which norms exactly, especially because no silence box specific norms have been created (yet). Requirements that can be retrieved out of this set are:
The box should be modular.
The box should be able to be assembled and disassembled x amount of times before it breaks.
The box should have a lower carbon footprint than Box 1 and Box 2.

Set 10: assembly, modularity, liability, size.
Conclusion: modular is the most important node. Missing information: regarding the choice of who is going to assemble the product and the liability. Who will be liable for the damage that can occur if something goes wrong if VKI does not assemble the box themselves. Ikea is a good example, but this should be further investigated if VKI wants the customer to build their own box.

Requirement: Next to the importance of modularity, assembly is important as well, since the web pulls towards that node the most. Therefore the following requirements can be formulated:
Components should be able to be carried with maximum 2 persons.
The box may not exceed a weight of x kg.
The smallest sized box should at least accommodate one person.
It should be possible to assemble the box with 2 persons.
In this set, the ease of built for the mechanics can be involved: The box should fit on a rolling container, for higher mobility when disassembled.

Set 11: VKI freedom, customer freedom, target group.
Conclusion: customer freedom is most important and after that the target group. VKI freedom is less important. Missing information: definition of the target group. This is not done because of keeping a higher freedom for the design and for VKI. But by not determining the target group, it is hard to define which customer freedom is desired. But, this can also be shifted the other way around. The customer freedom that is available will eventually determine the target group. The group with the desire for the most customer freedom will seek for the product with the most freedom. It is some kind of filter for the target group. To determine the customer freedom, VKI needs to decide how much freedom they want themselves and how much freedom they want to give to the customer. The logical step would be to determine the freedom according to the business strategy VKI is currently applying, to make sure that this product family will fit into their business strategy.

Requirement: it is hard to formulate this into a requirement:
The customer freedom available in the silence box should be aligned with the business strategy.

In this case, the business strategy of VKI will determine the requirement.

Set 12: packaging, shipment, price.
Conclusion: obviously price is most important. Then shipment. Missing information: Dependent on the shipment the packaging will be determined. Because when it is send by mail and not transported by VKI, it probably needs more protection. This will also have effect on the construction. Because, if the product is transported and thus assembled by VKI, the packaging is less important. Price is also influenced by the amount of packaging. Here, VKI can also decide based on their business strategy if they want to deliver their product and assemble themselves or not. Of course, the liability is an important aspect in this case as well, as mentioned before. So, to make handling and shipping easier, the following requirements are determined:
The box should fit on a rolling container, for higher mobility when disassembled.

All pre-assembled components should fit in a standard elevator.

Set 13: ventilation, norms, allergies, fire security.
Conclusion: Here the network pulls towards norms and fire security. Missing information: For fire security and ventilation it should be researched which norms apply (same as set 9). But, by the experience of VKI currently, with box type 1 and 2, customers have asked about these points:
- Origin of materials
- Fire rating of the materials
- Ergonomic sound product (arboportaal punten)

Requirement:
The ventilation should ventilate x m2 per hour for good air quality dependent on the size of the box.

6. CONCEPTS

During research, some brainstorming or ideas have been thought of. Furthermore, in the end of the research phase, a common brainstorm session with fellow Industrial Design students and a mechanic has been done. Lastly, two other techniques have been used to brainstorm for new ideas:

- Morphological diagram
- Mood board (Pinterest)

During these brainstorm sessions, only the constraint of modularity is taken into account. Of course, it is important in the brainstorm to have no constraints in order to prevent tunnel vision. But, in this case, the requirements of modular is very important. Therefore, this is the first filter after the first ideas, since ideas that cannot be turned into a modular system or that are not convenient to make modular are not interesting. Then the ideas are turned into concepts. The purpose of these concepts is to find the underlying and personal strategy of some of the employees of VKI. The final outcomes are the following concepts:

THE GREEN BOX

This concept is designed with the focus on sustainability, so several choices have been made because it is the most or more sustainable option. To start with the base, the construction is constructed with some kind of inset caps with legs (see Figure 40). These inset caps have legs smaller than the tubes used for construction, so these construction tubes fit over the legs of the inset caps. These corner pieces and connecting pieces can be used to create a cubicle frame and is modular by adding other corner and connecting pieces plus connecting tubes. Then, walls are created with complete glass or wooden panes (or any material suitable). These are put together with a top beam and a U-shaped buckling frame to keep the wood or glass in place. Here, a corner profile buckling frame (2x L-shaped) and a regular tube buckling frame are used to caulk the glass between. The corner profile is welded to the top beam, where the glass is caulked onto. The corner profile is welded and grinded. Then, the tube buckling frame is caulked into place. This buckling frame is also welded and grinded. There will be top and bottom modules, just like Box 1.
So, 3 inset caps will form one pillar with 2 different sized tubes. Therefore, many different configuration options are possible, like in Figure 40. For the inside, sustainable materials are used such as felt from IDID, which is felt created of old uniforms of defense, or uniforms of IKEA. This felt will be mounted with magnets, which are fixed to folded cut-outs of the tube buckling frame. Furthermore, accessories are made from old supermarket shelfs. The small shelf for a 1 x 1 configuration can be made from an actual shelf and other accessories use parts of these shelfs. Due to this fact, shelfs can determine the actual size of the box to make sure it fits. Lastly, the product is turned into a PSS. Therefore, everything is as much as interchangeable as possible. Modules are replaced per module to make it easier and faster. But, hereby the requirement of fitting in an elevator and minimize weight is more important. An important feature that can be added is a green wall, which is used for ventilation. Here, from the bottom air is 'sucked' in and flowing past the plants to the other, higher ventilation port where the air can flow in the box. So, there is passive incoming air but active outgoing air. By sucking air out at the top with a ventilator, the natural occurrence of air flow due to a low air pressure is achieved, sucking in new, fresh air.

Option: not welding the buckling frames and make both U-shaped. The top beam will have a slit in which the glass slides in.

Strategy:

- Number one focus is sustainability
- Ventilation principle
- Circularity
- Ease of built
- Lifetime
- Standard

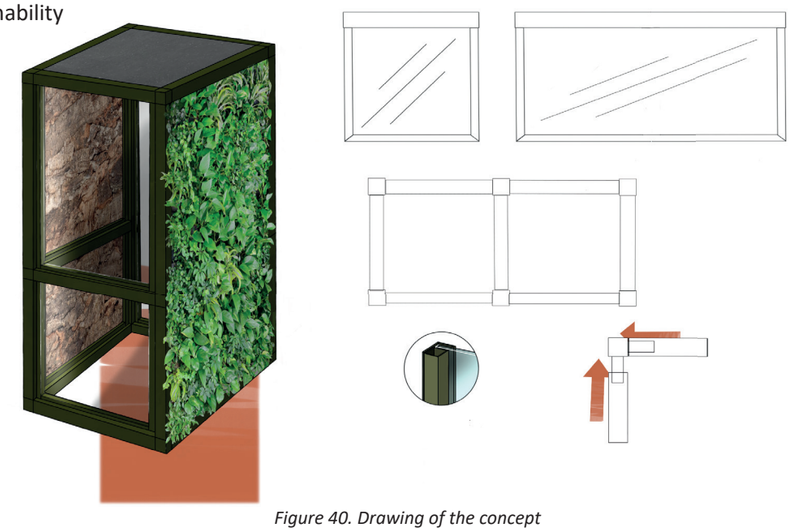


Figure 40. Drawing of the concept

MULTIBOX

The base of this box are perfotubes. These tubes have a hole pattern over all 4 sides of the tube. These holes are used to hang beams into at the bottom, middle and top with the use of hooks the end of the beams. The bottom and top beam look the same, only the hooks or the profile is mounted exactly the other way around. The profile is U-shaped dependent on the required size of the tube that is used to mound the profile on. This profile is welded on and grinded flat. But, the grind does not need to be too nice; it won't be visible. The middle beam will have the same hooks to mount the beams but has a different, flat profile (see Figure 41). This is because another tube will be placed on the other side to 'trap' the wood or glass. This tube is rectangular and will first be pushed into one side of the perfotube pillar. Then, it can be slid into the pillar on the other side. It is important that the side without a tab is slid in first because it is necessary to slide it in a bit further than it is supposed to be when the part is in place. Then, the side with the tab, there is a hole in the tab and a small hole the tube (next to all the other holes). Here, using the other holes in the perfotube, a bolt can be inserted in the small hole and screwed into the tab, which has a welded on blind rivet nut. This could be done with a regular rivet, but to keep ease of disassembly that is not the best option. For looks, cover profiles to cover the perfotube holes can be used on the inside and outside. These can just be hooked in place. For the sides with wood, these are not needed because foam will be placed on top of the wood and will cover the holes. However, these holes can also stay open because they enable accessories to be hung onto. Also, at least some of the holes have to stay open at the outside and inside to ventilate. The holes for air flow coming in are on the bottom, and at the top for air flow going outside. The tube with the holes for outside going airflow will have ventilators to suck the air out of the box. Therefore, the same ventilation principle as the green box is used. Furthermore, due to the fact of the perfotube, creating many opportunities to add accessories and other modules to the box, the box has many more function aside being a meeting and working space. For example:

- Place to relax by hanging a hammock
- A booster by adding biodynamic lights
- Small canteen, like a place to relax by adding a small coffee corner
- Silent disco to celebrate good deals or to get out of your creative block by adding silent disco headphones
- Greenhouse by adding greenwalls and the right lighting. This greenwall is also an advantage by creating cleaner air
- Small gallery by hanging up art or even a shop for the art
- Tiny outside office (quite important to make sure it is watertight)
- Small warehouse by adding more shelves in the perfotube
- Energy generating by adding a cycle or something that people have to drive themselves to generate energy
- Recording room or music room. In the corners small speakers can be added
- Wardrobe by adding hooks to the perfotube or even tubes from left to right with hangars or hooks to hang coats onto

Strategy

- Ease of built
- Customer freedom
- Standard
- Ease of production
- Competition
- Modular

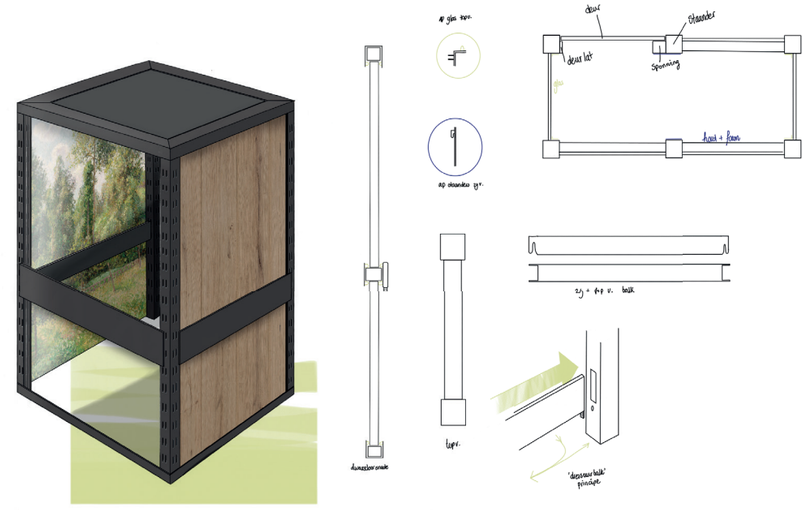


Figure 41. Drawing of the concept

FLATPACK BOX

This concept is based on the internally researched flatpack snap system at VKI. These can be inserted in wood at both sides which enables mounting these parts together on site, instead of gluing them together at pre-assembly. But, because of the novelty of these connectors, other connectors that are somewhat simpler can be used as well, which also don't require any preassembly (except for the connector itself). So, 3 types of wood panels are connected to wood pillars. One type of wood panel curves around the corner at one side, the other side is straight. Another panel is completely straight, and the last one is completely bend (see Figure 42). These three types enable the flatpacker to be modular. With these different segments, different widths and lengths can be created. These segments are wrapped around and at the outside of the pillars. These pillars are connected with each other with a bottom beam and a top beam using a triangular shaped tongue which is inserted in the pillars groove, which can be seen in Figure 42. On the completely wooden panels, PET felt or other acoustic material can be inserted with magnet. These magnets are drilled into the wood panel and glued into the cavity, being flush with the wooden panels' surface. The acoustic material, the magnet is glued into. For the panel with glass, the glass is glued in between two wooden panels. At the edges some material is milled away to create space for the glass. This is done on both sides. These parts are glued together or can be nailed together. Preferably it is nailed, which is easier. Furthermore, if these nails are at the very side of the panel, it will be hidden behind the pillar. At both cases caulk is used to ensure that the glass is stuck. This panel is preassembled (panel + glass). The milled out grooves play a big role in enabling this. Because of these grooves, the panels and glass can only be stuck together in one way (with some common sense). Lastly, the roof is created out of 3 different panels to fit any type of box. Here, one panel has no rounded corners, one has two rounded corners and the last one has one round corner. These all have grooves as well ,which can be seen in Figure 42. With these grooves, the roof enables extra strength and rigidity by laying these grooves over the outside panels. Furthermore, it creates a sleek look to the box without any seams. The door is quite easy to add, since the hinges can be screwed into the already existing pillar. Then, the rebate can be drilled into place as well, which will have a draught profile and a magnet or a regular door closing mechanism.

Strategy:

- Competition
- Ease of built
- Price
- Standard

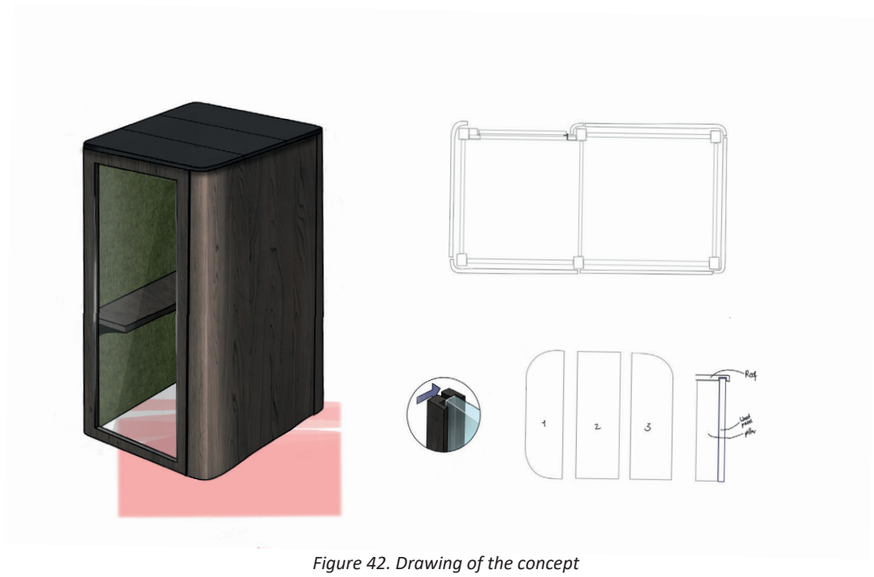


Figure 42. Drawing of the concept

MORPHOLOGICAL DIAGRAM

Table 6. Morphological diagram of a brainstorm session

Subfunction	Solution						
Structure	Clicking system (flat pack) wood	Ears, wood & metal	Hooks, wood & metal	Welding, metal	Glue, wood		
Adjust light brightness/ventilation speed	Turning knob	Buttons for different settings	Touch screen	Sliding switch			
Turn on light/ventilation	Turning knob	Button(s)	Touch screen	Sliding switch	Regular switch		
Ventilation principle	Active Naturally (bottom → top)	Passive Naturally	Active top → top	Passive top → top			
Closing principle door	Turning (90 deg)	Sliding	Folding	Folding + sliding			
Closing mechanism door	Regular door handle	Hook that falls in place after the door is in closing place	Magnet	Push to open/close	Electronic sensor + motor	Snappers	Rolling closure
Levelling	Feet	Rubber underneath	Floor that ensures 90 degrees angles				
Charging devices	Wireless (visible or invisible)	Plug	Charging cable included	USB-A USB-C ports			

7. RADAR PLOT

All the main nodes of the web will be used as decision making criteria for the concept choice. In this way, a less subjective choice of which concept is the best concept to further develop. The nodes in the web are used because the nodes can be focused on in the design strategy. For example, if there is more focus on circularity, probably the concept with the best score on circularity will be chosen. The radar plot is a tool to map out strong and weak points to finally come to an as objective as possible concept choice. To be able to asses every concept in the same way for each node, relative or quantitative measures can be used, and some of the nodes are combined because of their direct relations, which will be all explained underneath.

Sustainability: By the use of a quick LCA, the sustainability is assessed based on the expected carbon footprint of the new concepts, benchmarked to the old types. Here, materials have effect on this as well. If it is not important to determine these materials, the footprints of the old materials are used. The expected lifetime of the box will play a role in this too, using the functional unit. In this project, this was not possible due to time constraints. This is estimated.

Modular: This key point is measured on how well the concept comply to the following requirements:

- The modules should be designed in such a way that if new, extra modules are developed later on, as little as possible components in modules should be replaced to be able to add the extra module or accessories.
- The box should be easy to assemble and disassemble.
- Components should be able to be carried with maximum 2 persons.
- It should be possible to assemble the box with 2 persons.

The existing boxes (Box 1, 2 and 3) could be assessed based on the field research. The concepts were estimated by the author.

Ventilation: This factor is dependent on whether the concepts will use the same ventilation or not. If the same ventilation unit is used/determined for all concepts only the size of the box will influence the performance. But, also the ventilation principle plays a role in this. When these 2 factors (box size and ventilation principle) are different, it may be necessary that a different ventilation unit should be applied. These factors can all be measured in the ventilation requirement: the ventilation should ventilate 'so much' m2 per hour for good air quality dependent on the size of the box. The CO_2 concentration may not exceed 1000 PPM. Here the size is the dependent factor that will determine how much m2 will be needed to be ventilated. In the current designs of the boxes, the same ventilation systems are used, so dependent on size, the quality of ventilation is the same. For the new designs this is a difficult aspect to measure and will be based on ventilation principle and overall design.

Silencing: How well the box will dampen the noise from inside and outside is dependent on the materials and the construction. This is hard to measure without a prototype, but some materials will silence more than others. This is dependent on the surface of the material and its density. So, this factor will be based on the proposed materials. But, this factor is only useful if specific materials are assigned to the concept. This will be benchmarked to the best concept, which will be a 100%. Everything as good as or underneath will be relative to that best performing concept in this key point. For Box 1 and 2 these numbers were known at the time of creating the radar plot. For Box 3 and the concepts, this was not known, but estimated on overall concept. For example, the Greenbox will probably dampen more noise than the Multibox, because of the greenwall and the holes in the tubes of the Multibox.

Price: Every above mentioned key point is a factor of the price. Therefore it is again hard to measure. But some shapes are just harder to make, cost more time and are more sensitive for errors. Furthermore, the price can also be measured with the amount of standardization that is possible. This also has to do with the amount of customer freedom and the amount of choices they have. But, this will be measured in a separate factor, excluding it from the price. Here is only looked at the amount of standardization and easiness of production relatively to each other and the predecessors. Here, the easiest and most standardized product will be the benchmark for all other concepts and existing boxes. That concept will be a 100%. For Box 1 and , prices were known. For Box 3 and the concepts, this was still unknown and were again estimated.

Customer freedom: The strategy of VKI states customer freedom is more important. That is what makes them and their products unique compared to other interior builders. This key point will be measured with the factors size, accessories, assembly, amount of customer choices and VKI freedom. Of course, the customer and VKI freedom are contradicting to each other. This is also a relative amount which will be compared to each concept and both existing boxes. Here, the concept or box type with the highest amount of each factor will be 100%, making it the benchmark to the others.

Competition: This will point out the potential of the concepts to be better than the existing types. Obviously, this factor will be benchmarked to the existing types. What features make them stand out from all other boxes? How many features make them stand out? How much could these be worth to the customer? This is all compared to each other and currently still subjective. Preferably, this is checked with a customer survey as well.

Norms, allergies, fire resistance: These points can be measured together and are almost all dependent on the material that is chosen. If no material is predetermined, the allergies and fire resistance will be hard or even impossible to determine, but still some norms can be looked at. For example in size; does it comply to the minimum amount of working space for x scenario? Also, wood just burns easier than metal, so a box consisting completely out of wood will have a lower fire resistance that a box made of solely metal.

Circularity: How hard or easy is it to make this concept into a closed loop lifecycle? Is PSS involved or not? This is also dependent on materials, how modular and standard the box is and how much customer freedom is involved. Lastly, also how the product enables for relocation, reuse and recycling.

Ease of build: How easy and fast is it to build up the box? This is determined by the number of parts that have to be assembled on site, and how many parts are already pre-assembled. Next to this, it should be measured with the mechanics. For the concepts and Box 3, this was not possible at the time of this analysis. However, for Box 1 and 2 this is based on the field research done earlier in the project.

A lot of points of measure are points of benchmarking with the current type of boxes. Therefore, this plot will also show if the new redesign are at least as good as their predecessors.

The scores in the radar plot are rated from 1 to 10, with 10 being the best and 1 the worst. For the new designs, these scores are all based on estimation and logic, since nothing is measurable.

Table 7. Scores of the boxes

	Multibox	Greenbox	Flatpacker	Box 1	Box 2	Box 3
Sustainability	10	10	7	9	6	9
Price	5	5	10	6	8	8
Modular	10	7	8	7	1	7
Ventilation	7	7	6	6	5	6
Sound proofing	5	7	6	7	7	7
Customer freedom	8	4	6	7	3	6
Competition	7	7	8	6	5	7
Norms, allergies and fire security	7	6	4	6	6	6
Curcularity	8	9	4	7	4	7
Ease of built	6	7	10	9	4	6
Robustness	6	7	4	10	7	10
Lifespan	10	7	4	9	6	9
Standard	8	9	7	7	10	7
Ease of production	9	7	7	7	8	10

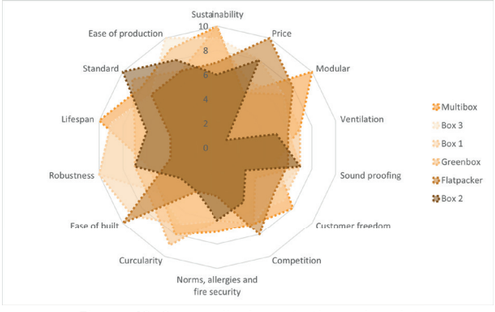


Figure 43. Scores displayes in the radar plot

8.TEST CASES

In this chapter, the personal effects on the three existing boxes have been analyzed.

Project manager x Box 1: This personal strategy could have had an effect on the material chosen, also in combination with focus on standards. But the box is already quite suitable for a PSS and that again is on its turn in relation to sustainability and circularity. The biggest difference will be in the accessories. Those are not in the box now, but applying the personal strategy, they might be. Combined with VKI's strategy and brand identity, this personal strategy could be an addition and this box could be right up VKI's alley. So in this case, it has a positive effect.

Developer x Box 1: This one does not quite match. It does match on modularity and robustness but not on ease of production and ease of construction. Here the focus is precisely on key points that do have a relationship with each other and thus affect each other. For example, looking at ease of production and ease of construction: these are close to each other because they affect each other but depending on the design, they have a positive or negative effect on each other. In this case it will have a negative effect since developer considers production more important. This effect can be seen in the design of Box 3. This is his design and he learned a lot from Box 1. Here, production takes priority over construction, which affects on its turn the price. Furthermore, the underlying focus points only have more positive effect on the quality of the box apart from the ease of construction. All in all, it has a positive effect because the box can become even better and fit better in VKI's line; more quality and ease of production.
Technical drawer x Box 1: Only 2 points of similarity in strategy of the box and the personal strategy and its effects: modularity and lifetime. Here once again, ease of production clashes with ease of construction. But, robustness does result from the key point lifetime, which is a key point of their strategy. But, sustainability is not in here at all. This is where a PSS plays a major role. This could be applied but does not really fit within the current strategy of VKI, or the internal strategy observed in this project. In that perspective it is then a negative result that this personal strategy yields. However, here negative only implies that it does not fit VKI's currently, which does not mean that this is not or cannot become a future step for VKI.

Owner x Box 1: This box does not really fit into Owner's strategy. Especially not when there is looked at what underlying key points the personal strategy has, such as standards, competition and PSS. What's interesting is that he does not necessarily find this an important focus point, according to what he said in his interview. Only competition is important in his eyes. Yet these points draw the most towards his key points. This shows that they are still more important than he thinks and wants. So even with these other points, it will not have a positive effect on the design of the box. However, these personal effects and the key points which they attract have a logical relationship with each other. For example, if Technical drawer focuses on durability, this will change things in material, production and both of these will affect how sound absorbing it is and how easy it is to produce (and so on).

Project manager x Box 2: This box does not fit the project manager's strategy anyway. Thus, a very different type of box could have been designed if it had been for this strategy. Currently, it is known that this box also did not go quite as smoothly as desired, especially looking at aftersales. Here the project manager's personal strategy would be very effective. The aftersales problems would have not happened. Furthermore, it would been made modular (but everyone of the interviewees would have done that) and would have more focus on additional accessories for great customer freedom.

Developer x Box 2: If it is up to the strategy, it will at least be made modular and would look more like Box 3. But that box was designed with his strategy in mind, so that makes sense. His strategy mainly affects the ventilation and the materials, combined with a focus on sound proofing. This will raise the specifications and quality of the box and have a positive effect for the brand identity.

Technical drawer x Box 2: This box does not fit the personal strategy at all. It would have changed it to at least modular, because this is also becoming more important in combination with sustainability and the lifetime. However, the box would have remained standard , especially looking at the sustainability aspect. But here, all standards, but also the PSS, come to the surface. Quality is what VKI stands for, so this new design strategy could fit, but a progressive, sustainable service box is not really part of VKI's image. They are modern but not exactly innovators. Thus, in this perspective, this also has a negative effect.

Owner x Box 2: Here, the same thing going on as with Technical drawer. Only there is deliberately more focus on sound proofing. However, there is no focus on sustainability but rather on service (PSS). Thus, if this strategy is applied to the box, it would not fit the VKI.

Project manager x Box 3: With this strategy, the box would look more like Box 1. No ease of production, but ease of construction. Doing everything as much as possible in-house (at the production facility), so less should be done on site. Also, this strategy will effect again the materials, in combination with sustainability and norms. However, this will also have a positive effect on freedom within VKI. This box will fit less into the strategy of VKI because so it has less ease of production, but it is modular and has a high level of customer freedom. Especially the part of PSS and sustainability is not part of the strategy and identity now, but does not exclude that it does not fit. However, for now this means that this personal strategy has a negative effect.

Developer x Box 3: This one is tricky. The developer designed this box so he naturally applied his personal strategy with some other requirements. What can be seen is that this box has not yet been developed further and thus lacks further development of sound proofing and ventilation. However, overall this is a positive addition to the portfolio of VKI.

Technical planner x Box 3: basically the same story as the previous two boxes. The technical drawer is more forward-thinking than the design can currently facilitate. Many adjustments have to be made to apply the strategy's key points which therefore do not really fit into the brand identity.

Owner x Box 3: Just like with the technical drawer and previous designs, the same story applies. Actually this personal strategy is too innovative for VKI's current strategy. So, it does not fit with VKI's current product portfolio and brand identity.